



Jinan, CHINA

Bangalore, INDIA

Bangkok, THAILAND

Jakarta, INDONESIA

CDM VIABILITY OF CURB-AIR CASES

Four Asian Projects Evaluated

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Abbreviations

ACM	Approved Consolidated Methodologies
AMS	Approved Small Scale Methodology
BGPG	Biomass Gasification for Power Generation
BMA	Bangkok Metropolitan Administration
BMTA	Bangkok Mass Transit Authority
BRT	Bus Rapid Transit
CDM-POA	Clean Development Mechanism – Programme of Activities
CER	Certified Emission Reduction
CH ₄	Methane
CHP	Combined Heat & Power System
CNG	Compressed Natural Gas
CO ₂	Carbon Dioxide
COPERT	Computer Programme to calculate Emission from Road Transport
DLT	Department of Land and Transport
DNA	Designated National Authority
EF	Emission Factor
ER	Emission Reductions
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
GJ	Giga-Joule
GVW	Gross Vehicle Weight
GWh	Giga Watt Hours
Ha	Hectare
IEA	International Energy Agency

IEE	Intelligent Energy Europe
IPCC	Intergovernmental Panel on Climate change
IRR	Internal Rate of Return
ISO	International Organization for Standardization
ITS	Intelligent Transportation System
KSRTC	Karnataka State Road Transport Corporation
KWh	Kilowatt Hours
LNG	Liquefied Natural Gas
LRTAP	Long Range Transboundary Air Pollution
MOTC	Ministry of Transport and Communications
MW	Mega-Watt
MWh	Mega Watt-hours
NM	New Methodology
NMT	Non-motorized Transport
NMVOC	Non-Methane Volatile Organic Compound
NO _x	Nitrogen Oxide
O&M	Operation & Maintenance
O ₃	Ozone
OM & BM	Operation & Built Margin
OTP	Office of Transport Policy Plans
PCI	Pacific Consultants International Co. Ltd.
PCU	Passenger Car Unit
PDD	Project Design Development
PIN	Project Idea Note
PV	Photo-Voltaic
R&D	Research & Development
RMB	Chinese currency in Hong Kong
SO ₂	Sulphur Dioxide
TPM	Total Particular Matter

UNFCCC	United Nations Framework Conventions on Climate Change
USD	United States Dollar
VOC	Volatile Organic Compound
YOLL	Years of Life Lost

1. Introduction to the Four Asian Projects

Air pollution comes from various sources - stationary sources such as factories, power plants, etc; mobile sources like cars, buses, planes, trucks and trains and natural sources such as wildfires, windblown dust and volcanic eruptions. The CURB-AIR project focuses on the opportunities that carbon finance may provide for improving air quality from various sources in the developing countries. The four Asian cities involved in the CURB-AIR project are all rapidly growing urban centres, experiencing different levels of air pollution:

- Bangalore (India)
- Bangkok (Thailand)
- Jakarta (Indonesia)
- Jinan (China)

Air pollution has a range of negative effects on human health, which also affects the economic activity of the cities. The government officials in these cities are taking up projects aiming to reduce the concentration of air pollutants in these cities as well as help in improving the health of the people (Schwela and Haq, 2008 – A Review of Air Pollution Policies in Four Asian Cities). It is interesting to see that although some of the cities' general air pollution levels might be low, levels of particular individual pollutants such as particle matter or nitrogen oxides are quite high and therefore causes severe health problems. Cities like Jinan have always faced the problem of high SO₂ emissions by local coal-fired boilers as well as high particulate matter (PM) in the air caused by open burning of biomass, while in Bangkok and Jakarta the transport sector was identified to be the main source of PM due to poorly implemented regulation and the city of Bangalore faces the problem of poor air quality due to industrial activities, vehicles and stationary engines and refuse burning.

Thus, it is clear that making a comparison between different cities and their levels of air pollution and the health hazard can be extremely hard. A common source of emission of local air pollutants as well as greenhouse gases (GHGs) is the combustion of fossil fuels; therefore, policies can be designed in a manner that contributes in combating both deteriorating air quality as well as climate change mitigation. For developing countries, the Clean Development Mechanisms (CDM) was designed under the Kyoto Protocol, where countries can attract finance and technology by implementing projects that reduce GHG emissions.

The main focus of the CURB-AIR project, CDM and urban air pollution: partnerships enhancing synergies in urban air and health in Kyoto mechanisms (CURB-AIR), is to utilize CDM for improving the air quality of the Asian cities.

In the framework of the CURB-AIR project, a case study for each of the four Asian cities was identified and developed; these four projects represent promising opportunities for measures that improve air quality and can potentially be developed as a CDM project. Also these may be replicated in their respective countries or around the world for reduction of air pollutant and greenhouse gas emissions. In this respect, the following options were identified in consultation with local policymakers & stakeholders details of these projects are given in Annex I).

➤ **Bus rapid transit (BRT) systems in Jakarta and Bangkok**

The BRT, a bus-based mass transit system, delivers fast, comfortable, and cost effective urban mobility and can also 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 organization dispatching vehicles.
- Potentially a fuel switch to low carbon fuels.

BRT systems can 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.

➤ **For Bangalore, use of Ethanol/diesel blend in bus fleet**

The ethanol-diesel blend has a composition of 7.7% ethanol from molasses, 91.8% petro-diesel and 0.5% of a proprietary additive to provide a technical and commercially viable clear homogenous and stable fuel that can be utilized in unmodified engines and existing fuel delivery infrastructure. The blending of ethanol and diesel is done onsite with computerized state of art dosing equipment. The fuel is used in the bus fleet of Karnataka, South-India.

➤ **Biomass gasification for power generation project in Jinan**

The biomass gasification for power generation (BGPG) project is a biomass utilization 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 bundled by five times into a small-scale CDM project.

The key requirements for a CDM project to be approved are utilisation of an approved baseline and monitoring methodology, proving additionality and contributing to the sustainable development in the host country. In view of this, this report aims to evaluate the viability of these case studies in the respective cities in meeting their baseline methodologies, sustainable development and additionality criteria under the CDM process.

The report follows a structure where section 2 describes the baseline and monitoring aspects of the case studies; section 3 analyses the additionality of the projects after being taken up as CDM projects with respect to the baseline in the cities. Section 4 details out the long term effects of the projects in meeting the national development goals; section 5 gives an overview of the air quality scenario of the four Asian cities before and after the implementation of the project. Finally, section 6 gives the overview on the CDM viability of the case projects in the four Asian cities based on the previous sections. Please see the CURB-AIR website [www.curb-air.org (2007)] for a more detailed discussion on the links and opportunities.

2. Baseline Methodologies of the Projects

A critical element of the CDM is that a project should lead to *real and measurable* emission reductions. In order to determine how much GHG emission reductions the proposed project achieves; it is necessary to know how much emissions there would be without the project: the baseline emissions. This refers to what would have happened if the CDM project would not be implemented (e.g. electricity would be produced by using coal rather than wind energy). Also there are likely to be GHG emissions related to the project itself (Figure 1).

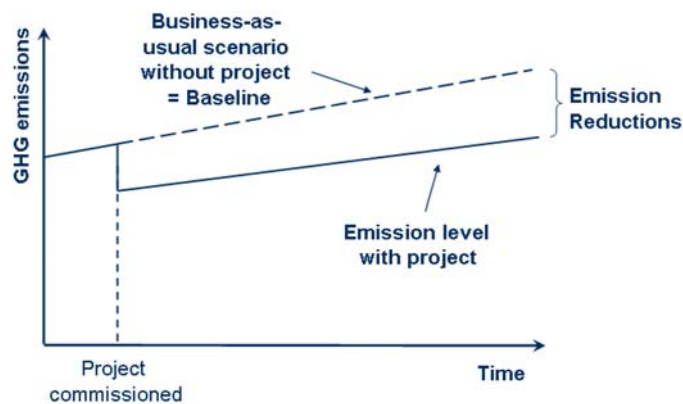


Figure 1: **Baseline scenario and emission reductions of a CDM project**

Source: Tyndall Centre, 2007

For a project to use an approved baseline and monitoring methodology (AM) two routes exist:

- *Use an existing AM:* As of January 2008 more than 60 methodologies covering different project types have been approved for large-scale projects 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 can be found 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 who then approves or rejects 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.

This section of the report gives an overview of the key issues in the baseline and monitoring methodologies of the four case studies identified in the CURB-AIR project, specifically for the Bangkok BRT case, Annex I provide a more detailed analysis.

Bangalore case study

The biofuel methodologies approved for the transport sector till date are:

- AMS – IIIT (Plant oil production and use for transport applications); and
- AM0047 (Production of biodiesel based on waste oils and/or waste fats from biogenic origin for use as fuel --- Version 2), which can be used as examples.

These two methodologies can be used as examples however they cannot be used for the KSRTC¹'s ethanol-diesel project because both methodologies used are either based on plant oil or waste cooking oil which does not account for the necessary emission factor, leakage, etc. required for use of ethanol-diesel blend.

Applicability

The fuel mix developed for the purpose of emission reduction follows the necessary conditions:

- 1) Feedstock inputs: For this methodology, ethanol is defined as the fermentation product of the molasses, the by-product of the sugarcane industry.
- 2) Product outputs:
 - a. The petrodiesel and the ethanol are comply with the national regulation and international standards, but there is no national regulations and international standards formulated for the blend of ethanol and petrodiesel
 - b. The by-product, dried distillers' grains and solubles (DDGS), is being used as animal feed.
- 3) Consumption of ethanol-diesel blend:
 - a. The ethanol-diesel blend is supplied to consumers within the country whose existing stationary installations or vehicles, that actually combust the blend, are included in the project boundary.
 - b. The consumer of ethanol-diesel blend in the transport sector is a captive fleet.

¹ Karnataka State Road Transport Corporation, the project developer

- c. No major modifications in the consumer stationary installations or in the vehicles engines are necessary to consume/combust the ethanol-diesel blend. In case of stationary installations, the blending fraction can have any value between 0 and 100%. In case of vehicles use, the blending proportion must be low enough to ensure that the technical performance characteristics of the ethanol-diesel blend do not differ significantly from those of pure petrodiesel. The maximum allowable blending proportion is 7.7% by volume.
- 4) Activities for which CERs are claimed:
- a. Project participants claim CERs only for the CO₂ emissions from petrodiesel being displaced by the ethanol-diesel.
 - b. Project participants do not claim CERs for the following: (i) Reductions in life-cycle emissions associated with the production of displaced petrodiesel; (ii) Biodiesel consumed for non-energy purposes; (iii) Utilization of by-products such as DDGS.

Baseline and methodology

The baseline scenario has to be determined for the following element in the context of project activity: What would happen on the project activity level? And what would happen in absence of CDM activity? The credible alternatives in accordance with legal and regulatory requirement at project activity level may include:

- Continuation of current practices with no investment in ethanol-diesel blend production capacity
- Continuation of petro-diesel consumption
- Project activity implemented without CDM revenues
- Investments in developing capacity for production of alternate fuels like CNG, LPG, biodiesel, etc. for consumption of a mix of above alternative fuels

Continuation of petrodiesel consumption: Total petrodiesel consumption in India in 2006-07 was 52.33 million tonnes and this is likely to grow even in the coming future. Current production of ethanol in India is around 11.36 million litres annually, which is only 37% of the total production capacity. Based on these figures, it can be concluded said that there will be enough ethanol in the Indian market for use as fuel in the ethanol-diesel blend. In spite of the abundance of ethanol in the country, the mandatory regulation of blending ethanol with petrol is yet to be implemented. So, we can say that without the CDM activity, the blending of ethanol with diesel is unlikely to take off and the baseline scenario will continue with petrodiesel.

Project activity implemented without CDM revenues: The project activity might encounter the following barriers if implemented without CDM revenues:

- i. There are no appropriate technological standards being introduced with respect to ethanol, which makes it difficult to reach to the consumers. With the project being registered as CDM activity, the attention of policy makers would result in a policy for ethanol industry.
- ii. Though there has been a lot of research on the field of ethanol, but for commercial purpose all the current demand for ethanol is met through sugarcane production plants in the country.
- iii. Also, the market for ethanol is limited to local distribution, direct sale and purchase.

Investments in developing capacity for production of alternate fuels like CNG, LPG, biodiesel, etc. for consumption of a mix of above alternative fuels: The price of ethanol is marginally lower than that of petro-diesel but with the solublizer cost, labor cost and other handling cost, including installation cost and underground tank, etc., the cost of ethanol diesel blend is marginally more by 5 paisa than petro-diesel and depending on the unpredictable ethanol production of the country and conversion cost, it is likely that the project developer might shift to alternate fuels like the CNG, LNG, etc. or to mix of alternate fuels like ethanol, biodiesel, electricity, hybrid, etc. apart from CNG, LNG as mentioned. But with the limitation of limited supply of raw materials for investing in production of CNG, LNG, etc. and also due to inadequate expertise in such resources with the project developer, it is likely that developer might not invest in alternate fuels.

In absence of CDM activity, the most likely scenario will be the continuation of use of petro-diesel with no investment in ethanol-diesel blend production capacity, which will be our baseline. This is because of high prices of alternative fuel, inadequate technical standards and inaccessibility.

Bangkok case study

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 Narathiwat Road. The project is expected to ease the traffic along this route, particularly the Rama III Road-Narathiwat 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, Thaksin Bridge, and Bangkok Bridge. The traffic along these bridges, measured in terms of passenger car units increased by 20% in December 2005-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 system². The designated BRT buses are also designed to use compressed natural gas (CNG) (instead of clean diesel as originally planned) contributing further to reduced CO₂ (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 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).

² 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.

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 tests of the methodology. 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 subsidized 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 a distinguishing feature 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 criticized 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.

Concluding remarks

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.

Jakarta case study

Based on the transport master plan, Jakarta will develop and establish 15 corridors of bus way until the year 2010, which will be done in 6 phases. The first phase consists of Corridor 1; second phase consists of Corridor 2 and 3, third phase of Corridor 4 to 7, fourth phase of Corridor 8 to 10, fifth phase of Corridor 11 to 13 and the last phase of Corridor 14 and 15. Consistent with the Master plan, up to beginning of 2007 three phases of bus way development have been completed and they are in operation. The road infrastructure of fourth corridor has been started in early 2007 and finalized in end of 2007. However, the development of bus stops and its equipments has just started in early 2008. It is planned that overall development and procurement of the complete bus way system for Corridor 8, 9 and 10 to be finalized later this year.

Route of corridor 11-13 are already planned but no feasibility study has been done yet. Therefore, these three corridors have been proposed to be developed as CDM project. However, the routes of corridor 14-15 are not yet firmly defined; therefore these corridors have not been proposed to be developed as CDM project at this stage.

Based on discussions with the city government, Pelangi as part of CURB-AIR decided to take Corridor 11-13, which was planned to be developed in 2008. Some similarities with Transmilenio and the approval of AM0031 for TransMilenio BRT by the CDM Executive Board are the basic reasons for working on TransJakarta to be a CDM project. The idea was also supported and in line with the Governor's Decree no. 75/2006 on CDM.

AM00031 Baseline Methodology

As TransJakarta Bus way System is very much a mimic of Transmilenio, it is very likely that AM0031 of Transmilenio in Bogotá will be applicable to be used as reference to TransJakarta Bus way System to be implemented as a CDM project. *Table 1* shows the similarity and potential to use AM00031 for TransJakarta.

Table 1: *Applicability of AM00031*

Methodology AM0031	TransJakarta Corridor 11-13
1. The project has a clear plan on how to reduce existing public transport capacities either through scrapping, permit restrictions, economic instruments or other means and replacing them by a BRT system.	1. Plans to <i>scrap</i> existing buses within the same route
2. Local regulations do not constrain the establishment or expansion of a BRT system.	2. The local government owns the proposed project
3. Fuels used in the baseline and/or project case are unblended gasoline, diesel, LNG or CNG. Projects using bio-fuels either in the baseline or project case are not eligible to use this methodology.	3. Fuels used in the baseline are gasoline and diesel. Buses in the proposed project will use CNG
4. The BRT system as well as the baseline public transport system and other public transport options are road-based.	4. The baseline public transport system and the BRT system for the proposed project are road based
5. The BRT system partially or fully replaces a traditional public transport system in a given city. The methodology cannot be used for BRT systems in areas where currently no public transport is available	5. The proposed project partially replaces the traditional buses within the same routes
6. 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	6. In the absence of the proposed project, a continuation of the current public transport system (baseline scenario) are considered as sources of anthropogenic emissions of GHG

greenhouse gases (GHG) that would occur in the absence of the proposed project activity (i.e. the baseline scenario)	
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Based on the comparison above, it is clear that AM00031 can be used for TransJakarta Bus way System Phase V. However, a brief calculation has been conducted to predict the potential emission reduction of these corridors, and as the result, the potential annual GHGs emission reduction is predicted about 20,000 ton CO₂ eq. According to the existing CDM regulation, such CDM activity is usually falling under Small Scale CDM Type III. Therefore, one can consider the option to establish new methodology under Simplified Small Scale Methodology (AMS), as no approved small-scale methodology for BRT exists as of early 2008.

There is no restriction for TransJakarta Bus way Phase V to be developed not as a small scale project; however one has to carefully consider the issue of transaction cost and potential revenue from CDM. Implementation of AM00031 might result in resource-intensive activities both for preparing the PDD as well as in conducting the monitoring in the future.

AM0031 Monitoring Methodology

The AM0031 monitoring methodology requires a number of measures to be implemented. To allow the most accurate calculation, control of passengers in the baseline has to be conducted either electronically or mechanically, while on-board passenger survey has to be conducted in the project to gather data and information of their initial mode of transport (to show the share of mode-shifting to BRT). Monitoring and measurement of fuel consumption is very important to get more accurate share of emission reduction from engine technology and engine efficiency. Leakage is another important aspect in calculating the actual total emission reduction due to the implementation of the project compare to the emission of the baseline.

Type of data to be monitored and its frequency are mentioned in Bangkok case (see Annex I). For the case of TransJakarta Phase V, such data can be obtained from the respective agencies including the traffic office of DKI Jakarta, the statistic agency and the police office of DKI Jakarta, the TransJakarta management and consortium of operators for corridor 11-13 as well as periodic survey.

However, thorough feasibility study will play the most important role to get the accurate data to be served as the baseline and to get detailed plan including management and operation to get the most accurate prediction of the project itself.

Determination of Baseline Emissions

Using AM00031 the baseline emissions consists of emission of CO₂, CH₄ and N₂O from other transport modes previously used by BRT passengers. For this purpose, detail data of type of transport modes including its population, age and fuel type have to be gathered. Further data on average fuel consumption and number of passengers and trip length to be served are also needed to calculate the baseline emission. Emission factor for each GHG, each mode and fuel type need to be measured or otherwise use the IPCC emission factor.

Another important aspect for a CDM project is establishing the project boundary. The project boundary of TransJakarta Busway System Phase V will be the area along the corridors with time boundary from the process of infrastructure development until the operationalization of the corridors. The decision of project boundary will not only affect the emission of the project but also emission of the baseline as well as potential leakage.

Thorough survey and analysis of the baseline condition are essential elements for calculating the baseline emissions. Most of the required data are available but scattered in a number of institutions. Reliable data in relation to the current buses operation along the three corridors would be the most difficult to get due to the undisclosed operational data in most of the existing operators. However, as TransJakarta is DKI Jakarta's program, the traffic office of DKI Jakarta should have clear authority to gather such data from the operators.

Based on limited information, the potential baseline emission on yearly basis is predicted to be around 35,000 ton CO₂-eq/yr.

Calculation of Project Activity Emissions

The calculation of project emission can be done using the total trip length of service, fuel consumption and number of passengers shift from other transport modes. Up to date, detailed feasibility study for Phase V is not yet available. Therefore, it is difficult to calculate the potential emission of the proposed CDM Project. Based on limited information on Phase V planning, annual emission from the project is predicted to be less than 15,000 ton CO₂-eq/yr.

Calculation of Leakage

There are two potential types of leakage, namely negative and positive ones. Negative leakage defined as increased of GHG emission outside the project boundary due to the implementation of the project; while the positive one is decreased GHG emission outside the project boundary due to the implementation of the project. In the case of TransJakarta Busway Phase V, both leakages need to be considered.

Negative leakage will likely happen due to the rerouting of the existing public buses which have partial same route as the respective corridors. Negative leakage might also happen due to rerouting of private motorized vehicles to avoid heavy traffic along the corridors due to the decreasing of number of lanes for private vehicles.

Positive leakage will likely happen due to the increased number of passengers shifting from other transport modes in other corridors connected to the three corridors. Currently, a relatively big portion of DKI Jakarta's population decided to keep using the private vehicle due to the limited network of TransJakarta. Therefore, bettering the network by adding Phase V will encourage them to leave their private vehicles at home and shift to TransJakarta fully.

GHG emission reductions

Based on brief calculation using the currently limited data and information of Phase V and not including the potential leakage, the predicted emission reduction is around 20,000 ton CO₂ equivalent annually. As mentioned previously, the potential reduction is considered to be very small and there is a possibility to have it as a small scale CDM project.

General issues related to methodology

Based on brief calculation, one has to consider the potential cost and potential benefit of having TransJakarta Bus way System Phase V as a CDM Project. There is no restriction to have project with small emission reduction to be developed using AM, however the cost implication to prepare the PDD as well as for conducting validation, registration, verification and monitoring should be considered carefully. As one and the most valid additionality of having Phase V as a CDM project is basically to solve the investment (and financial) barrier, then one has to consider the final result of total cost and total revenue related to its implementation as a CDM project.

One possibility is to develop Phase V as small scale CDM project to reduce the cost related to transaction. Unfortunately, up to date there is no approved simplified small scale methodology for BRT. It means that new methodology has to be submitted and may have to go through a lengthy process as well. One might want to consider a revision of AMS.III.C by adding the fact of having modes shifting and reroute of the current bus operation.

With the current development of the whole TransJakarta Bus way System, it turned out that Phase IV is not yet in operation due to the pending budget from finalizing the infrastructure development, buses purchasing and its operation and management. One can argue the possibility to have Phase IV to be developed as CDM project using investment and financial

analysis as the basis for eligibility. On the other side, the development of Phase V and Phase VI has not been started; even detail feasibility studies for both are not yet final. Taking this fact into consideration, there is a possibility to submit the three phases as programmatic CDM in the urban transport sector instead of applying AM00031. However, there might be another argument especially regarding Phase IV as the infrastructure development is partially done.

Developing TransJakarta Bus way System as programmatic CDM may reduce the transaction cost especially in relation with development of baseline and monitoring methodology. However, as this might be the first programmatic CDM, one has to get prepared with potential of a lengthy process of getting approval of the methodologies.

Recommendations and further action

As can be seen earlier, to allow the implementation of TransJakarta Phase V as a CDM project the most important aspect is to get the right and reliable data for both baseline as well as for the proposed project itself. Without detailed data, it is impossible to prepare PIN (Project Identification Notes) as well as PDD (Project Design Document). Data collection needs to be done through a combination of activities including workshops and surveys. A detail and thorough feasibility study for Phase V has to be done and finalized in the very near future to allow proper preparation for developing PIN and PDD, including revision of baseline methodology when necessary.

With the progress both in DKI Jakarta as well as internationally in the CDM arena, there is a need to have further detail consideration and assessment of having Phase IV, V and VI to be developed as programmatic CDM (CDM-POA) in urban public transport sector. It is most likely that other cities in developing countries will have a step-wise urban public transport development which might be considered as CDM-POA. Therefore, new methodology for CDM-POA in urban public transport would be important to be developed. Such methodology has to be as much as possible simplified to adapt with the developing countries conditions.

Jinan case study

For the Jinan case study, 5 x 2MW Biomass gasification for power generation, the approved baseline methodology ACM0006³ Version 6 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.

³ See www.cdm.unfccc.int for all approved and new methodologies

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 utilizing 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 CO₂ emissions;
- CO₂ emissions from project related fuel and electricity consumption (biomass transportation and boiler starting);
- Optional CH₄ from uncontrolled burning for the baseline and if these are chosen, also CH₄ from biomass residue combustion in the project.

The leakage issue can be easily resolved, following L1.

Monitoring Plan

The Biomass project meets all applicability of Monitoring Methodology approved in ACM0006. Because the final case actually is 5 BGPG stations bundled together. So the monitoring methodology can be duplicated from one to the else.

Small-scale methodology

For the Jinan case we chose to use a large-scale methodology specifically suited for biomass projects. However the Jinan case could also qualify as a (bundled) small-scale CDM project, in which case AMS-I-D (renewable electricity for a grid) can be used.

3. Additionality of the Projects

In article 12 of the Kyoto Protocol, the objectives of the CDM are to contribute to sustainable development and assist in meeting the GHG requirements of Annex I countries. The process of baseline determination, comparison of emissions of a proposed project with the emissions that would be generated if the project doesn't get clearance for CDM, have a significant role in defining additionality of the project, which has proven to be complex issue.

Additionality is the extent to which there is a reduction in GHG emissions as a result of the certified project activity that would not have occurred in the absence of the activity. In assessing the additionality the following steps can be followed by the project developer as well as validators and designated operational entities (*Figure 3*):

1. Identification of alternative scenario
2. Analyze Investment
3. Analyze barriers
4. Analyze common practices
5. Analyze CDM project impact

Hence based on the above assessment criteria of additionality, this chapter reviews the four cities' case studies selected under the CURB-AIR project.

Bangalore case study

Step 0: The project activity is currently supplying ethanol-diesel blend and the project participants does not claim for crediting period starting before the date of registration.

Step 1: Identification of alternatives to the project activity in consistent with current laws and regulations.

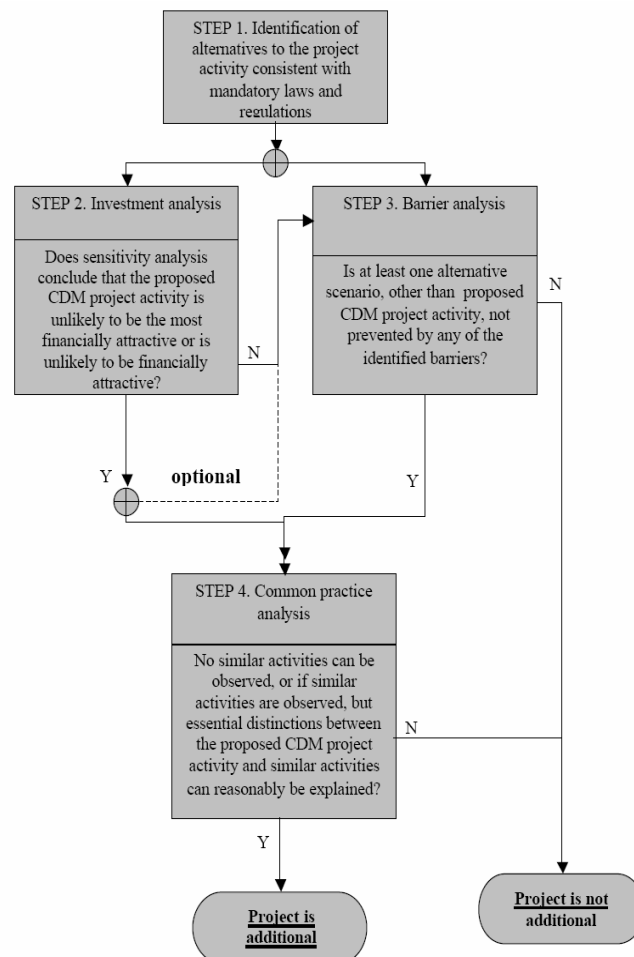


Figure 2: **Additionality Assessment Criteria**

Source: Tool for the demonstration and assessment of additionality (version 3)

The alternatives are:

- a) Continuation of current practices with no investment in ethanol-diesel blend production capacity i.e. continuation of petro-diesel consumption with no investment in ethanol diesel blend production capacity
- b) Project activity implemented without CDM revenues
- c) Investments in developing capacity for production of alternate fuels like CNG, LPG, biodiesel, etc. for consumption of a mix of above alternative fuels

Continuation of petrodiesel consumption: The total petrodiesel consumption in India in 2006-07 was 52.33 million tonnes and this is likely to increase in the coming future if the said project and other measures are not implemented. In order to have a secure supply of ethanol for the project, the current production of ethanol in the country is around 11.36 million litres⁴ annually, which is only 37% of the total production capacity. Of this amount, only 27% is used for industrial purposes, 33% is used for potable use and only 3% is used for other purposes, rest is surplus. Based on these figures, it can be concluded that there will be enough ethanol in the Indian market for use as fuel in the ethanol-diesel blend and without CDM initiative the production capacity of ethanol is unlikely to increase for use as transportation sector fuel.

Project activity implemented without CDM revenues: The project activity might encounter the following barriers if implemented without CDM revenues:

- i. There are no appropriate technological standards being introduced with respect to ethanol, which makes it difficult to reach to the consumers. With the project being registered as CDM activity, the attention of policy makers would result in a policy for ethanol industry since the potential of the industry for use as alternate fuel is still unexploited.
- ii. Though there has been a lot of research on the use of ethanol as transport fuel, very few projects have been implemented in the country.
- iii. Also, the market for ethanol is limited to local distribution, direct sale and purchase.

Investments in developing capacity for production of alternate fuels like CNG, LPG, biodiesel, etc. for consumption of a mix of above alternative fuels: The price of ethanol is marginally lower than that of petro-diesel, but with the additive⁵ cost, labor cost and other handling cost, including installation cost and underground tank, etc., the cost of ethanol

⁴ Ethanol India; the website link for the page is <http://www.ethanolindia.net/ethanol.html>

⁵ To blend ethanol with diesel, an additive has to be added by the project developer

diesel blend is marginally more by 5 paisa⁶ than petro-diesel. Along with the unpredictable ethanol production in the country and conversion cost, it is likely that the project developer might shift to alternate fuels like the CNG, LNG, etc. or to mix of alternate fuels like ethanol, biodiesel, electricity, hybrid, etc. apart from CNG, LNG as mentioned. But with the limitation of limited supply of raw materials for investing in production of CNG, LNG, etc. and also due to inadequate expertise in such resources with the project developer, it is likely that developer might not invest in alternate fuels.

In absence of CDM activity, the most likely scenario will be the continuation of use of petro-diesel with no investment in ethanol-diesel blend production capacity, which will be our baseline. This is because of high prices of alternative fuel, inadequate technical standards and inaccessibility.

Step 3: Barrier analysis

- Regulatory barriers: The Government of India had made it mandatory for the oil companies to mix 5% ethanol with petrol since 2002 throughout the country and subsequently increase it to 10% by 2010. But the regulation is yet to be implemented throughout the country. With the project being implemented as CDM project, the use of ethanol as transportation fuel is likely to be promoted.
- Financial barriers: The project is not profitable for KSRTC as the cost of ethanol-diesel blend is slightly higher than petrodiesel by 5 paisa because of the cost of the solubizer, but even then they are likely to go ahead with the project for the benefit of emission reduction in the city. Thus, with the CDM project the difference in the cost of the blend as compared to petrodiesel can be covered.

Step 4: Common practice analysis

The Indian economy is growing at a rate little over 8% in 2006 - 07⁷. This means that by 2011 we will double the consumption of petroleum products, electricity, food and other commodities to keep this growth rate. Last year Indian government imported about Rs. 161,049.52 crores or (USD 39762.84) in Apr – Oct, 2006-07⁸ worth of petroleum products. Thus, to maintain the economic growth rate, a sustainable energy development program is required which doesn't depend on oil imports. Transport sector is the major consumer of petroleum products in India. With increased concerns of climate change and GHG emissions, Government of India has made it mandatory for petrol companies to mix 5%

⁶ Monetary unit equivalent to 1/100 of a rupee in India

⁷ Planning Commission's Paper on An approach to Eleventh Five Year Plan (2007 - 2012)

⁸ Department of Commerce

ethanol with petrol. But, the regulation is yet to be implemented throughout the country. This indifference among policy makers about ethanol mix is the main reason behind not having established technical standards for ethanol as alternate fuel options.

Thus, with diesel blended with ethanol, using exclusive and unique technology, it can help in reducing GHG emission and creating technical standards for ethanol in India, which is far from common practice.

Step 5: Impact of the CDM registration

The approval and registration of the project activity as CDM activity will alleviate the identified barriers by attracting the attention of policy makers to establish technical standards for ethanol in India.

Bangkok case study

Step 1: Identification of alternatives to the project activity

The “credible and realistic” alternatives to the proposed project activity are:

- Continuation of the current situation
- Construction of more bridges in this area to cross the Chao Phraya River
- Construction of a monorail exactly along the BRT route
- Implementation of the project without CDM

Continue with the current situation: The current situation includes the construction of a 2.2 kilometer extension of the BTS SkyTrain on Silom line, which is planned to start operation in the third quarter of 2008. This extension will be another option to transport passenger from the old town of Thonburi (now part of Metropolitan Bangkok) to Bangkok commercial areas and is expected to significantly reduce the traffic across Taksin Bridge. However, this will not have an impact on the traffic across Rama III Bridge and Bangkok Bridge. So, continuing with the current situation, even with this ongoing construction, will not solve the problem being addressed by the BRT project. It is also “not an option” as announced by the BMA.

Construct more bridges in this area to cross the Chao Phraya River: Construction of more bridges to cross Chao Phraya River is a likely solution to alleviate congested traffic during peak hours between Thonburi and Bangkok. At present, the alternative crossings of the Chao Phraya River in this area are through:

- Bangkok Bridge

- Rama III Bridge
- Rama IX Bridge
- Thaksin Bridge
- Industrial Ring Bridge

Four more bridges across Chao Phraya River in Bangkok area are planned to construct to including the area nearby BRT project. A bridge from Chan Road to Charoen Nakorn Road with four lanes has been proposed. But limited space is a major obstacle in the construction more bridges in Bangkok. The investment cost of this option could be twice the actual construction cost because of the cost of taking over land from the people in the area.

Construct a monorail exactly along the BRT route: With limited space in the Bangkok area, a monorail construction may need to be elevated to reduce the construction area. Investment cost of monorail can vary greatly from 20 – 50 million USD (or 0.70 – 1.75 billion THB) per kilometer depending on length, location, speed, utilities, and other requirements. A monorail and BRT system can transport passengers at the same rate. As a result, the cost of elevated monorail and the longer construction period are not attractive compared to the BRT system.

Implement the project not as CDM: At present, BMA is going to continue the BRT construction with or without CDM initiation. However, with CDM project, BMA could have financial benefits to help supporting the future project.

This step should show that all alternatives comply with laws and regulations. For the implementation of the BRT project, the BMA will need to arrange for legal licensing to operate BRT. The current requirement is for BMA to operate fixed-route bus transport in Bangkok. It must apply for the operating license from the Department of Land Transport and must comply with the Land Transport Act 1979 (law on passenger transport).⁹ In addition, the alignment of the BRT lane is located along road facilities owned by various agencies, including the BMA, Department of Highways (MOTC), and Public Works Department (Ministry of the Interior). The service agreement should address not only the actual service itself, and a reservation of a lane for BRT, but also the longer term allocation of organizational responsibilities for maintenance of the BRT lane (resurfacing, repairing, and repainting).

⁹ PCI/AEC, 2005, p. 15-6.

Step 2: Investment analysis

The investment analysis must show that the project activity is not the most financially attractive or is financially unattractive. Financial data and information for the southern route is not readily available. However, some information is available for the combined first phase BRT (including both the southern and northern routes). *Table 2* lists or breaks down the capital investment cost of the first phase BRT. These represent only the initial capital cost of the project's total initial investment, or Stage a cost, which also includes project development cost, interest during construction, and initial working capital. Stage B costs include expansion of the bus fleet and refurbishment and replacement (see *Table 3*). The project will be fully financed by BMA.

Table 2: Capital investment costs of the first phase BRT project (in million baht at 2005 prices)

Cost items	Financial cost	Economic cost
Infrastructure	335.19	314.94
Civil works	216.00	202.78
Architectural	119.19	112.16
E&M	291.32	274.14
ITS and Ticketing	413.51	370.73
ITS	114.08	102.33
Ticketing and miscellaneous	299.43	268.40
Depot	100.00	94.10
Buses (29 for Southern route)	356.29	285.39
Grand total	1,204.99	1,065.16

Source: PCI/AES (2005), p. 13-5

Table 3: Expansion of the bus fleet for the Southern route

	2007	2012	2017	2022
Total buses	29	44	59	88

Source: PCI/AES (2005)

The aggregate financial analysis of the whole Phase 1 BRT (including both the Southern and Northern routes) shows that the project is not a profitable venture. The earnings generated by the project will just be enough to cover operating and maintenance costs but not capital investment. The project would require a subsidy estimated for the two routes at an average of 5 baht per passenger for the 20-year period, or at a maximum amount of 16 baht per passenger. These conclusions can be easily extended to the southern route.

Given the above-mentioned financial information about the BRT project, it seems that it can easily pass this stage of the additionality test.

However, the Tool requires using appropriate financial indicators a comparison of the project activity with alternatives to show that it is less attractive than at least one alternative, or that it is financially unattractive compared with an appropriate benchmark. Given the information above about the BRT project, it seems that the appropriate method to use is the benchmark analysis. This benchmark should come from BMA based on its own criteria in deciding on infrastructure projects.

On the other hand, the fact that the project is 100% financed by public funds it seems that it is not necessary to undertake this step, like what was done for Transmilenio and Metro bus Insurgents. Instead, these two BRT projects proceeded with the barrier analysis.

Step 3: Barrier analysis

The barrier analysis must identify barriers that prevent the implementation of the CDM project and show that at least one alternative other than the project activity is not prevented by the identified barriers.

The following barriers have been identified for the project:

- Political barriers—The BMA had hoped to launch the BRT project in 2005. But the project was delayed because of lack of the support from the national government. The main reason being given for the latter was that the local government of Bangkok comes from a different political party. The other angle of the political barrier is the public opposition to the project, particularly from car owners. They claim that the project will give priority to mass transit over private cars (as BRT buses take at least one lane of the road).
- Financial or investment barriers—It has been shown that the project is not profitable and requires subsidy. The BMA can finance the capital cost of the project, but would not be

able to recover it because the revenue of the project (coming from fares) can only finance operating and maintenance costs.

- Regulatory and institutional barriers—Ministry of Transport through the Department of Land Transport would not grant license to BMA to operate BRT. Again, the main reason for this would be political. Also, many agencies regulate and manage the traffic in Bangkok, and the role of BMA is in fact the “smallest”.¹⁰ The project must comply with all the requirements and regulations of all these other agencies.
- Operational barriers—BMA could not obtain right of way from the other owners of road transport and infrastructure, including land for park and ride and depot stations.
- Organizational barriers—BMA had planned to operate the BRT project with BMTA (the national agency operating and granting franchises to the buses in Bangkok). But BMTA backed out claiming that it was undergoing restructuring and was not ready to implement the BRT. Again, the underlying reason for this barrier maybe political.

The construction of more bridges, especially being a national government concern, should not be prevented by any of these barriers. Thus, it seems that the Bangkok BRT project can easily pass this test. Nevertheless, the methodology requires a more in depth analysis of these barriers.

Step 4: Common practice analysis

The objective of common practice analysis is to show that no similar activities can be observed, or if there are, essential distinctions can be explained with the proposed CDM project.

BRT routes or dedicated and separate lanes for BRT buses have been constructed and implemented elsewhere. In fact, the first Bangkok BRT project was “inspired” by three similar existing BRT projects: Sydney Transitway, Las Vegas MAX, and Mexico City Metrobus Insurgentes.¹¹ In developing Asia, the first Bangkok BRT is similar to BRT systems in operation in China’s cities Beijing and Hangzhou. Compared with other Asian metropolis, Bangkok’s first BRT is distinct from those of Jakarta and Seoul, which are complete BRT systems.

The common practice analysis should examine the features of these systems and compare them to the Bangkok BRT project. Offhand, it seems that the benefit of the Bangkok BRT in

¹⁰ *The Nation*, 7 January 2007.

¹¹ Based on discussions with Dr Kerati of PCI.

easing particularly the traffic crossing the Chao Phraya River could be one of its distinguishing features. Its integration with other modern urban mass transit systems in the city is also another feature that might be cited.

Jakarta case study

Step 0: The project activity is currently in design engineering details and therefore project participants will only be able to claim for crediting period starting right after the date of registration.

Step 1: The project activity has no conflict with both national as well as local laws and regulations.

Step 2 (investment analysis): The project activity can't be implemented without the CDM revenues mainly due to limited funding of the Regional Government of Jakarta mostly to maintain the level of services and to keep it operated sustainably. By implementing corridor 11, 12, and 13 of TransJakarta BRT as CDM, there will be additional revenue to support maintenance and operations within the respective corridors. However, further detailed financial analysis has to be made and finalized to show this case.

Step 4: Common practice analysis.

TransJakarta BRT is the first BRT in Indonesia; therefore one can yet not consider BRT as a common practice in Indonesia, even in Asia. However, based on study the PDF-B phase of global environment facility (GEF) project for Jakarta it was found that the implementation of TransJakarta BRT has increased the awareness and been shifting the thinking for a reformation of public transport system in urban area in Indonesia. Interest for establishing and operating BRT has been shown by some other big cities such as Surabaya and Bandung. The Indonesian Department of Transportation even has considered BRT as initial step for introducing urban mass public transport in big cities in Indonesia.

Step 5: Impact of the CDM registration.

The approval and registration of the project activity as CDM activity will eliminate the identified barriers as it will give guarantee for the sustainable operation of the BRT in the future.

Jinan case study

Step 1: Identification of alternatives to the project

Four alternatives for the Jinan BGPG can be explored:

1. Construction of a fossil fuel power plant with equivalent amount of installed capacity or annual electricity output;
2. Construction of a power plant using other renewable energy resources with equivalent installed capacity or equivalent annual electricity output;
3. BGPG without CER credits;
4. Supply of equivalent annual power output by the Grid where the proposed project would locate.

Specific analysis on the four alternatives scenarios resulted in the following conclusions:

- 1) A similar installation capacity of a fossil fuel power plant as the proposed project (10 MW) can not happen, because coal-fired plants with a capacity of 135MW or less are prohibited from building in large grid such as provincial grids, and the fossil fuel-fired power units with less than 100MW capacity is strictly regulated for installation according to current regulations in China. Therefore, the alternative fossil fuel power plant with the equivalent power output as the proposed project refers to a fossil fuel power plant of 10MW or less, which is not possibly built either under China's existing regulatory framework. (Notice on Strictly Prohibiting the Installation of Fuel-fired Generation with the Capacity of 135MW or below issued by the General Office of the State Council, decree no. 2002-6; Interim Rules on the Installation and Management of Small-scale Fuel-fired Generators issued in August 1997).
- 2) Besides biomass energy, solar PV, geothermal, hydro and wind energy are the possible renewable energy technologies that could be applied in the Central China Power Grid. However, solar PV, geothermal and wind energy of the similar installed capacity as the proposed project are technologies far from being attractive investment in the grid in China because of the limited technology development status and the high cost for power generation comparing to fossil fuel technology. Also, hydropower is not a technology attracting investment in the region, due to lack of hydro resource in Jinan area. The low-plate geographic character of Jinan would make it impossible for wind power to be developed by some attracting investment.

- 3) BGPG without CER credits; from a CDM point of view, the calculations show that the project is (marginally) additional since the IRR threshold level is just not reached (7.3% instead of 8%, see Annexure), but small deviations (e.g. a 5% increase of biomass price or a 5% reduction in electricity tariffs) cause considerable drops in IRR. Given the uncertainty in such values, the simplified approach, similar to other CDM projects, for this small scale CDM project is defensible.
- 4) The installed capacity of the Central China Power Grid keeps increasing for many years. Hence, the alternative 4) is a feasible alternative which is also selected as the baseline scenario for the proposed project.

Step 3: Barrier analysis

- Consistency with mandatory laws and regulations

With regard to the Renewable Energy Law, although the Government has set the targets for China's renewable energy generation to reach 10 and 12 percent of total generation by 2020 and 2040 respectively, these targets have not become a part of the Law, and it is not yet clear how these targets will be met until all the detailed implementing regulations are stipulated. The newly issued implementation rules of Renewable Energy Law will have a positive impact on the tariff of the proposed project, which means it will be guaranteed an indicative tariff for per kWh that is 0.25 Yuan higher than the average tariff for coal-fired plants in the region. However, as a new technology, the indicative tariff is not sufficient enough to support the development of the proposed project and still requires the backing of CDM to be commercially viable.

The BGPG project activity is consistent with the national policies for environmental protection, energy conservation and sustainable development. However, there exists no binding legal and regulatory requirement for this type of projects yet. It could be concluded that except alternative 1) to power generation, all the other alternatives are in accordance with the existing Chinese laws and regulations.

- Barrier analysis

Cost disadvantages and uncertainties in the green electric price policy in China can be listed as the first two barriers. In comparison with coal-fired power plants in China, the costs of building a biomass plant with same power generation capacity are much higher. Currently, although the Chinese central government is encouraging the renewable energy utilization, the price list and transparent supervising system/mechanisms for any renewable energy

laws or regulations for this green power generated from biomass power plants are not clear at the moment.

The proposed project will be the first BGPG project in the province even in China. Consequently, the project was approved as a demonstration project in Shandong province evidently representing a technological breakthrough. This innovation implies higher development and operational risks, which are ultimately translated into a higher financial risk for the proposed project.

On the technological barrier side, even having the Shandong government already financing a 500 kW installation, there is a 200 kW installation running since 2005 and the technology is own (SDERI) developed; still the technology is not market ready for commercialization. Although Shandong government has given some financial support, it is about 500 million Yuan, still a small part which is mainly used in technology improvement compared with the total required investment.

Since no such grid-connected BGPG project was installed in China, there is a lack of skilled and trained manpower to build and operate this type of facilities. This also represents a technological barrier relevant to the project activity.

A large collecting and management system, including collecting, packing, storage, transportation and dispatch management, etc. is one of the essential elements for the proposed project, which involves the communication with local individual farmers and presents a no-easy mission to the inexperienced project developer. Apart from this, it is also expected that the expenses for collection and transportation will increase due to increased labour and transportation costs.

The biomass price in the local market will continuously fluctuate because of seasonable variations, which results in very unstable expenditures for operation and power generation. Due to the relatively small capacity of the plant, any change in the electricity tariff structure will greatly affect the plant's financial performance.

Step 4: Common practice analysis

Large scale biomass power plant occurred in Shanxian, Shandong province, which developed by National Bio-Energy Co. Ltd. The central boiler system is mainly based on Danish company Burnmeister & Wain Energy A/S where the direct combustion technology and process were developed.

Up to 2005, the biggest biomass gasification power generation demonstration project (Circulating Fluid Bed technology) was put into delivery in Jiangsu Province with an installed capacity of 5MW that is developed by Guangzhou Energy Research Institution under State 863 R&D Program. Therefore, biomass project and especially the BGPG project is evidently not a common practice in China.

4. Sustainability Criteria of the Projects

According to World Commission on Environment and Development, sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

The CDM Executive Board has not specified any common guidelines for the sustainable development and it is up to the developing host countries to determine their own criteria and assessment process of linkage between the national development goals and CDM projects. Sustainability is composed into three inseparable and interrelated parts – economic development, environmental protection and social advancement. The criteria for Sustainable Development may be broadly categorized as:

Social criteria: The project should improve the quality of life, alleviate poverty, and improve equity.

Economic criteria: The project should provide financial returns to local entities, resulting in positive impact on balance of payments and transfers new technology.

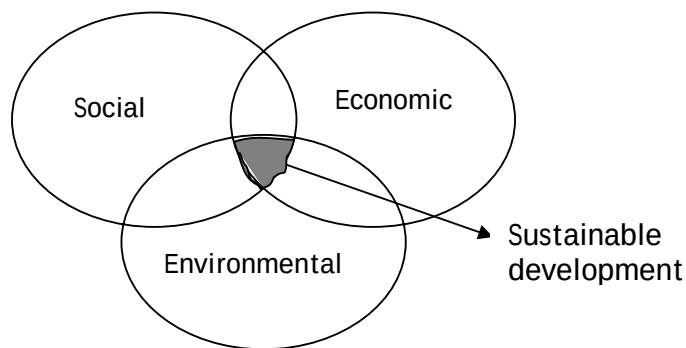


Figure 3: **Criteria for Sustainable Development**

Environmental criteria: The project should reduce greenhouse gas emissions by the use of fossil fuels, conserve local resources, reduce pressure on the local environments, provide health and other environmental benefits and meet energy and environmental policies.

Based on these criteria, the sustainable development criteria of the four case studies under the CURB-AIR project are reviewed in the following section.

Bangalore Case Study

Environmental well-being:

1. Lowers vehicle emissions including GHG and particulate matter (PM) and oxides of nitrogen (NO_x).

Social well-being:

1. The agricultural sector will be hugely benefited with the increase in the demand of ethanol from the sugarcane industry.

Economic well-being:

1. Reduces the dependency on imports of crude oil. It also promotes renewable fuel.

Technological well-being:

1. With the revolutionary technology of blending ethanol with diesel, the technical inability of mixing ethanol with diesel is solved.

Bangkok Case Study

Environment:

1. Using a more efficient transport system, including infrastructure and bus technology, and a clean fuel in the form of natural gas, the BRT project will lead to both reduced GHG and air pollutant emissions. The project is also intended to replace half of the air-conditioned but old and less efficient buses that use diesel, further contributing to the emissions reductions. Similarly, the project is expected to take off the road some 19,000 private cars that use gasoline.

When fully operational and with more BRT routes constructed in the city, the BRT system can also lead to reduce trips from motorized boats that cross the Chao Phraya River. This would result in reduced pollution of the river as these boats used diesel or gasoline.

2. The project will reduce the use of diesel by removing old buses on the BRT route and gasoline by displacing cars.
3. The BRT system will continue to be operated by a private company contracted by the local government of Bangkok.

Social:

1. The project has completed an IEE report. The project has complied with other legal requirements, including land use change and resettlement.
2. Public or stakeholders' consultation was conducted by the local government through an independent entity.
3. Knowledge and skills on the use of the new bus technology and transportation system used by the BRT project will be transferred to the people working in the project, including those at the technical and management level.

Economic:

1. The BRT project will employ people and generate income for their respective households.
2. The project will contribute to the improvement of quality of life of people working in it by providing stable source of income and to the passengers using it by providing more travel comfort and speed and to the general public in general through reduced pollution and improved traffic.

Jakarta Case Study

The project contributes to sustainable development as per the criteria and indicators released by the Indonesian DNA are:

1. Improved environment through less GHG in form of CO₂, and other air pollution emission such as particulate matter and NO_x. This can be achieved through the implementation of a more efficient transport system.
2. Improved social wellbeing as a result of less time lost in congestion, less respiratory diseases due to less particle matter pollution and fewer accidents per passenger transported.
3. Economic benefits in macroeconomic level. Modern transit system is intended to reduce economic costs of congestion in Jakarta.
4. Job creation for more than 2,000 temporary constructions for unskilled workers for construction works of Phase 5.

Jinan Case Study

Jinan city is interested in developing a 2MW biomass gasification demonstration power plant using straws from corn, wheat, and cotton. The final project proposed for CURB-AIR would be a total 10MW (2MW bundled by 5 times) to meet requirements of small scale CDM project. The technology employed is developed by Energy Research Institute of Shandong Academy of Sciences (SDERI).

The electricity generated by the JBGP 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, JBGP project will utilize the unused agricultural residues, here mainly

straws, to avoid the scenario of direct burning in open air or left decay meanwhile realizing a reduction of methane emissions.

In Jinan, there are many villages which have rich agricultural resources suitable for feedstock of JBGP. The implementation of the JBGP project will realize biomass further comprehensive utilization and serve as a demonstration project in Shandong Province. The development of the JBGP 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 more tax revenues. Meanwhile, the project will generate additional online power capacity from a renewable energy source to meet the strong local electricity demand. Additionally, JBGP project will not only reduce GHG emission and SO₂ emissions caused by local coal-fired boilers, but also to some extent abate air pollution, especially particular matter (PM) caused by direct burning of biomass. Economic growth, social benefits and environmental improvement will be achieved in the region by conducting the project. Last but not the least; the proposed project would develop a new kind of renewable energy technology, which is consistent with China's national energy policy and sustainable development strategy. All of these would be sufficient to prove the sustainability of JBGP as a potential CDM project, together with the following data.

A 2MW BGP would consume about 16,900 tons straws annually with 13,000MWh electricity generated and reduce CO₂ with above 10000 ton per year calculated according to Methodology ACM0002 and ACM0006. And based on the difference between emissions from open air burning and that from biomass used in BGP involving transportation and the diesel, the total particular matter (TPM) and SO₂, main air pollutants, would reduce above 210 tons and 65 tons respectively¹² in one year running. Additionally, a 2MW BGP could create the profit as high as two million Yuan/RMB for the village with 30-35 more job positions¹³.

¹² Andreae M. , Merlet P., Emission of trace gases and aerosols from biomass burning, Global Biogeochemical Cycles Vol 15, No 4, pages 955-966, December 2001

¹³ Feasibility Study of 2MW Biomass power station by Shandong Jinnuo New Materials Development Co. Ltd. June, 2007

5. Environmental Impact of the Projects

Air quality and CDM could be mutually beneficial. In this project a first attempt was made not only to identify these benefits, but also to make a first estimation of the quantitative impacts of the proposed projects in the four Asian cities. Unfortunately, not all required data to perform such a first analysis was available, except for the Jinan biomass gasification project (BGPG), where sufficient data and methodology could be found. This chapter contains a description of the methodology used and the results obtained from it.

Introduction

Jinan city is interested in developing a 2MW biomass gasification demonstration power plant using straws from corn, wheat, and cotton. The final project proposed for CURB-AIR would be a total 10MW (2MW bundled by 5 times) to meet requirements of small scale CDM project. The technology employed has been developed by Energy Research Institute of Shandong Academy of Sciences (SDERI).

For the impact of the pollutants which are reduced by the project by replacing open air burning of biomass residues with the combustion in the BGPG, a suitable methodology is needed. One of the best known possible examples is the European Commission project on Externalities of Energy¹⁴ in which a methodology and values were developed to estimate the (health) impacts of pollutants from electricity generation and others by means of external costs. These external costs are not included in any economic or market pricing but do carry a monetized effect on human health, crop yield, building materials and others.

The methodology is based on the sequence of emissions - dispersion - concentration changes - dose response functions - impacts and finally monetization of these impacts. This sequence is illustrated in the Figure 4. Of course, a lot of uncertainties are involved in each of the steps of this concept; therefore European research is continuing in order to improve the methodology. As far as known, no specific methodology or parameters for China or the Jinan region in particular are available.

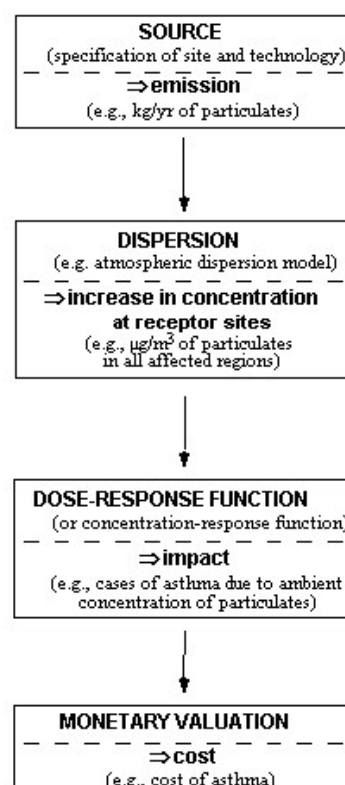


Figure 4: **Externalities concept**

¹⁴ <http://www.externe.info/>

A straightforward approach

To estimate the impact of air pollutants emissions, monetization is quite often used to quantify this impact. From the EU ExternE project, Rabl & Spadaro (2000) derived average damage costs of pollutants from the energy system (*Table 4*).

Table 4: *Damage costs based on Rabl & Spadaro (2006)*

Pollutant	Damage (€/kg)
CO	0.002
NO _x	16.0
SO ₂	10.2
PM10	15.4
VOC	0.9

The emission levels of the Jinan situation, involving annually 15,278¹⁵ tonnes of dry biomass residue without (open air burning) and with the project (BGPG) are recapitulated in *Table 5*. The reduction of most pollutants is very high, above 80%, except for NO_x for which the estimated emissions from combustion in the BGPG are still quite high. If the installation would have a NO_x reducing device, these emissions could come further down. Also, there is no information available about SO₂ emissions from the BGPG,

which would probably occur during the gasification of the biomass residues.

Table 5: *Air pollutant emissions*

Emissions (kg)	Open a air burning of biomass residues	2 MW BGPG Project emissions				Emission reduction	
		Truck transport	Biomass use	Diesel use	Total	kg	%
CO	14,05,539	95.7	242761	6.3	2,42,863	11,62,676	83
NO _x	38,194	152.0	24276	83.8	24,512	13,682	36
SO ₂	6,111	0.1	-	0.1	0.2	6,111	100
PM	1,98,609	8.0	4855	0.8	4,864	1,93,745	98
VOC	1,06,943	21.6	12138	2.1	12,162	94,781	89

¹⁵ 15,278 tonnes is the amount of dry biomass residues that would be annually used by the 2 MW_e BGPG plant, in absence of the BGPG project this amount is burnt in open air

This air pollutant emission reduction accompanies a GHG reduction of 98% which is the difference between the CO₂ from displaced electricity - which is mainly from coal fired plants - and CH₄ from open air burning and the GHG emissions related to the BGPG project. These project emissions comprise CO₂ from transport and from auxiliary fuel and CH₄ from the biomass combustion in the BGPG plant. Since biomass residue is considered to generate no CO₂ emissions during combustion, the large benefit (98% GHG emissions) arises from the displacement of the fossil based CO₂ from electricity (*Figure 5*).

Applying the damage cost values to both situations, the situation with open air burning would lead to a cost of about 3.83 million € (or 38.3 million RMB). With the project in place, the damage costs would reduce to 0.48 million € (or 4.8 million RMB), an eight fold reduction compared to the open air burning situation.

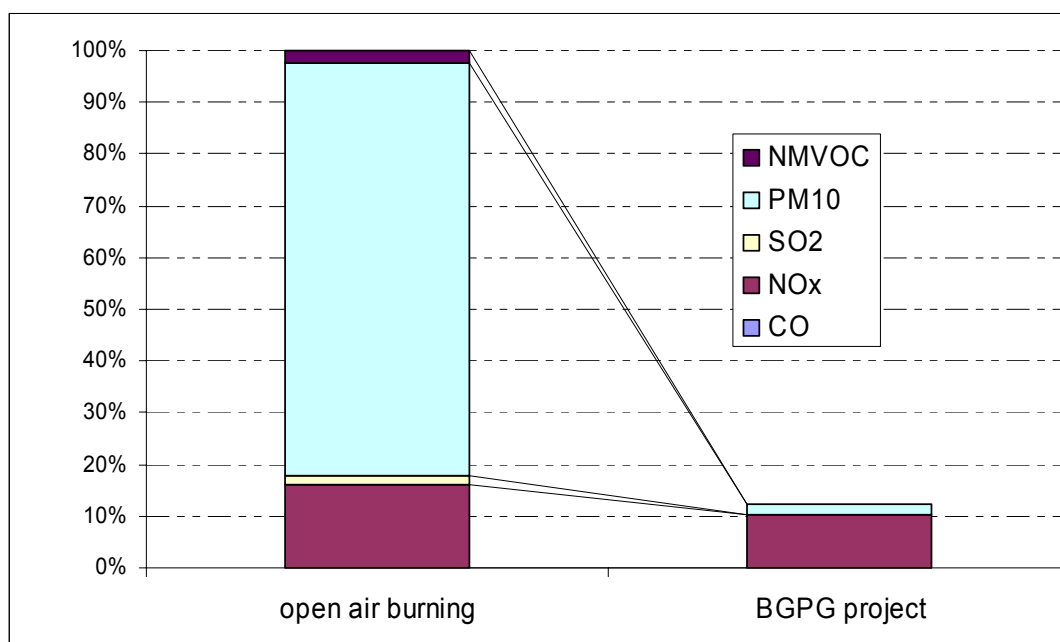


Figure 5: Comparison of the damage impacts by pollutant for the Jinan case

Note: The largest cost reduction is due to the reduction of particulate matter (PM) (30 million RMB out of 34 million RMB), followed by the NO_x reduction contribution. However, damage by NO_x emissions remains the major item in the remaining damage costs (82%).

Even if the used damage costs levels would not apply for Jinan, the difference between the two cost-calculations give a clear picture of the size of environmental impact reduction that could be achieved by the project, which is about 88%.

Again, if the BGPG emissions, by applying NO_x reduction techniques on the combustion plant, could be reduced further, the environmental and human health damage would reduce further, increasing the indirect benefits of the project for its surrounding area and people.

The EcoSenseLight approach

A more detailed approach and calculation of the human health and environmental damage can be performed by using the European Commission developed EcoSenseLight¹⁶ methodology. Although the methodology is developed for Europe, some comparison for Jinan can be made. The focus will be on relative damage reductions, not so much on the absolute values - although these will be given as well to indicate the order of magnitude.

Brief Methodological Description

The EcoSenseLight on-line calculation tool allows calculating damage effects on human health (mortality and morbidity), on crops and on building materials¹⁷. These calculations can be performed for all 25 EU member countries as well for groups of EU countries.

For the air pollutants, NO_x, SO₂ and VOC emission levels need to be given as well as the height on which they are emitted and the area where they occur. To simulate the Jinan case, calculations with emissions at ground level and in a rural area are performed for each member state. For the impacts, only the impacts within the members state's borders is taken into account since emissions in one member state do not only affect environment and health within that member state but also in surrounding ones. These last effects are not taken into account because the focus is on the impact on the direct and local surroundings of the Jinan situation.

For the monetization, the default value of 75,000 €/YOLL (Year of Life Lost) is maintained. The effects of the pollutants are translated into effects by ozone (O₃), particulate matter (PM10), sulphates and nitrates on human health and by N and S and related acids' depositions on crops and buildings.

Comparison between impacts by open air burning of biomass residues and the Jinan BGPG project

A first series of on-line calculations was performed with the emission levels generated by open air burning of 15,278 tonnes¹⁸ of biomass residues. The second series covered the emissions by the 2MW Jinan BGPG project (see *Table 6*).

¹⁶ (http://ecoweb.ier.uni-stuttgart.de/ecosense_web/ecosensele_web/frame.php)

¹⁷ for a detailed description see:

http://ecoweb.ier.uni-stuttgart.de/ecosense_web/ecosensele_web/ERF_and_MonVal_for_EcoSenseLE_V1.3.pdf

¹⁸ 15278 tonnes is the amount of dry biomass residues that would be annually used by the BGPG plant

The *Table 6* gives a summary of the results and it should be noticed once more that not the absolute levels are the most important, the relative changes and differences are. The variations of the impacts among the member states are quite large, with PM having the largest contribution to the impact on mortality and morbidity. If for other substances (like ozone) negative values occur, these are explained by the fact that the concentrations of secondary pollutants may decrease according to chemical transformation due to some emission of primary pollutants. Total health damage varies between 4.5 and 6.6 million € (or 45 to 66 million RMB) with mortality having the largest impact share, almost twice the one from morbidity.

Table 6: *Health impacts from open air biomass residue burning according to EcoSenseLight calculations*

k€	Mortality		Morbidity		Total health impacts	
	Reference	Range	Reference	Range	Reference	Range
O ₃	3.8	-0.1 ~ 3.9	11.7	-0.4 ~ 12.3	15.5	-0.6 ~ 16.2
PM10	3882.9	2896.4 ~ 4264.8	1996.8	1481.9 ~ 2197.1	5879.6	4378.3 ~ 6461.8
Sulphate	11.3	0.2 ~ 12.6	5.8	0.1 ~ 6.5	17.1	0.4 ~ 19.1
Nitrate	76.7	0.6 ~ 79.4	39.4	0.3 ~ 40.8	116.1	0.9 ~ 120.2
Total (rounded)	3970	2930 ~ 438	2050	1520 ~ 2250	6030	4450 ~ 6630

In order to review the robustness of the results, a number of sensitivity cases have been run with YOLL values varying between 5000 and 125 000€. These runs showed that the mortality impacts of the different substances are directly proportional to the YOLL values, for morbidity only the PM impact is directly proportional, the impact of the other substances is constant.

A similar analysis has been done for the impacts on crops and building materials exposed to the effects of the pollutants' emissions from the same amount of open air biomass burning (*Table 7*). The damage on these elements is however an order of magnitude smaller than the health impacts - now about 0.05 million € or 0.5 million RMB for the Reference - and with a much wider range. Negative values for yield losses on crops may occur because of fertilizing effects of SO₂ and N deposition. The minimum and maximum of the total impact is not equal to the sum of the minimum and maximum of crops and materials separately because these extremes do not necessarily coincide for the same EU country.

Table 7: Crop and material damage impacts from open air biomass residue burning according to EcoSenseLight calculations

k€	Crops		Materials		Total impacts	
	Reference	Range	Reference	Range	Reference	Range
Deposition of N and related Acids & O ₃	51	-0.2 ~ 125	2	0 ~ 2.8	53	-0.2 ~ 127.8
Deposition of S and related Acids & SO ₂	0	-0.2 ~ 0	1	0.1 ~ 1.8	1	-0.2 ~ 1.9
Total (rounded)	51	-0.2 ~ 125	4	0.1 ~ 5	54	-0.1 ~ 130

The second series of runs comprised the pollutants' emission impact from the 2 MW Jinan BGGP project. *Table 8 and 9* contains the outcomes of the runs. The damage reduction on health is more than 96%, on crops and materials it is more than 80%. The fact that PM emissions are reduced considerably by the project explain this large reduction in health damage, the reduction in crop and material damage is less clear to allocate to a single emission source. Again, the impacts on crops and materials are much less than the health impacts.

Strangely enough, the project creates also health benefits from sulphates, but this may be due to methodological shortcomings of the simplified on-line calculations or to the fact that chemical transformations take place in the path between emissions and impacts. For each of the substances, the damage reduction is well over 90%, except for nitrates. As explained above, this may be due to the fact that the project still generates a considerable amount of NO_x emissions.

Table 8: *Health and other damage impacts from the Jinan BGPG project according to EcoSenseLight calculations*

k€	Mortality		Morbidity		Total health impacts	
	Reference	Range	Reference	Range	Reference	Range
O ₃	0	-1.1 ~ 0.3	1	-3.5 ~ 1	1	-4.7 ~ 1.4
PM10	95	70.7 ~ 105.1	49	36.3 ~ 54.1	143	107 ~ 159.2
Sulphate	-1	-1.7 ~ 0	-1	-0.9 ~ 0	-2	-2.5 ~ 0
Nitrate	50	0.4 ~ 51.8	26	0.2 ~ 26.6	75	0.6 ~ 78.4
Total (rounded)	143	73 ~ 152	75	4 ~ 78	218	110 ~ 229

Table 9: *Crop and material damage impacts from the Jinan BGPG project according to EcoSenseLight calculation*

k€	Crops		Materials		Total impacts	
	Reference	Range	Reference	Range	Reference	Range
Deposition of N and related Acids & O ₃	9	-2.4 ~ 24.9	2	0 ~ 1.8	11	-1.8 ~ 25.3
Deposition of S and related Acids & SO ₂	0	0 ~ 0	0	0 ~ 0	0	0 ~ 0
Total (rounded)	9	-2.4 ~ 24.9	2	0 ~ 2	11	-1.8 ~ 25

Comparing now the reference values for both cases (*Figure 6*), i.e. open air burning and the BGPG project; the damage costs are reduced with 96% (range between 96 and 8%).

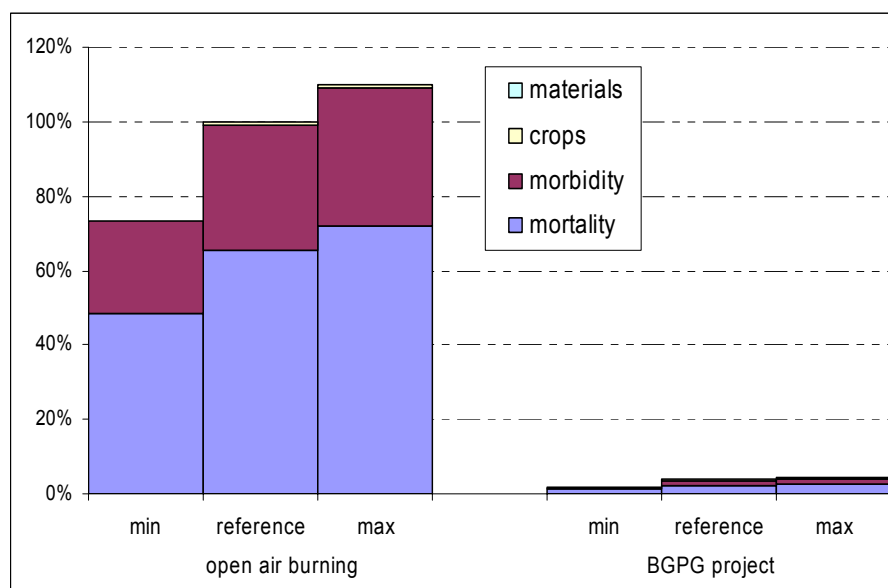


Figure 6: *Comparison of damage impacts on different elements according to the EcoSenseLight approach*

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, etc. 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 reduce with 88% following the simplified approach. If a more detailed analysis is followed using the on-line EcoSenseLight tool, health damage would decrease with 96% and material (crops and building materials) with 80%. Total damage reduces between 96 and 98% taken into account the range among the different countries included in EcoSenseLight.

In both the cases the largest share of damage reduction is caused by a significant reduction of particulate matter emissions (98%) by switching from open air biomass residue burning to the BGPG project. The total emissions of CO, NO_x, SO₂, PM and NMVOC - which are considered to be the most contributing to local air pollution - reduce with 84% by implementing the project.

Other projects

Of the other projects in CURB-AIR, two consider the BRT system (Jakarta and Bangkok) for improving air quality. The Jakarta BRT is based on the Transmilenio project in Bogotá. For this Transmilenio project, the PDD contains some information on the background data used to estimate the GHG reduction achieved. This same background data has been used as input in a simple stand alone COPERT model in which two cases were compared, the Base case, i.e. without the project, and a case with the project implemented (for 1 year). The Base

consists of the replaced personal cars, taxis and existing buses by the Transmilenio project as described in the PDD.

The COPERT model is an acknowledged transportation model used by various European countries to estimate in detail the emissions from road transport (all modes). They use the outcomes for several international reporting requirements such as LRTAP and UNFCCC. Compared to a CO₂ reduction of 64% by the project, the reduction of the air pollutants (CO, NO_x, SO₂, PM10 and NMVOC) amounts to 88% as illustrated below (*Figure 7*). The main reduction occurs in CO and NMVOC by the substitution of gasoline cars by the BRT buses. The remaining air pollutant emissions consist mainly of NO_x. Higher standard buses (Euro III and higher) may reduce this even further.

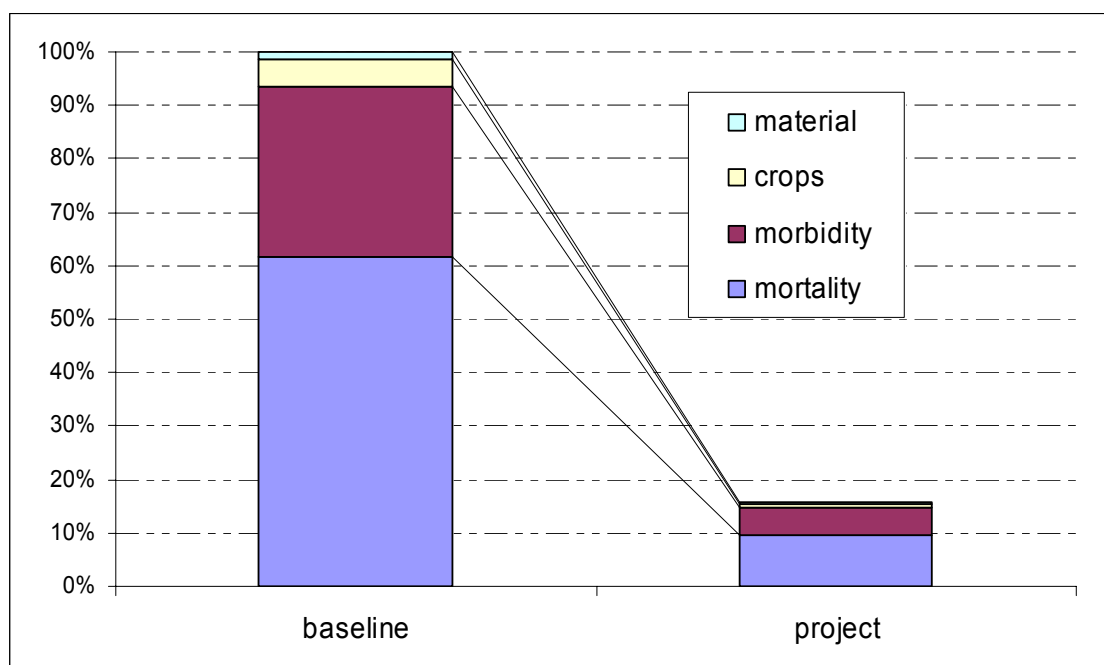


Figure 7: Comparison of air pollutant emissions for the Transmilenio Bogota case using a simplified COPERT model

Similar to the Jinan case a calculation has been done using the same EcoSenseLight model, but now with different location selection for the damage impact calculation, namely in an urban area. Similarly, the results show a considerable reduction in damage costs as well, now on average 84% (*Figure 8*). As the Transmilenio project is substituting transportation modes, some damage still remains.

Of course this simplified approach needs much more carefully selected methodologies and assumptions, but these results show already the extent to which AQ-CDM projects can contribute to local air pollutant and related damage (cost) reduction. Further research should be targeted to make such methodology available for project developers and local

governmental experts in order to assess the benefits of proposed AQ-CDM projects in Asian cities.

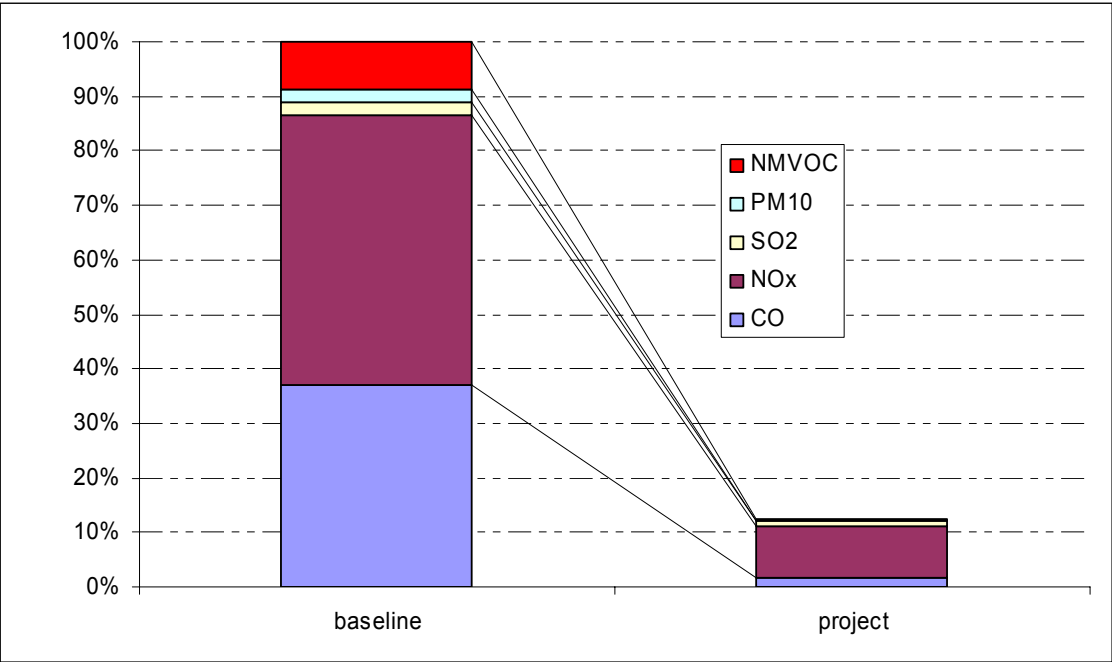


Figure 8: *Comparison of air pollutant emissions for the Transmilenio Bogota case using EcoSenseLight approach*

6. Conclusions and Recommendations

Climate change and air pollution are two environmental problems caused mainly by fossil fuel combustion. Although the emissions of greenhouse gases and health-affecting air pollutants are intricately linked, their impacts are very different in terms of temporal and spatial distribution. Air pollutant emissions mostly have a short-term and local impact on human health and the environment, while climate change is affecting the global environment in the long run.

The Clean Development Mechanism (CDM) is a vehicle to attract finance for projects in developing countries that reduce greenhouse gas emissions. Reduced air pollution could be a very important co-benefit of CDM projects, thereby making it a potentially interesting option for urban policymakers, which are more interested in air quality than climate change. The CURB-AIR project (CDM & Urban air pollution: partnerships enhancing synergies between urban air and Kyoto mechanisms) focuses on the question: *how can the CDM be utilised to improve urban air quality in Asian cities?* It is a research and capacity enhancement project implemented by three European and four Asian institutions and co-funded by the EC-Asia Pro Eco Programme, which was completed in January 2008.

Case studies

A major part of the project was to identify promising option in each of the four cities where an Asian partner was located. These represent technologies that reduce urban air pollution significantly, but can also potentially be developed as a CDM project:

- Bangalore (India): Utilisation of an ethanol/diesel blend in the bus fleet in the South Indian state of Karnataka. The ethanol will be sourced from molasses, a sugarcane by-product and mixed with diesel by using an additive. This technology is still in demonstration phase.
- Bangkok (Thailand): Establishment of new Bus Rapid Transit lines, complementing existing public transport routes.
- Jakarta (Indonesia): Extension of the existing Bus Rapid Transit (BRT) network by Phase V, the implementation of which is uncertain due to financial constraint and decreasing political support.
- Jinan (China): 5 x 2 MW biomass gasification for power generation, using a new 2-stage gasification technology currently in demonstration. The biomass will be obtained from agricultural waste in villages in Shandong province, which otherwise would have been burned in the open.

These projects have been identified in cooperation with local policymakers in the cities as well as project developers. In the course of the project we have been looking into how these projects could be developed under the CDM. This report discusses the CDM related issues for the four case studies.

CDM viability

Key requirements for a project to be registered as a CDM project are: utilisation of an approved baseline methodology, proving project additionality, contribution to sustainable development in the host country, and compliance with monitoring conditions. These aspects are summarised for the four case projects in the following table.

Table 10: *CDM Viability Assessment*

	Bangalore (ethanol/diesel)	Bangkok (BRT)	Jakarta (BRT)	Jinan (Biomass)
Baseline methodology	NMS required; experience of AM47 and AMS.III-T can be used	AM31 not applicable; NM229 more applicable but needs approval	AM31 likely to be applicable, as situation is similar to TransMilênio; No AMS exists	ACM6 or AMS.I-D can be used
GHG reduction estimate (ktCO ₂ -eq/yr)	18	10 (first line)	20	60
Additionality	Can be proven by common practice analysis; without CERs it's not likely to be financially attractive	1 st line likely to go ahead without CDM; next six lines likely to be additional	Can be proven based on financial and political constraints	IRR increases from 7% to 13% due to CER revenues; project is also far from common practice
Monitoring	Not analysed	High data requirement	High data requirement for AM31 might be limiting factor	Can be done using ACM6 or AMS.I-D
Sustainable development contribution	Significant AQ improvement; local income generation; reduced oil dependency; technological advancement	Improved AQ by displacing private vehicles and introducing more efficient mass transport; increased comfort; reduced congestion	Improved AQ by displacing private vehicles; increased comfort; reduced congestion	Substantial reduction of seasonal air pollution; technological development; reduced fossil fuel use; local income.
Final remarks on CDM viability	Very promising CDM option if NMS is developed and approved	CDM implementation depends on NM229 approval and perhaps development of more applicable methodologies	Promising, but data requirement likely to be bottleneck; NMS could be an option	Promising option with potential for replication; current demonstration plant will provide proof of technology

AM: Approved Methodology; NM: New Methodology; AMS: Approved Small-scale methodology; NMS: New Small-scale Methodology; AQ: air quality; CER: Certified Emission Reduction; GHG: greenhouse gases; kt: 1000 tonnes.

Next steps

Based on the preceding analysis for the four case studies we draw the following recommendations in order to develop these projects under the CDM:

- Bangalore: development of a new baseline and monitoring methodology based on approved biofuel methodologies; and better quantification of air pollution reduction by the ethanol/diesel blend
- Bangkok: improvement of the rejected NM229; cooperation with stakeholder to obtain detailed baseline data and passenger surveys; consider option of programmatic or sectoral CDM
- Jakarta: carry out detailed feasibility study focused on the data requirements for AM31; consider developing a small-scale methodology for BRT or programmatic CDM to include more corridors into a single CDM project in order to reduce transaction cost.
- Jinan: operate current biomass demonstration plant in 2008 and assess potential for replication under CDM to be commissioned in 2009.

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²¹ Deputy Governor, BMA.

Annex I: Case Studies

Bangalore Case Study: Ethanol blending with diesel for use as fuel substitute by Karnataka State Road Transport Corporation (KSRTC)

1.1 Introduction

Industrial development in India over the last decade is conspicuous to urban agglomeration. It is estimated that the major share of air pollution in the Indian cities are 72% due to vehicles, 20% due to industries and the rest due to domestic sources²². Thus, the air pollution problem in the city of Bangalore is a result of combination of forces – economic, administrative, social, legal and cultural. Also, industrial activities like the fossil fuel combustion (petrol, diesel, kerosene) in motor 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. Of the total 61% emission from the energy sector, the transport sector in India 15% of GHG emissions. About 42% of liquid fuel emissions are from diesel. Emission estimates have revealed that nearly 27 Mt of CO₂ were emitted in 1980, increasing to about 105 Mt in 2000²³.

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 organizations, 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 program is yet to take off with full steam due to anomaly in supplies and prices of ethanol.

²² "IT Scenario Karnataka - IT Industries". Department of IT and Biotechnology. 2006. Government of Karnataka

²³ Singh A, Gangopadhyay S, Nanda PK, Bhattacharya S, Sharma C, Bhan C., Central Road Research Institute

1.2 Ethanol Scenario

On a world wide basis out of the total annual production of 50.98 Billion liters of ethanol in 2006²⁴, 68% is used as an automotive fuel, 21% is utilized 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 annum²⁵ while it stands fourth in the world in ethanol production with a production about 2.3 Billion liters per annum²⁶. The ethanol production in India is mainly from molasses; the by-product from sugar mills.

With the government's initiative of 5% ethanol blending with petrol, the, Karnataka State Road Transport Corporation (KSRTC), Bangalore has initiated the use of ethanol diesel blend in the transport sector, especially bus fleet. They have been provided with the technical support for the initiative from Energenics Pte Ltd, Singapore, who introduced the ethanol-diesel blend as EnerDiesel™.

1.3 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 technical and commercially viable clear homogenous and stable fuel that can be utilized in unmodified engines and existing fuel delivery infrastructure. The blending of ethanol and diesel is done onsite with computerized state of art dosing equipment. The dosing units are microprocessor controlled and it delivers ethanol and the additive at

Parameter	% Reduction	
	Min	Max
PM	20	46
NO _x	1.8	6.0
CO	12	23
SMOKE	60	70

Table 1.1: Reduction of Pollutants

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 running in 450 buses. KSRTC is now planning to use it on all 4000 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 Kilometers per litre (Kmpl). But the

²⁴ Renewable Fuels Association

²⁵ India in Business, Ministry of External Affairs, Government of India

²⁶ Ethanol India

additive and the optimal percentage of ethanol (7.7%) in the blend has resulted in an increase of Kmpl by 1.75%.

1.4 Reduction Results

The trial runs which when extended to 4000 buses can be developed as a CDM activity. With 7.7% ethanol blending, CO₂ reductions 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. Apart from carbon reduction, there has been a significant amount of reduction in various polluting parameters like particulate matter, oxides of nitrogen, smoke, etc. The percentage reduction in the above parameters has been tabulated in the *Table 1.1*. Smoke emission checks were performed on all buses prior to their conversion. The average values of smoke measured was around 40 HSU. The smoke emission tests within a week of use of ethanol-diesel mix showed a reduction of around 30% and after 4 weeks the smoke levels have reduced to a significant 60% decrease. The smoke emissions are in the range of 15-20 HSU after continuous use of ethanol-diesel blend.

1.5 Clean Development Mechanism (CDM) - Baseline and Additionality

With the annual carbon reduction being 18,000 tonnes, the project can be qualified as a small-scale project (for which the upper limit is 60,000 tCO₂/yr) for CDM. Thus to prepare the PDD simple procedures can be used. This includes application of the 'Combined tool for determining the baseline and additionality'. According to this procedure, the baseline scenario as well as additionality can be determined using a simple investment analysis and/or barrier analysis.

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 cost, the ethanol-diesel blend comes out to be expensive than diesel. Therefore, with diesel as the baseline fuel, the investment analysis would 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 petro, 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 could be used as an example. In addition, several large-scale methodologies for ethanol have been submitted in the past three years, all of which are 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.

1.6 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 required for the use of ethanol diesel blend

9. The engine and other components has also increased lifetime.
10. The life of the engine oil is increased

1.7 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 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 refueling or fuel storage infrastructures or substantial retraining of maintenance staffs.

1.8 Conclusion

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 concerns regarding the new methodology approval should be appropriately accommodated during the methodology development stage 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.

Bangkok Case Study: Development of a Bus Rapid Transport (BRT) CDM Baseline and Monitoring Methodology

2.1 Introduction

Bangkok is the capital city of Thailand. It is situated on the low flat plain of Chao Phraya River which extends to the Gulf of Thailand. The city of Bangkok covers an area of 1,568.737 km² and is divided into 50 districts and 160 sub-districts. Since 1960 Bangkok has undergone rapid urbanization and industrialization. In 2005, the total population of Bangkok was 5.658 million constituting 27.3 per cent of the urban population in Thailand.²⁷ The population density increased from 3,536 to 3,607 persons per sq. km. from 1990 to 2005. However, approximately 3.2 million people commute to Bangkok and are suspected to reside in the city without being included in the city census.²⁸ The number of motor vehicles in Bangkok had increased on average by 300,000 vehicles per year during the period 1990–2002 and reached 6.25 million in 2005²⁹, which is estimated to account for approximately one fifth of the total number of vehicles in Thailand. Private cars, including metered taxicabs for hire, account for 50% of the 16 million trips made in Bangkok daily. The above-mentioned factors have resulted in traffic congestion, transportation delays, and increased levels of air pollution, not to mention the impacts on commuters' comfort, health, and behavior.

One solution to this traffic and urban air quality problem has been the development of a more efficient and more environment-friendly mass transport system. Thus, Bangkok opened its electric railway system, the SkyTrain, in 1999 and electric subway or underground system, the MRT, in 2003. The SkyTrain consists of two lines—Sukhumvit and Silom lines—along Bangkok's major commercial areas, which have a total length of 22.9 km and carry over 400,000 passengers daily. The first MRT route from Hua Lam Phung to Bang Sue has a total length of 19.7 km and serves more than 250,000 passengers daily. The SkyTrain and the MRT account for only 7% of the trips made through the public transport systems. Buses still dominate at 70%. (The balance is accounted for by river taxis or ferries and suburban train.) But extensions to these two systems are either under construction or at the planning stages.

²⁷ Quoted from BMA, 2005 and UN, 2005 in CEERD, 2007.

²⁸ Quoted from UNEP/BMA, 2002 in CEERD, 2007.

²⁹ Of this total, 2.5 million are motorcycles.

To “fill the gap between rail mass transit and bus service,”³⁰ the Bus Rapid Transit (BRT)³¹ has been also conceived as another urban transport solution. It will be specifically established in areas that have high transport demand but cannot construct rail mass transit due to budget constraints.³² The SkyTrain costs 1.5-2.5 billion baht per km to construct, and the MRT, 2.2-3.5 billion baht per km. Meanwhile, the BRT is estimated to cost 80-120 million baht per km, less than 10% the electric rail system. Construction of the BRT system is also three times faster than the SkyTrain.

Besides these inherent advantages, the BRT is also expected to have the following direct and indirect benefits:³³

- Saving in vehicle operating costs
- Saving in passenger travel time and costs
- Provision of higher quality passenger service
- Environmental improvement through the provision of high standard buses (natural gas-fuelled Euro III engines replacing older diesel technologies)
- Increase of SkyTrain and MRT passengers (because of their link to BRT)
- Income of the BRT service suppliers
- Contribution to urban development along the route³⁴
- Contribution to the increase of job opportunities

More specifically, the project will reduce the travel speed of adjacent vehicular traffic by 30% at selected locations.³⁵ Consequently, the average daily travel time on section of the road adjacent to the BRT corridor along Rama III Road will increase by around 20%.³⁶ All in all, the introduction of the BRT will decrease the Level of Service by at least 10%.³⁷

³⁰ Vikitsreth (2007).

³¹ BRT has no universally accepted definition, but can be defined as a “mass transit system using exclusive right of way lanes that mimic the rapidity and performance of metro systems but utilize bus technology rather than rail vehicle technology.” (Wright, 2004, p. 1)

³² Vikitsreth (2007).

³³ PCI/AEC (2005), p. 13-5.

³⁴ The BRT project is expected to boost property development along its route. Already, there are 14,000-15,000 completed condominium units along Narathiwat-Ratchanakarin and Rama III Road

³⁵ On average, the impact of the two routes will decrease the average travel speed in the BMR from 19.95 km/hr to 19.81 km/hr, or by 0.70%.

³⁶ PCI/AEC (2005), p. 3-22.

³⁷ The Level of Service of a roadway is measured by the volume to capacity ratio. This estimated reduction in the Level of Service applies to the two BRT routes, including the northern route. It was obtained by

2.2 Objectives and Scope of the Study

BRT projects use new buses that have lower emissions per kilometer and large buses that result in lower emissions per transported passenger than normal or regular buses. The envisioned higher occupancy rate also leads to more efficient transport system overall. BRT projects also expect passengers to shift from using private cars, taxis, less efficient buses, and in the case of Bangkok motor bikes and three-wheeled tuktuks that are also used as taxis. In fact, it is estimated the project when fully operational would remove from the road 20,000 cars per day! BRT buses also use clean fuels, whether clean diesel or like in Bangkok, natural gas. All these mean reduced carbon emissions and thus, make BRT projects potential CDM projects.

However, despite the huge potential of BRT projects in reducing GHG or carbon emissions, there is still only one approved methodology for BRT projects. In fact, including three small scale methodologies, there are only four approved methodologies for transport sector out of a total 92 approved methodologies as at this writing Dalkmann et. al. (2007) indicates the difficulties with transport projects as CDM projects:

- Difficulty in establishing a baseline;
- Difficulty in proving or demonstrating additionality;
- Difficulty in measuring and monitoring direct and indirect project emissions;
- Large data requirements.

Thus, an overall objective of the case study is to contribute to the development of a baseline methodology for transport CDM projects. Furthermore, with a new methodology that proceeds from the Bangkok BRT project, the study also seeks to prepare the development of the project under the CDM framework.

Specifically, the study will examine the application of the transport CDM methodologies that have been so far developed or development of a new one based on the first Bangkok BRT project. The study will look at different aspects of CDM methodology development, including identification of the baseline scenario, demonstration of additionality, calculation of baseline and project emissions and leakage, and application of a relevant monitoring methodology.

considering the changes in the volume to capacity ratio at two locations on each of the BRT routes—southern and northern routes.

2.3 Description of the Project Activity

The first Bangkok BRT project is one of two routes under the first phase BRT project of the Bangkok Metropolitan Administration (BMA), the developer and eventual owner of the project. It is officially called the Southern Route (The other is called the Northern Route). The Southern Route spans a total distance of 15.8 km, and comprises three major segments—Mahai Sawan Road, Rama III Road, and Narathiwat Road—and 12 stations.³⁸ The Mahai Sawan segment includes a “vital crossing of the Chao Phraya River,”³⁹ an addition to the original plan but is now the major feature of the project. The project is expected to contribute to the easing of the traffic in one of the major crossings of the Chao Phraya River. In particular, the BRT project is expected to affect directly the traffic along Bangkok Bridge, Rama III Bridge, and Thaksin Bridge, which all cross the river in this vicinity and have seen substantial increase in the volume of traffic (see *Table 2.1*).

Table 2.1: *Increase in Daily Traffic in the BRT-affected routes (in passenger car units, pcu)*

Affected routes	Dec 2005	Jan-Feb 2006	Increase
Bangkok Bridge	60,549	81,285	34%
Rama III Bridge	77,299	91,711	19%
Thaksin Bridge	99,651	111,708	12%

The BRT project will also impact the traffic on river boat crossing the Chao Phraya River. The directly affected route by the BRT project is the ferry crossing on Sathorn Pier and Taksin Pier, which accounted for 10% of this kind of traffic, that is using river boat, along the Chao Phraya River and had seen a 10.2% annual increase in average daily traffic, from 14,411 passengers in 2003 to 19,312 passengers in 2006.

The BRT project will also impact on the traffic along its entire route, in particular along its three major segments—the Narathiwat Road, the Rama III Road, and Mahai Sawan (see *Table 2.2 and 2.3*).

³⁸ The original plan was 17 stations; but to cut on costs, the number was reduced to 12.

³⁹ PCI/AEC (2005), p. 1-7. It also notes that the initial plan of the southern route excluded the Mahai Sawan segment. However, “a review of the route potential confirmed that, due to the limitation in feeder bus opportunities within the Rama III road segment, as well as the most promising opportunity inherent to providing cross-river rapid transit, a linkage to Thon Buri (through the Mahai Sawan segment) should be provided.”

Table 2.2: Rush hour traffic nearby BRT project area

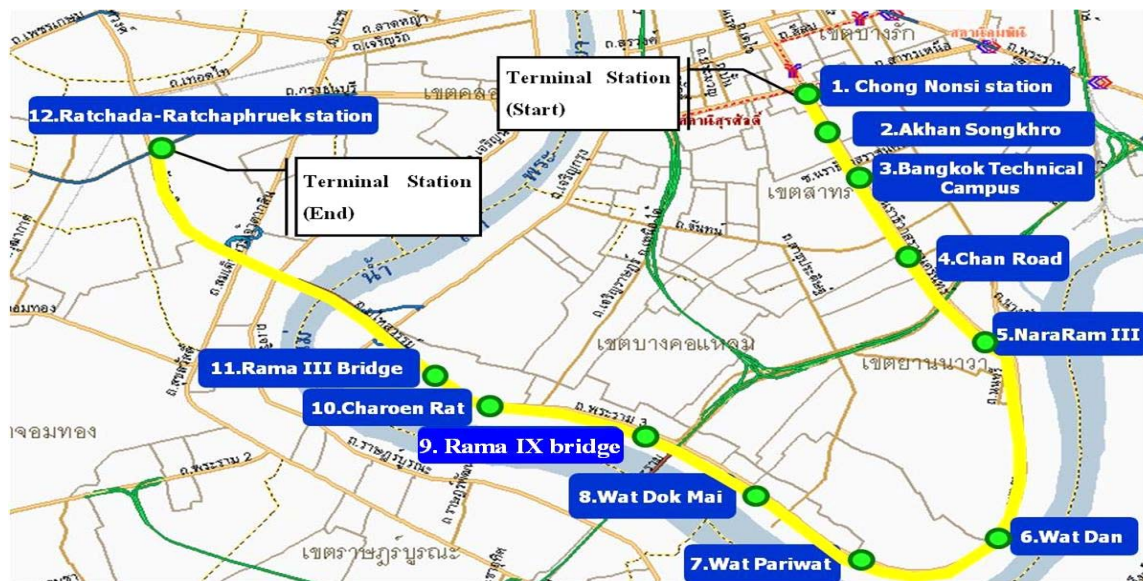
	Average speed during 06:00 – 09:00 (km/hr)					
	2002	2003	2004	2005	2006	2007
Rama III Bridge (Mahaisawan – Chareonkrung)	21.1	7.1	12.5	11.3	12.0	8.2
Taksin Bridge (Krungthonburi – Sathom)	12.6	15.0	13.7	16.7	20.8	13.7
Narathiwas (Rama III – Suriwongse, inbound)						

Table 2.3: Traffic volume along BRT project during rush hour

Traffic volume during 07:00 – 09:00 (vehicle/hr)	2003	2004	2005	2006
Charoenkrung – Rama III	2476	3913	-	-
Rama III – Sathupradit	2962	3096	-	-
Rama III – Narathiwas	3495	2639	3375	3724
Narathiwas – Sathorn	-	3934	3907	-
Narathiwas – Silom	-	3074	2736	1215

Note: The general improvement of vehicle speed in 2002-2006 may be due to the operation of the MRT and its connection to the Sky Train, which has a station in Taksin Bridge

Figure 2.1: The Southern Route—the first Bangkok BRT project



Source: Vikitsreth (2007).

Unlike BRT systems in other major Asian cities (for example, Jakarta⁴⁰ and Seoul), the first Bangkok BRT is a single independent route and not part of a complete BRT system characterized by trunk and feeder routes. However, BMA has formulated a network of 10 BRT routes extending over 157 km. In addition, the Office of Transport Policy and Planning (OTP) of the Ministry of Transport have formulated nine lines extending over 380 km. In fact, BMA plans are underway for six more BRT routes during the next three years (*Table 2.4*).

Table 2.4: Future BRT routes in Bangkok

Route	Distance (km)	Cost (billion baht)
Mochit BTS-Chaeng Wattana (government center in Nonthaburi)	13.5	1.50
Surawong-Ratchaphruek-Pracha Uthit	23.0	2.17
Don Muang-Minburi-Suvarnabhumi	38.0	4.53
Pakret-Mochit	18.7	1.12
Minburi-Srinakarin-soi Bearing	25.0	31.2
Bangna-Suvarnabhumi	15.6	1.93

Source: The Nation, 29 October 2007

Transport CDM Baseline and Monitoring Methodologies Applicable to Bangkok BRT

- *Overview of relevant transport CDM methodologies*

According to Dalkmann et. al. (2007), the transport CDM methodologies that have been submitted so far can be divided into three different categories—fuel switch, efficiency improvements, and modal shift. BRT projects methodologies fall under efficiency improvements but contain modal shift elements. The BRT methodologies that have been submitted so far refer to only two BRT projects. The only approved methodology, Methodology for Bus Rapid Transit Projects (AM0031), refer to the TransMilenio BRT in Bogotá, Colombia. Prior to approval, AM0031 was submitted as NM0052 and NM0105. Methodologies have been developed as well for the Metrobus BRT project in Mexico City. These were submitted as NM0158 and NM0229, and both have been disapproved.

⁴⁰ See the other case study on TransJakarta BRT also in the framework of this Pro Eco CURB-AIR project.

- *Methodology for Bus Rapid Transit Projects (AM0031)—TransMilenio (Bogotá, Colombia)*

The objective of TransMilenio is “to establish an efficient, safe, rapid, convenient, comfortable, and effective modern mass transit system ensuring high ridership levels.”⁴¹ The project consists of four phases. Phase I was completed in 2000, and phases II-IV will be completed between 2003 and 2015. Phase I constructed 42.2 km of trunk BRT routes, and phases II-IV will construct an additional 165.1 km of trunk routes. The whole system comprises trunk routes and feeder routes. The city of Bogota, which TransMilenio serves, has been divided into eight “feeder regions.” TransMilenio has currently 70 feeder routes with a total distance of 468 km. The CDM project refers to TransMilenio phases II-IV, but the crediting period covers only part of phase IV, or until 2012. By that time, it is expected that TransMilenio will have consisted of 130 km of new dedicated lanes (trunk routes) and bus stations, around 1,200 new articulated buses with a capacity of 160 passengers operating on trunk routes, and 500 new large buses operating on feeder routes. By 2012, the project will have reached the capacity to transport 1.8 million passengers daily. It estimates an annual emission of 245,563 tonnes of CO₂eq during the first crediting period 2006-2012.

AM0031 was developed for the TransMilenio phases II-IV. It is applicable to project activities that reduce emissions through the construction and operation of a Bus Rapid Transit System for urban road-based transport. The methodology is also applicable to extensions or expansions (adding new routes and lines) of existing BRT systems. The other applicability conditions of AM0031 and how the first Bangkok BRT satisfies each of these conditions are presented in *Table 2.5*

Table 2.5: Applicability conditions of AM0031

Applicability conditions	Project situation
The project has a clear plan to reduce existing public transport capacities either through scrapping, permit restrictions, economic instruments or other means	The first Bangkok BRT intends to replace half of the air-conditioned but old buses presently plying the BRT route. However, it seems there is no clear plan for doing so. It appears that BRT is more of a policy response to the growing traffic volume in the area and will also absorb the capacity gap left by these old buses when

⁴¹ Grutter Consulting (2006), p. 3.

and replacing them by a BRT system.	they retire.
Local regulations do not constrain the establishment or expansion of a BRT system	The BMA will need to arrange for legal licensing to operate BRT. The current requirement is for BMA to operate fixed-route bus transport in Bangkok it must apply for the operating license from the Department of Land Transport and must comply with the Land Transport Act 1979 (law on passenger transport). (PCI/AEC, 2005, p. 15-6) The alignment of the BRT lane is located along road facilities of various ownership, including the BMA, Department of Highways (MOTC), and Public Works Department (Ministry of the Interior). The service agreement should address not only the actual service itself, and a reservation of a lane for BRT, but also the longer term allocation of organizational responsibilities for maintenance of the BRT lane (resurfacing, repairing and repainting)
The fuel(s) used in the baseline and/or project case are unblended gasoline, diesel, LNG or CNG. Projects using biofuels either in the baseline or project case are not eligible to use this methodology	The project will use natural gas
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	The project is road-based.

analysis).	
The BRT system partially or fully replaces a traditional public transport system in a given city. The methodology cannot be used for BRT systems in areas where currently no public transport is available	The project is intended to replace half of the old air-conditioned buses currently plying the BRT route. However, it is not clear whether this is a direct action even if executed gradually or is simply a necessary consequence of the retirement of the buses. Based on the first applicability condition, it seems the methodology applies to a direct or deliberate action to replace public transport system.
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 gases (GHG) that would occur in the absence of the proposed project activity (i.e. the baseline scenario)	In the absence of the project activity, the BMA would have explored other options to address the growing traffic along the BRT route, particularly the crossing of the Chao Phraya River

Table 2.5 indicates up-front that it is not applicable to the Bangkok BRT project. For one, it applies to a BRT system with trunk routes and feeder, while the project under study consists of a single route, even if it is part of a tentative plan to construct more BRT routes. Besides being tentative, the plan also lists future BRT routes with no explicit linkages among them (see also Table 2.4). The other main reason why AM0031 is not applicable to the first Bangkok BRT project is failure to satisfy the last condition to have as baseline scenario continuation of the present situation. BMA has declared that “a continuation of the present situation is not an option.”⁴² In fact, the BRT project, which is scheduled to become operational in August 2008, has been planned and is now being constructed without consideration for the CDM option.⁴³

- *Methodology for Mass Rapid Transit Projects (NM 229)—Metrobus Insurgentes (Mexico City)*

Metrobus Insurgentes has the same objective as TransMilenio but limited to an exclusive bus lane along Insurgentes Avenue in Mexico City. It does not encompass feeder lines but it has the core components of a BRT included.⁴⁴ The project is divided into two phases. Phase I constructs 34 new bus stations and two terminals along a 19.6 km route, and phase II adds 8 km to cover most of the 34 km stretch of Insurgentes Avenue. The first phase will deploy 97 new articulated buses with a capacity of 160 persons and will transport 250,000 passengers per day. The first phase also included the scrapping of 350 buses plying along Insurgentes Avenue. The CDM project includes both phases. It estimates an annual emission of 23,600 tonnes of CO₂eq during the first crediting period 2008-2014.

Unlike AM0031, which is only for road-based transport, the proposed methodology for Metrobus Insurgentes is also applicable to rail-based passenger transport systems. The Methodology for Mass Rapid Transit Projects (NM229) also applies only for transport systems in which passengers only make part of their trip. As a result, the basis for calculating the baseline and project emissions under this methodology is passenger-km (in contrast to passenger-trips in AM0031). NM229 also applies to partial system changes or extensions such as the introduction of segregated BRT lanes without feeder

⁴² Hermachudha (2007b). BMA also estimates the “cost of doing-nothing” to be more than 4.5 million USD per year due to increase in air pollution, increase in energy consumption, increase in vehicle operation cost, time loss, and road accidents.

⁴³ It will be shown later, however, that the project seems to be additional and the most appropriate baseline scenario seems to be implementing it without CDM.

⁴⁴ UNFCCC (2007d), p. 2.

lines, a new light-duty rail, tram, or metro-line, or the extension of an existing line. (Whereas AM0031 applies to BRT systems that completely replace an existing public transport system.) Except for these important differences, the other applicability conditions of NM229 mirror those of AM0031.

As shown in *Table 2.6*, the first Bangkok BRT project seems to satisfy all but one condition of NM229. Like AM0031, NM229 requires that the baseline scenario (without the CDM project) should be the continuation of the present situation. As shown earlier, this is not an option for the local government of Bangkok. Without the BRT project, the local government will explore other options to address the growing traffic along the BRT route, particularly the crossing of the Chao Phraya River

Table 2.6: Applicability conditions of NM229

Applicability conditions	Project situation
1. The project constructs a new infrastructure consisting either of segregated bus lanes or a rail-track system. The methodology is not applicable for operational improvements of already existing and operating rail or road based systems	The project will construct a dedicated lane for BRT buses
2. The methodology is applicable for passenger transport only.	The BRT project is for passenger transport only
3. All fuels are eligible except bio-fuels for the project and baseline case. Eligible fuels include electricity e.g. for trolleybuses or for rail-based systems.	The BRT project will use CNG.
4. The methodology excludes air and water-based systems from analysis.	The BRT project is purely road-based.
5. The methodology cannot be used in areas where currently no public transport is available	There are buses plying the BRT route. The project is linked to the present electric rail system through one of its terminal stations and is an alternative to a segment

	of the electric rail system located near its other terminal station.
6. 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 greenhouse gases (GHG) that would occur in the absence of the proposed project activity (i.e. the baseline scenario)	In the absence of the project activity, the BMA would have explored other options to address the growing traffic along the BRT route, particularly the crossing of the Chao Phraya River.

▪ *Justification on choice of methodology*

Pending analysis of the alternatives to the project and determination of the baseline scenario, NM229 is clearly the more applicable methodology for the first Bangkok BRT project. The analysis of the different aspects of methodological development will be based on NM229. In fact, NM229 and AM0031 use the same tool for the determination of baseline scenario and demonstration of additionality. However, they differ in the calculations of baseline and project emissions and leakage, which are based on the inherent features and characteristics of the BRT projects.

Notwithstanding, NM229, like its precursor NM158, has been disapproved by the Executive Board. The main reasons for the disapproval of the methodology, as given in the Meth panel summary recommendations, are as follows:⁴⁵

1. Baseline emissions might be higher than presented. The amount of passengers per time unit that can be transported in the project situation might be higher than in the existing situation. This is due to the fact that the existing transport system has a certain maximum capacity based on the amount of passengers that can be transported by the existing vehicles per time unit.
2. Definition of project boundary is vague. The definitions provided are rather ambiguous. Several concepts (i.e. project boundary, project zone, zone of influence) are mentioned and at some point it is not clear whether these mean the same thing or refer to different contexts.

⁴⁵ UNFCCC (2007b).

3. Methodology for getting information to calculate leakage may not be effective. The project might induce some passenger to make longer trips than they would have in the absence of the project. This would produce a leakage. The proposed survey to determine these passengers might not get accurate and reliable responses.
4. Methodology might not capture all induced traffic that becomes part of project emissions. The methodology claims that the project will attract passengers who would not have made the trip without the project. However, induced traffic can also come as a result of changes in the urban landscape as the BRT system eventually allows for living farther away from the workplace. The proposed survey will not capture this kind of induced traffic.

Project boundary

By definition project boundary “shall encompass all anthropogenic emissions by sources of greenhouse gases (GHG) under the control of the project participants that are significant and reasonably attributable to the CDM project activity.”⁴⁶ In this regard, both AM0031 and NM229 define the project boundary, in terms of emissions, as the emissions caused by the passengers transported by the BRT project. Specifically for NM229, these refer to the emissions caused by passengers transported by the project on the segregated bus lane (or on the rail-based mass transport system). On the other hand, baseline emissions are the anthropogenic emissions that would occur in the absence of the project activity within the project boundary.

According to NM229, the physical delineation of the project boundary is determined by the outreach of the project as well as its zone of influence. In the case of the first Bangkok BRT, the physical delineation of the project boundary is the entire southern route of the Phase 1 BRT project, which spans a distance of 15.8 km and comprises 12 stations along three major segments: Mahai Sawan Road, Rama III Road, and Narathiwat Road.

In addition, the Mahai Sawan segment includes a “vital crossing of the Chao Phraya river,” which is the most promising benefit of the first BRT project in Bangkok—that is, easing the traffic crossing the Chao Phraya river in the vicinity of the BRT project.⁴⁷ In this regard, the traffic along Rama III Bridge, Bangkok Bridge, and Taksin Bridge should also be included in the project boundary, or zone of influence, as these will be affected

⁴⁶ UNEP (2005), p. 182.

⁴⁷ Based on discussions with Dr Kerati, PCI.

directly by the BRT project. Rama III Bridge and Bangkok Bridge are directly along the route of the BRT project. (Rama III Bridge is a continuation of Rama III Road, and Bangkok Bridge lies in parallel Rama III Bridge.) Taksin Bridge is not along the BRT route, but the traffic along this bridge, which is near one terminal of the BRT project, has the option to use the BRT system once it becomes operational.

The BRT project will also impact the traffic using river boat to cross the Chao Phraya River, particularly on Sathorn Pier and Taksin Pier.⁴⁸ These passengers have the option to cross the river through the Rama III Bridge and Ratchada-Ratchapruerk stations of the BRT.

Table 2.7: Emission sources of project activity and baseline

	Source	Gas	Included	Justification/explanation
Baseline	Mobile source emissions of different modes of transport for passengers transported by the project	CO ₂	Yes	Major emission source from fuels used buses, taxi, and passenger cars along the BRT route, as well as river ferries crossing the Chao Phraya River
		CH ₄	Yes	Natural gas is used as fuel by some buses, all taxis, and few cars in the baseline
		N ₂ O		Negligible
Project	BRT system	CO ₂		Major emission source
		CH ₄		BRT buses will use CNG
		N ₂ O		Negligible

⁴⁸ There is another ferry crossing between Bangkok Bridge and Taksin Bridge that could use the BRT instead. But the traffic is very small compared to that between Sathorn and Taksin Piers.

However, one main criticism of NM229 is the vague definition of the project boundary, because it uses a number of terms (including, as mentioned, zone of influence, physical project boundary, physical delineation, outreach, route) that are not very clearly defined but it seems these can be used interchangeably.

Identification of baseline scenario

Both AM0031 and NM229 methodologies use the three-step approach to determine the baseline scenario:

- Step 1: Identify all alternatives
- Step 2: Analyze options using the “Tool for the demonstration and assessment of additionality (Version 04)”
- Step 3: If a step 2 result in more than one possible scenario, the baseline scenario is the one with the lowest possible emissions.

Step 1: Identification of all alternatives

This step requires the identification of all options available (to project participants) that meet the same requirement as the proposed project activity. These should include:

- Continuation of the present situation; and
- Implementing the project not as a CDM project activity.

The BRT project is intended to reduce the congestion of the traffic along the BRT route and in particular the crossing the Chao Phraya River along and within the vicinity of the BRT route. Based on discussions with PCI, the closest alternatives to address this current situation are:

- Construction of more bridges in this area to cross the Chao Phraya River
- Construction of a monorail exactly along the BRT route

Step 2: Analysis of options

The methodology recommends the use of the “Tool for the demonstration and assessment of additionality” to analyze the options identified in step 1.

Continue with the current situation. The current situation includes the construction of a 2.2 kilometer extension of the BTS SkyTrain on Silom line, which is planned to start

operation in the third quarter of 2008. This extension will be another option to transport passenger from the old town of Thonburi (now part of Metropolitan Bangkok) to Bangkok commercial areas and is expected to significantly reduce the traffic across Taksin Bridge. However, this will not have an impact on the traffic across Rama III Bridge and Bangkok Bridge. So, continuing with the current situation, even with this ongoing construction, will not solve the problem being addressed by the BRT project. It is also “not an option” as announced by the BMA.

Construct more bridges in this area to cross the Chao Phraya River. Construction of more bridges to cross Chao Phraya River is a likely solution to alleviate congested traffic during peak hours between Thonburi and Bangkok. At present, the alternative crossings of the Chao Phraya River in this area are through:

- Bangkok Bridge
- Rama III Bridge
- Rama IX Bridge
- Thaksin Bridge
- Industrial Ring Bridge

Four more bridges across Chao Phraya River in Bangkok area are planned to construct to including the area nearby BRT project. A bridge from Chan Road to Charoen Nakorn Road with four lanes has been proposed. But limited space is a major obstacle in the construction more bridges in Bangkok. The investment cost of this option could be twice the actual construction cost because of the cost of taking over land from the people in the area.

Construct a monorail exactly along the BRT route. With limited space in the Bangkok area, a monorail construction may need to be elevated to reduce the construction area. Investment cost of monorail can vary greatly from 20 – 50 million USD (or 0.70 – 1.75 billion THB) per kilometer depending on length, location, speed, utilities, and other requirements. A monorail and BRT system can transport passengers at the same rate. As a result, the cost of elevated monorail and the longer construction period are not attractive compared to the BRT system.

Implement the project not as CDM. At present, BMA is going to continue the BRT construction with or without CDM initiation. However, with CDM project, BMA could have financial benefits to help in supporting the future project.

Step 3: Selection of baseline and justification

Both AM0031 and NM229 require that the baseline scenario should be the continuation of the present situation in the absence of the proposed CDM project. However, as discussed above, this is a “no option” but from the perspective of the project proponent, in this case the BMA. The other two alternatives—construction of more bridges or monorail—are more likely options. However, their respective costs could be higher than constructing a BRT. This is definitely the case for the monorail, besides its longer construction time. Moreover, the BRT could generate lower emissions than the monorail option because the leakage emissions of the electricity that would be used to run the monorail could be significant. Thus, it seems that the most likely baseline scenario for the Bangkok BRT case is the implementation of the project without CDM.

Analysis of Additionality

Both AM0031 and NM229 used the UNFCCC “Tools for the demonstration and assessment of additionality” in proving the additionality of the respective BRT projects. The Tool recommends the following steps:

- Identification of alternatives to the project activity
- Investment analysis to determine that the proposed project activity is not the most economically or financially attractive option
- Barrier analysis to identify barriers that prevent the implementation of the CDM project and show that at least one alternative other than the project activity is not prevented by the identified barriers
- Common practice analysis to show that no similar activities can be observed, or if there are essential distinctions can be explained with the proposed CDM project

These steps are depicted in the figure below:

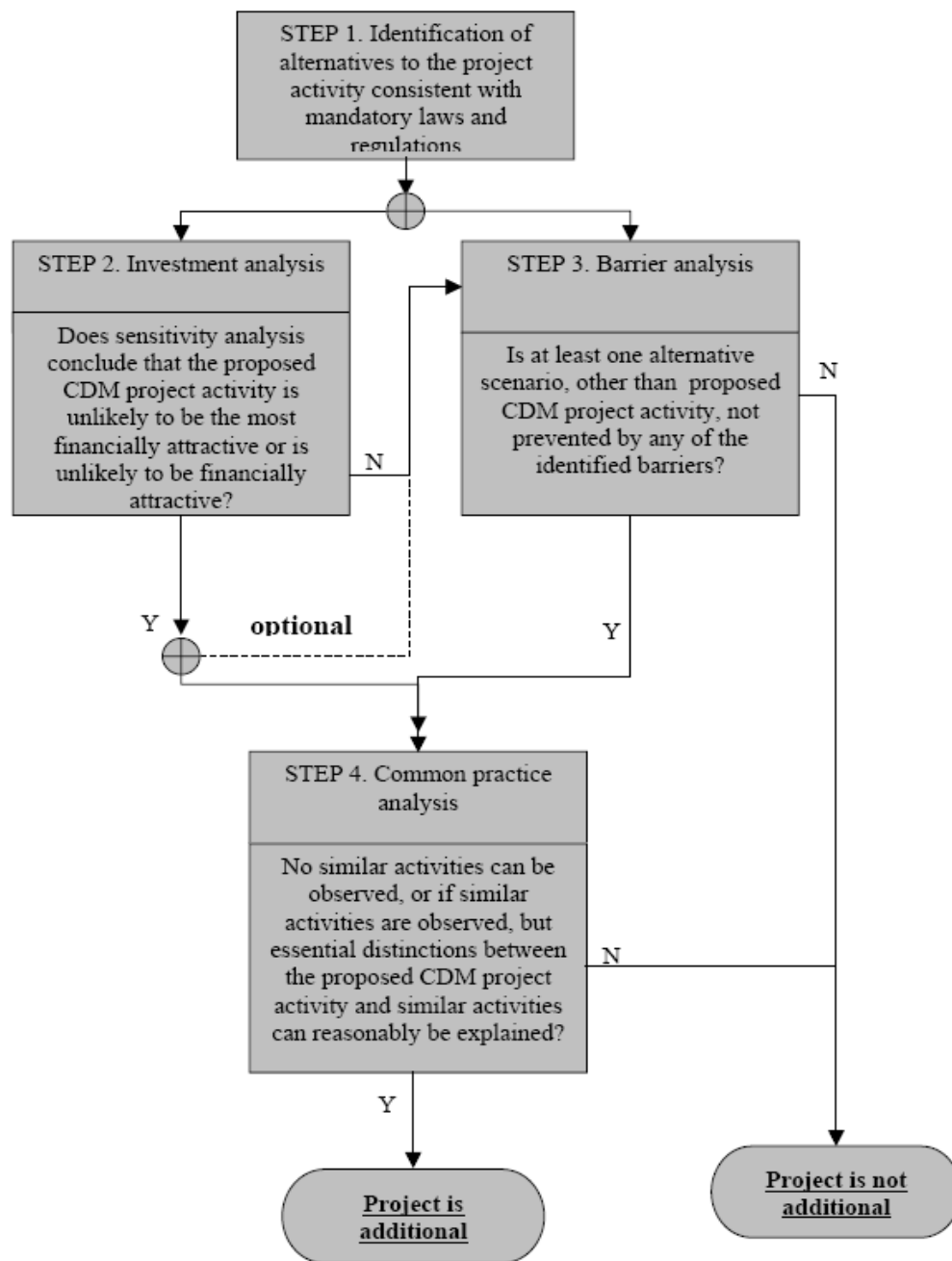


Figure 2.2: Additionality Assessment

Source: UNFCCC (2007)

As shown above, performing the barrier analysis is not necessary once the investment analysis criteria have been satisfied.

Identification of alternatives to the project activity

As discussed earlier, the “credible and realistic” alternatives to the proposed project activity are:

- Continuation of the current situation
- Construction of more bridges in this area to cross the Chao Phraya River
- Construction of a monorail exactly along the BRT route
- Implementation of the project without CDM

This step should show that all alternatives comply with laws and regulations. For the implementation of the BRT project, the BMA will need to arrange for legal licensing to operate BRT. The current requirement is for BMA to operate fixed-route bus transport in Bangkok. It must apply for the operating license from the Department of Land Transport and must comply with the Land Transport Act 1979 (law on passenger transport).⁴⁹ In addition, the alignment of the BRT lane is located along road facilities owned by various agencies, including the BMA, Department of Highways (MOTC), and Public Works Department (Ministry of the Interior). The service agreement should address not only the actual service itself, and a reservation of a lane for BRT, but also the longer term allocation of organizational responsibilities for maintenance of the BRT lane (resurfacing, repairing, and repainting).

Investment analysis

The investment analysis must show that the project activity is not the most financially attractive or is financially unattractive. Financial data and information for the southern route is not readily available. However, some information is available for the combined first phase BRT (including both the southern and northern routes). Lists or breaks down the capital investment cost of the first phase BRT. These represent only the initial capital cost of the project’s total initial investment, or Stage a cost, which also includes project development cost, interest during construction, and initial working capital. Stage B costs

⁴⁹ PCI/AEC (2005), p. 15-6.

include expansion of the bus fleet and refurbishment and replacement (see *Table 2.8*). The project will be fully financed by BMA.

Table 2.8: Capital investment costs of the first phase BRT project (In million baht at 2005 prices)

Cost items	Financial cost	Economic cost
Infrastructure	335.19	314.94
Civil works	216.00	202.78
Architectural	119.19	112.16
E&M	291.32	274.14
ITS and Ticketing	413.51	370.73
ITS	114.08	102.33
Ticketing and miscellaneous	299.43	268.40
Depot	100.00	94.10
Buses (29 for Southern route)	356.29	285.39
Grand total	1,204.99	1,065.16

Source: PCI/AES (2005), p. 13-5.

Table 2.9: Expansion of the bus fleet for the Southern route

	2007	2012	2017	2022
Total buses	29	44	59	88

Source: PCI/AES (2005)

The aggregate financial analysis of the whole Phase 1 BRT (including both the Southern and Northern routes) shows that the project is not a profitable venture. The earnings generated by the project will just be enough to cover operating and maintenance costs but not capital investment. The project would require a subsidy estimated for the two routes at an average of 5 baht per passenger for the 20-year period, or at a maximum amount of 16 baht per passenger. These conclusions can be easily extended to the southern route.

Given the above-mentioned financial information about the BRT project, it seems that it can easily pass this stage of the additionality test.

However, the Tool requires using appropriate financial indicators a comparison of the project activity with alternatives to show that it is less attractive than at least one alternative, or that it is financially unattractive compared with an appropriate benchmark. Given the information above about the BRT project, it seems that the appropriate method to use is the benchmark analysis. This benchmark should come from BMA based on its own criteria in deciding on infrastructure projects.

On the other hand, the fact that the project is 100% financed by public funds it seems that it is not necessary to undertake this step, like what was done for TransMilenio and Metrobus Insurgentes. Instead, these two BRT projects proceeded with the barrier analysis.

Barrier analysis

The barrier analysis must identify barriers that prevent the implementation of the CDM project and show that at least one alternative other than the project activity is not prevented by the identified barriers.

The following barriers have been identified for the project:

- Political barriers—The BMA had hoped to launch the BRT project in 2005. But the project was delayed because of lack of the support from the national government. The main reason being given for the latter was that the local government of Bangkok comes from a different political party. The other angle of the political barrier is the public opposition to the project, particularly from car owners. They claim that the project will give priority to mass transit over private cars (as BRT buses take at least one lane of the road).

- Financial or investment barriers—it has been shown that the project is not profitable and requires subsidy. The BMA can finance the capital cost of the project, but would not be able to recover it because the revenue of the project (coming from fares) can only finance operating and maintenance costs.
- Regulatory and institutional barriers—Ministry of Transport through the Department of Land Transport would not grant license to BMA to operate BRT. Again, the main reason for this would be political. Also, many agencies regulate and manage the traffic in Bangkok, and the role of BMA is in fact the “smallest”.⁵⁰ The project must comply with all the requirements and regulations of all these other agencies.
- Operational barriers—BMA could not obtain right of way from the other owners of road transport and infrastructure, including land for park and ride and depot stations.
- Organizational barriers—BMA had planned to operate the BRT project with BMTA (the national agency operating and granting franchises to the buses in Bangkok). But BMTA backed out claiming that it was undergoing restructuring and was not ready to implement the BRT. Again, the underlying reason for this barrier maybe political.

The construction of more bridges, especially being a national government concern, should not be prevented by any of these barriers. Thus, it seems that the Bangkok BRT project can easily pass this test. Nevertheless, the methodology requires a more in depth analysis of these barriers.

Common practice analysis

The objective of common practice analysis is to show that no similar activities can be observed, or if there are, essential distinctions can be explained with the proposed CDM project.

BRT routes or dedicated and separate lanes for BRT buses have been constructed and implemented elsewhere. In fact, the first Bangkok BRT project was “inspired” by three similar existing BRT projects: Sydney Transitway, Las Vegas MAX, and Mexico City Metrobus Insurgentes.⁵¹ In developing Asia, the first Bangkok BRT is similar to BRT

⁵⁰ *The Nation*, 7 January 2007.

⁵¹ Based on discussions with Dr Kerati of PCI.

systems in operation in China's cities Beijing and Hangzhou. Compared with other Asian metropolis, Bangkok's first BRT is distinct from those of Jakarta and Seoul, which are complete BRT systems.

The common practice analysis should examine the features of these systems and compare them to the Bangkok BRT project. Offhand, it seems that the benefit of the Bangkok BRT in easing particularly the traffic crossing the Chao Phraya River could be one of its distinguishing features. Its integration with other modern urban mass transit systems in the city is also another feature that might be cited.

Determination of Baseline Emissions

- Applicable methodology

In both AM0031 and NM229, the baseline emissions are “those which would have been caused by passengers using the project transport system and in absence of latter would have used other modes of transport including the traditional bus system as well as other modes of transport.”⁵² The difference between the two methodologies, as earlier mentioned, is that AM0031 uses passenger-trips while NM229 uses passenger-kilometers. The assumptions are that in AM0031 the passengers use the system to complete their trip, while in NM229 the passengers use the system for part of their trip.

The methodology for calculating baseline emissions in NM229 consists of the following steps:

1. Identify relevant vehicle categories
2. Determine the emissions factor per kilometer for each vehicle category
3. Determine the emission factor per passenger-kilometer
4. Calculate the baseline emissions

Vehicle categories may include, among other categories, buses of different sizes or capacities, passenger cars, taxis, motorcycles, tricycles, other mass transit systems, and non-motorized transport (NMT). The criteria to know which vehicle categories to include are: (a) significant share of passenger transport (using the vehicle category) in the zone of influence of the project; (b) an expected mode shift from this category to the

⁵² UNFCCC (2007c), p. 8.

project; (c) availability of data; and (c) expected benefit versus additional monitoring and complexity cost.

In the case of the Bangkok BRT, the project boundary, or zone of influence, would encompass the traffic along the entire BRT route, the traffic on the three bridges mentioned crossing the Chao Phraya River, and the traffic using the ferries connecting Thaksin and Sathorn Piers. The observe vehicle categories in this zone of influence includes large ordinary and air-conditioned buses, metered taxis, passenger cars, motorcycles and tuk-tuk (local equivalent of tricycles), and river boats. However, the number of passengers using the motorcycles and tuk-tuk in this zone of influence should be ascertained to see if they are significant. But these modes of transport is certainly very common in Bangkok

The emission factor per kilometer of each vehicle category is calculated based on the number of vehicles in the category, specific fuel consumption of the vehicle category, net calorific values of the different fuels used by the vehicle category, and the technology improvement factor of the vehicle category. The technology improvement factor is a fixed default value per vehicle category; the same value is applied over the entire crediting period. For the Bangkok BRT, technology improvement factor should also be assumed for the tuk-tuk and river boats, if these are relevant modes of transport.

The methodology also includes a formula for calculating emission factor per kilometer of buses if they are of different sizes. There are at least three sizes of buses plying Bangkok roads; but it seems that only large buses use the BRT route.

The emission factor per passenger-kilometer is then calculated for each vehicle category after knowing the average occupancy rate of the vehicle category (that is, the number of passengers using the vehicle category annually prior to project start).

The annual baseline emissions for all vehicle categories is finally calculated from the emissions factor per passenger-kilometer, total number of passengers transported by each vehicle category, and the average trip distance of passengers for each vehicle category.

Data requirements, availability, and sources

The description of the proposed methodology in NM229 indicates the range of data requirements to calculate the baseline emissions. The key data requirements are as follows:

- How many of each of the identified modes of transport and vehicle categories are passing through the BRT route each day as well as the other identified areas in the zone of influence?
- How many passengers and commuters are using these modes and vehicle categories everyday, along the BRT route and on the other areas in the zone of influence?
- What are the bus technologies currently existing along the BRT route?
- What are the fuels used by these buses, as well as the other vehicle categories?

A very preliminary assessment of data availability indicates that traffic data along the project's zone of influence are available. For example, traffic data expressed in passenger car units (pcu) are available on a monthly basis for the three bridges mentioned, during peak and off-peak hours, from the Traffic and Transportation Department of the BMA. The use of pcu harmonized all types of traffic on these bridges. It is certainly based on gathered data in terms of each vehicle category, which is more important in calculating baseline emissions. Nonetheless, the real data requirements are the number of passengers using each vehicle category.

Annual traffic data in terms of passengers per day are also available for the affected ferry crossing, also from BMA. There is a need to ascertain the kind of boats using this ferry crossing and the fuel they used.

Indeed, there is a need to know whether the required data are available from possible sources, including primarily the BMA and the Ministry of Transport. Otherwise, primary data collection techniques, such as surveys, should be devised.

Other issues

One of the criticisms on NM229 is that the methodology for calculating baseline emissions might exclude the possibility that the "amount of passengers per time unit that can be transported in the project situation along the considered road might be

significantly higher than in the existing situation.”⁵³ The evaluators of the methodology consider this kind of BRT project as a capacity addition to an existing transport system that certainly has a capacity in terms of the amount of passengers that can be transported by the existing vehicle categories. This means that the baseline and project situations would not provide the same transport service level. It is recommended that the baseline emissions are calculated in terms of the amount of passengers that could be transported by the baseline system.

The other comment in the calculation of the baseline emissions is that it does not consider the possibility that the project might induce some passengers to make longer trip than in the baseline scenario. The recommendation is to adjust the average trip distance in the calculation of the baseline emissions by a factor based on length of routes before and after the project.

Calculation of Project Activity Emissions

- Applicable methodology

Simply put, the project emissions are based on the fuel consumed by the project multiplied by the corresponding GHG emission factor. The emission factor is expressed in terms of energy units, so that the calculation of project emissions includes the net calorific value of the fuel (per unit of weight or volume). The total fuel consumption of the project is calculated from the specific fuel consumption of the BRT buses and the distance they travel.

Data requirement, availability, and sources

The following information has been provided by PCI on the buses that will be used by the Bangkok BRT project and their expected operation: Some of this information should be useful in calculating project emissions.

- Detail and Specification of BRT Buses:⁵⁴
 1. Length 11-12 m, Drive with CNG, Euro III emission standard, Automatic Transmission, Power $\geq$ 170 kiwi/ 220 hp (using CNG ISO 15403-2:2006), GVW 18,000 kg with full load capability

⁵³ UNFCCC (2007b), p. 26.

⁵⁴ Courtesy of PCI.

2. Vehicle body follows DLT standard, 80 passengers, 20 seats, 1200 cm² per standing passenger
 3. Manufactured from ISO 9000 or equivalent Manufacturer
 4. Never use before delivery
 5. Exit & entrance door for opposite right/ left side with automatic sliding, safety equipment, jam protection. Width ≥ 1.5 m, Height ≥ 1.8 m
 6. Fuel tank ≥ 900 litre
 7. At full load, minimum speed = 60 km/hr
 8. Coolant for air conditioning system is not environmental pollutant
- Route operation estimates
 1. Operating time (5 a.m.-11 p.m.) 18 hr
 2. Numbers of buses 45 buses
 3. Frequency in rush hour 3-5 min/bus
 4. Frequency in normal hour 5-7 min/bus
 5. Route length 16 km
 6. Average speed 30 km/hr
 7. Trip/day/bus (3-5 min/bus) 6 trip/day
 8. Total km/bus/day 200 km

The specific fuel consumption of the BRT buses should be available from the manufacturer or supplier of these buses. The actual distance travel by the buses should be available from the company that BMA will contract to operate and maintain the BRT system.⁵⁵

Other issues

So it appears that the calculation of project emissions is more straightforward and data requirements more manageable than that of baseline emissions. However, one major reason for the disapproval of NM229 is that the methodology for calculating project

⁵⁵ The initial proposal is to assign BMA Enterprises to operate the BRT system. BMA Enterprises also manages and operates the waste collection and disposal of the city.

emissions does not capture the emissions of induced traffic, or the trips of passengers (in the project situation) who would not have made the trip in the absence of the project.

Leakage Calculations

- Applicable Methodology

Leakage is defined as 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.

In NM229, the following sources of leakage have been identified:

1. Upstream emissions due to (a) construction activities; (2) earlier replacement of buses than under business as usual if scrappage of buses is made; and (c) extraction, production, and transport of fuels used (well-to-tank emissions)
2. Change of load factor of buses and taxi in the baseline transport system
3. Longer total trip of passengers and/or change of mode on the trip part not realized on the project
4. Reduced congestion on remaining roads, providing higher average speed and rebound effect

- Upstream emissions

Construction emissions are caused in the energy-intensive manufacture of cement that is used in the construction of new bus lanes to be used by the BRT system. The leakage is calculated based on the amount of cement used, emission factor for the manufacture of cement, and technical life-span of construction.

Vehicle replacement emissions are caused by the earlier scrappage of buses in the project activity than in the baseline scenario. The reduced life span of the buses means increased energy used for manufacturing the buses per operating year or kilometer. The leakage is calculated based on the number of units scrapped by the project, emission factor of bus manufacture, crediting period, average age when buses are scrapped in the baseline scenario, and average age of buses scrapped in the project activity.

The extraction, production, and transport of fuels cause GHG emissions. The leakage is calculated from total fuel consumption in the baseline and project and the well-to-tank

emission factor per fuel type. Total fuel consumption is computed per vehicle category and, thus, depends on specific fuel consumption of each vehicle category, number of vehicles per category and per fuel type, technology improvement factor, total number of passengers transported per vehicle category and their average trip distance, and occupancy rate of vehicle categories. For the well-to-tank emission factor per fuel type, two default values can be used. The lower default value is used when the respective fuel consumed in the baseline is higher than in the project. The higher default value is used when the respective fuel consumed in the project is higher than in the baseline.

- Emissions due to change of load factor

The project could have a negative impact on the load factor of buses and taxis along and near the BRT route and the rest of the city.

For buses, the leakage is calculated based on the number of buses substituted by the project (that is, the number of buses in the baseline that will not be required anymore to transport passengers that shift to the project) and the change of occupancy rate of buses in the baseline. If the occupancy rate of the buses in the baseline changes by less than 10%, then leakage is set to zero. If more buses are substituted by the project than the number of new buses required in the rest of the city, then the project needs to monitor the change of the load factor city wide.

In the case of taxis, the changes in load factor are monitored city-wide as taxis do not operate fixed routes (like buses). The leakage is calculated based on the number of taxis city-wide and the change in the occupancy rate of these taxis before and after the project. However, this leakage is calculated if the passenger-kilometer due to the passengers that would have used taxis in the absence of the project is greater than that caused by population growth of the entire city.

- Emissions due to longer total trip or change of mode

The BRT project could cause some passengers to take longer trip to use the project and/or use a different mode outside the project boundary than they would have used without the project. In fact, this is very likely in the case of the Bangkok BRT. An initial analysis of the impact of the project shows that some passengers now using the river ferries or Taksin Bridge might have to make longer trip to use the BRT. In the process, they might have to use a different mode in the part of the trip outside the project than they would have used without the project.

The leakage due to additional trip distance is based on the number of passengers in the project that makes the longer trip, the average trip distance outside the project of these passengers, and the emission factor per passenger-km of the vehicle category used by these passengers in the absence of the project.

On the other hand, the leakage due to the change of mode is based on the difference between the emission factors of vehicle categories used outside the project and of vehicle categories in the baseline, the number of passengers that change mode, and the average trip distance outside the project using the new mode of transport.

- Emissions due to reduced congestion

The BRT project aims to reduce traffic congestion along the BRT route and other areas inside its zone of influence (project boundary). This reduced congestion could lead to additional trips being made by passenger cars and thus higher emissions. This is also called the “rebound effect.” On the other hand, the reduced congestion also increases in higher average speeds and decreases less stop-and-go traffic resulting in lower emissions.

The leakage due to rebound effect is based on the elasticity factor for induced traffic, which is calculated from the difference in vehicle speed in the project and the baseline, the number of passenger cars in the zone of influence, the average trip distance these cars make in the zone of influence, and their emission factors.

On the other hand, the leakage due to higher average speeds is based primarily on the difference between emission factors at baseline speed and project speed of cars and taxis in the zone of influence.

Data requirements, availability, and sources

The leakage calculations require similar data like those to determine baseline and project emissions. In addition, there are data requirements specific to the calculation of leakage emissions. These include:

- Amount of cement used to construct the BRT lanes
- Number of buses scrapped by the project and their average age
- Number of buses not part of the project and their occupancy rate

- Number of buses and taxis city wide, and their respective occupancy rates
- Number of passengers that make longer trips and changed mode
- Number of cars
- Their respective emission factors and average trip-distance

The company now constructing the BRT project in Bangkok is the source of data on the amount of cement used to construct the BRT bus lanes and stations. BMA is the source of data for the number of buses, taxis, and passenger cars city-wide and in the project zone of influence. Otherwise, most of these data are obtained through surveys and close field monitoring.

Other issues

Another major criticism of NM229, leading to its disapproval by the CDM Executive Board, is the approach to determine the number of passengers that made longer trip than without the project and those that changed mode outside the project boundary. The way survey questions are phrased to determine induced traffic may not get accurate and reliable information. Moreover, the questions also do not account for induced traffic as a result of urban development. The methodology for calculating the elasticity factor of induced traffic due to higher average speeds is also questioned as to its theoretical rigor and basis.

Monitoring Methodology

- Applicable methodology

The monitoring methodologies are practically the same in AM0031 and NM229. To calculate baseline emissions, the number of passengers transported by the project is determined through electronic or mechanical controls. The different modes of transport of these passengers without the project are determined through on-board surveys. Average trip distances are determined from statistics and through surveys. To calculate project emissions, total fuel consumption of the project is based on actual measurement. The data and parameters for calculating leakage emissions are determined through close monitoring and field surveys.

- Data monitored

The monitoring methodology also lists the data and parameters to be monitored, as follows:

1. Number of passengers and share per vehicle category that use the project
2. Average trip distance of the above-mentioned passengers
3. Total fuel consumption of the BRT buses
4. Distance traveled by the BRT buses
5. Specific consumption of BRT buses
6. Amount of cement used for constructing the bus lanes
7. Number of buses scrapped by the project
8. Age of the buses scrapped by the project
9. Number of passengers per day transported by the project
10. Number of buses in the baseline that are not part of the project in the zone of influence and city-wide
11. Number of taxis in the city
12. Occupancy rate of baseline buses and taxis
13. Passengers transported by the project that make longer trip and per vehicle category used in the absence of the project
14. Additional average trip distance of the above-mentioned passengers
15. Passengers transported by the project that change mode to get to and from the project and per vehicle category used in the absence of the project
16. The average trip distance of the above-mentioned passengers
17. Number of cars and taxis in the zone of influence
18. Vehicle project speed in the zone of influence
19. Number of cars and taxis per fuel type

The list indicates the respective sources of these data and parameters and their respective monitoring frequency. Most data are proprietary, which means that they can be obtained from the project proponents themselves. In the case of the Bangkok BRT, these data would come from BMA and the public or private enterprise that will be

contracted by BMA to operate the project. A few of the data requirements would come from official sources or statistics, which, in the case of the Bangkok BRT project, includes BMA and Department of Land Transport of the Ministry of Transport. Most data are monitored annually, and some are monthly or at a minimum frequency every year.

- **Issues**

The issue that was raised earlier about the definition of project boundary is brought up again here. As many of these data make reference to “zone of influence” of the project, this should be clearly defined by the methodology. In the case of the Bangkok BRT, the “zone of influence” refers to the traffic that would be directly affected by the project and the passengers from these areas that would shift to BRT. This includes the BRT route; the three bridges mentioned crossing the Chao Praya River, and one river ferries terminal in the vicinity of these bridges.

The methodology should also make a clear distinction among similar data and parameters (for example, distances, passengers, and vehicle categories) and should clarify the measurement procedures and instruments, if any, and monitoring frequency.

Conclusions

- **Challenges**

The case study on the first Bangkok BRT project illustrates the challenges to the application or development of transport CDM methodologies and development of transport CDM projects. In the first place, until now there is only approved methodology on BRT projects, and that one cannot be used for the Bangkok BRT as it generally applies to complete BRT systems. The other methodology that had been submitted seems to be more applicable to the Bangkok BRT as it refers to single fixed BRT routes. However, it had been deemed inadequate and would need to undergo revision, resubmission, and approval before it can be used or applied.

On the other hand, the reasons for the disapproval of the above-mentioned methodology confirm the methodological difficulties with transport CDM projects. One of the criticisms against that methodology is the vague definition of the project boundary or “zone of influence” as it is alternatively called in the methodology. In the simplest case, the project boundary of this kind of BRT project should just encompass the BRT route. However, the methodology also refers to a “zone of influence,” apparently well beyond

the boundaries of the BRT route. A more appropriate or clearer definition of the project boundary is also important in determining the leakage of the BRT project, which by definition are the emissions caused directly by the project but outside the project boundary. For sure this issue should be confronted in the case of the Bangkok BRT, as it seems its zone of influence (or project boundary) in fact extends well beyond the BRT route.

Another strong comment against the submitted methodology for single fixed BRT routes is the reliability of the approach in obtaining accurate information for baseline and leakage calculations. For example, the baseline emissions must determine the different modes of transport of passengers in the project that will have used these other modes of transport in the absence of the project. The leakage calculations, on the other hand, must determine who among these passengers would have taken longer trip or used another mode of transport than in the situation without the project.

The definition of the baseline scenario is another challenge to the application of both the approved and rejected methodologies. To be applicable, both methodologies require that the baseline scenario is the continuation of the present situation. This has been ruled out in the case of the Bangkok BRT, in which the most probable baseline scenario is the implementation of the project without CDM.

Finally, but also very important, both the development and application of transport CDM methodologies, as illustrated in this case study, require a significant amount of data and far from simple monitoring procedures. This requires the cooperation of the local government of Bangkok, which is undertaking the project, the consultants in the development of the project, and the company now constructing the project. The collection of these data would be facilitated if the local government of Bangkok itself will pursue the BRT project as a CDM project. Given the high importance currently given by Bangkok politicians and non-politicians alike on climate change issues, it can be assumed that this is not remote.

- Recommendations

BRT projects undoubtedly need new CDM methodologies that are more applicable to situations in specific countries or cities. In the case of Bangkok, the new CDM methodologies that will be developed in the future must consider the manner in which BRT systems are planned in the city. Unlike the TransMilenio in Bogotá and Metrobus

Insurgentes in Mexico City, BRT systems in Bangkok are neither complete BRT system that intends to replace existing mass transit systems or just a single fixed BRT route. The Bangkok BRT project is the first in a series of BRT routes that will be constructed in Bangkok in the next three to five years. They are not aimed at replacing existing mass transit systems but are planned to complement other modern urban mass transit system, including elevated rail network and underground or subway system.

In this regard, it has been considered that the Bangkok BRT might be better if proposed under programmatic or sectoral CDM. The rules and procedures for programmatic CDM have been published but so far only one methodology has been approved. Moreover, a new methodology for Bangkok BRT under the programmatic CDM will not be without challenges.

Yet, “transport is too important to wait for CDM solutions.”⁵⁶ Transport projects are being planned and implemented in several cities in developing countries like Thailand. The common goals are to improve or achieve better efficiency in providing mobility and improve air quality. Notwithstanding, the CURB-AIR project has demonstrated that CDM offers project development and financing opportunities for transport projects that shift to cleaner fuels and improve efficiency. BRT projects in particular have specific features that make them strong candidates as CDM projects. With new and more applicable methodologies, the opportunity to develop BRT projects under CDM should not be overlooked.

⁵⁶ Dalkmann (2007).

Jakarta Case Study: Phase 5 of TransJakarta Project

3.1 Introduction

Jakarta, the capitol of the Republic of Indonesia, located in a lowland area about seven meters above sea level, with total area about 661.52 km². Jakarta is in fact a special province, officially named DKI Jakarta Raya. It is administratively divided into five municipalities (North, Central, West, East and South Jakarta) and one regency (Kepulauan Seribu, which consists of small islands in northern part of the city). Total population of DKI Jaya according to Jakarta 2004 statistic book is 7.47 million (Jakarta Statistic, 2004).

Similar to other big cities in developing countries, Jakarta has experienced a severe transport problem. The development of Jakarta has a very close link and interaction with the development of transport infrastructure. Increasing road development has led to urban sprawl. And yet, the urban sprawl has driven the road development further. Since early 1980s, major changes have been occurred in Jakarta and its vicinity. In the early 1980s, development was taking place in the centre of the city as the centre of activities and in the suburb area to support as housing for those working downtown. To accommodate the mobility and to connect these two separated developments, road infrastructure has been developed as a main choice.

Jakarta's vicinity known as BoDeTaBek consists of four smaller cities namely Bogor and Depok in the south, Tangerang in the west and Bekasi in the east. And as the result of shifting development within Jakarta to become more business area, more and more people moved to the vicinity while keeping their job and other social as well as commercial activities in Jakarta. This led to an increasing number of commuters to Jakarta not only during the working days but also during the weekend. About 4 million people are commuting between BoDeTaBek and Jakarta on daily basis which led to very heavy congested traffic during the day especially in Jakarta.

A study by Pelangi (2007) shows that the impact of congestion in Jakarta has reached about IDR 43 trillion (around Euro 3.5 billion) comprising IDR 27 trillion (Euro 2.1 billion) for vehicle operation, IDR 11 trillion (Euro 800 million) for time lost, and IDR 5 million (around 350 million) of health cost. It means that within less than five years, the cost of congestion has been more than tripled (the congestion cost in 2003 was IDR 12.8 billion or Euro 1 million). The main reason for this is a rocketing number of private vehicles

populations. The number of private cars has increased by 500,000 units during the period of 2001-2006, while the number of private motorcycles has doubled (about 3 million units). The rocketing private vehicle population also reflected its rocketing utilization. On the other side, public transport system has not been well organized, and led to reduced willingness of people to use it.

Many studies have been conducted to solve the transport problem in Jakarta starting from the mass-transit corridors, different types of mass rapid transit and even a transport master plan. Different discussions starting from idea to have the most modern and sophisticated mode such as MRT, subway and LRT were happening. However, very limited has been implemented especially due to the economic crisis that hit Indonesia in 1997.

Having seen the alarming transport problem in Jakarta, Pelangi as the then host of the Sustainable Transport Action Network for Asia and Pacific (SUSTRAN Asia-Pacific) in collaboration with the Institute for Transportation and Development Policy (ITDP) arranged a visit of the former Mayor of Bogota, Dr. Enrique Penalosa to Jakarta in November 2001. Bogota is the first city to launch BRT in the year 2001 called Transmilenio. The idea for having Dr. Penalosa visit was to give another view to not only the local government of Jakarta but also the central government of Indonesia as well as public and press in general on the relatively lower cost to solve the transport problem in Jakarta. This led to the establishment of the Indonesia Livable Communities Initiative (ILCI) in 2004 with focus in transport sector. The main reason for this is that a city with sustainable transport system will have less congestion; therefore the travel time will be reduced, energy will be consumed in more efficient manner and at the end, the environmental can be minimized. A sustainable transport system will also ensure equal access for each individual. A city with a sustainable transport system can be assured as a liveable city.

A big part of the initiative is dedicated to assist the local government of Jakarta with technical input from international experts of bus rapid transit (BRT) resulted to the launching of the first corridor of TransJakarta busway on January 15th, 2004.

Besides the implementation of the Transjakarta busway, the local government of Jakarta has also produced a macro transport masterplan of the city of Jakarta which includes plans for having a total of 15 BRT lines until the year 2010, monorail and subway.

Based on the masterplan, Jakarta will develop and establish 15 corridors of busway until the year 2010, which will be done in 6 phases. The first phase consists of Corridor 1, second phase consists of Corridor 2 and 3, third phase of Corridor 4 to 7, fourth phase of Corridor 8 to 10, fifth phase of Corridor 11 to 13 and the last phase of Corridor 14 and 15. Consistent with the Masterplan, up to beginning of 2007 three phases of busway development have been completed and they are in operation (see blue lines in Fig.1). The road infrastructure of fourth corridor has been started in early 2007 and finalised in end of 2007. However, the development of bus stops and its equipments has just started in early 2008. It is planned that overall development and procurement of the complete busway system for Corridor 8, 9 and 10 to be finalised later this year (see green lines in Fig.3.1).

Route of corridor 11-13 are already planned but no feasibility study has been done yet (see yellow lines in Fig.1). Therefore, these three corridors have been proposed to be developed as CDM project. However, the route of corridor 14-15 are not yet firmly defined, therefore these corridors have not been proposed to be developed as CDM project at this stage.

Based on discussions with the city government, Pelangi as part of CURBAIR decided to take Corridor 11-13, which was planned to be developed in 2008. Some similarities with Transmilenio and the approval of AM00031 for TransMillenio BRT by the CDM Executive Board are the basic reasons for working on TransJakarta to be a CDM project. The idea was also supported and in line with the Governor's Decree no. 75/2006 on CDM.

3.2 Description of Corridor 11-13

The three corridors will be developed during Phase V of the overall TransJakarta Busway System. Initially, it was planned that the development of road infrastructure and bus stops will be started in early 2008 once the corridor 8-10 is in operation. However, due to the latest development of the whole program, with pending decision on budget approval for finalization and operation of corridor 8-10, the development and budget for corridor 11-13 are also pending. It is expected that by mid of 2008 approval for budget to operate corridor 8-10 as well as approval to start the whole development process of corridor 11-13 will be issued by the local house of representatives.

Phase V (corridor 11-13) as shown in Fig.1 will cover and serving the southern part of the city. Corridor 11 will connect Ciledug, in south-west part of the city, and Blok M, the

south-end of corridor 1. This corridor is expected to reduce the incoming traffic to the city from one of the most populated residential area. Corridor 12 will connect Depok in south of Jakarta, which is the main university in Jakarta, to Manggarai as a transfer point to corridor 4. Corridor 13 will connect Pulo Gebang, another densely populated residential area in east of Jakarta, to Kampung Melayu. This corridor will have transfer points to corridor 7 and corridor 10.



Fig.3.1. TransJakarta Busway Map

Similar to other corridors, all the three corridors in Phase V will consists of not only new road and bus infrastructures, such as special lanes on the fast-lane of the road, bus stops and access to it as well as purchasing of new buses. As an integrated part of Phase V, better management including ticketing system and better transit system will be implemented as well.

Buses to be used in the three corridors are new buses using Euro-II standard fuelled by CNG. This will give incredible change in the quality of emission from buses as current buses in operation in DKI Jakarta are not even up to Euro-0 standard fuelled by diesel oil and have been in operation in average for more than 15 years.

Transit management is another big challenge for urban transport system in DKI Jakarta. Similar to other corridors, these three corridors will be equipped with map and info of the whole TransJakarta Busway network, while at the same time centralized control and coordination for the whole network is expected to increase the service.

Fare system of other corridors is not the same with the normal fare system in DKI earlier. The introduction of pre-board ticketing system and integrated fare system has been able to reduce timing for boarding of passengers and at the same time also reduce the total cost for travelling in general.

3.3 *Applicability of AM00031 Baseline and Monitoring Methodologies*

AM00031 Baseline Methodology

As TransJakarta Busway System is very much a mimic of Transmilenio, it is very likely that AM00031 of Transmilenio in Bogota will be applicable to be used as reference to TransJakarta Busway System to be implemented as a CDM project. Table below shows the similarity and potential to use AM00031 for TransJakarta.

Table 3.1. Applicability of AM00031

Methodology AM0031	TransJakarta Corridor 11-13
The project has a clear plan on how to reduce existing public transport capacities either through scrapping, permit restrictions, economic instruments or other means and replacing them by a BRT	Plans to scrap existing buses within the same route

system.	
Local regulations do not constrain the establishment or expansion of a BRT system.	The local government owns the proposed project
Fuels used in the baseline and/or project case are unblended gasoline, diesel, LNG or CNG. Projects using bio-fuels either in the baseline or project case are not eligible to use this methodology.	Fuels use in the baseline are gasoline and diesel. Buses in the proposed project will use CNG
The BRT system as well as the baseline public transport system and other public transport options are road-based.	The baseline public transport system and the BRT system for the proposed project are road based
The BRT system partially or fully replaces a traditional public transport system in a given city. The methodology cannot be used for BRT systems in areas where currently no public transport is available	The proposed project partially replaces the traditional buses within the same routes
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 greenhouse gases (GHG) that would occur in the absence of the proposed project activity (i.e. the baseline scenario)	In the absence of the proposed project, a continuation of the current public transport system (baseline scenario) are considered as sources of anthropogenic emissions of GHG

Based on the comparison above, it is clear that AM00031 can be used for TransJakarta Busway System Phase V. However, a brief calculation has been conducted to predict the potential emission reduction of these corridors, and as the result, the potential annual GHGs emission reduction is predicted about 20,000 ton CO₂ eq. According to the existing CDM regulation, such CDM activity is usually falling under Small Scale CDM Type III. Therefore, one can consider the option to establish new methodology under Simplified Small Scale Methodology (AMS).

There is no restriction for TransJakarta Busway Phase V to be developed not as a small scale project, however one has to carefully consider the issue of transaction cost and potential revenue from CDM. Implementation of AM00031 might result in resource-intensive activities both for preparing the PDD as well as in conducting the monitoring in the future.

AM 00031 Monitoring Methodology

The AM00031 monitoring methodology requires a number of measures to be implemented. To allow the most accurate calculation, control of passengers in the baseline has to be conducted either electronically or mechanically, while on-board passenger survey has to be conducted in the project to gather data and information of their initial mode of transport (to show the share of mode-shifting to BRT). Monitoring and measurement of fuel consumption is very important to get more accurate share of emission reduction from engine technology and engine efficiency. Leakage is another important aspect in calculating the actual total emission reduction due to the implementation of the project compare to the emission of the baseline.

Type of data to be monitored and its frequency are mentioned in Bangkok case. For the case of TransJakarta Phase V, such data can be obtained from the respective agencies including the traffic office of DKI Jakarta, the statistic agency and the police office of DKI Jakarta, the TransJakarta management and consortium of operators for corridor 11-13 as well as periodic survey.

However, thorough feasibility study will play the most important role to get the accurate data to be served as the baseline and to get detailed plan including management and operation to get the most accurate prediction of the project itself.

3.4 *Additionality of TransJakarta Busway Phase V*

As recommended by the CDM-Executive Board, a CDM project which use AM00031 has to show its additionality by passing the “Tools for the demonstration and assessment of additionality”.

Step 1: Identification of alternatives to the project activity

There are four alternatives can be considered to solve transport problem in DKI Jakarta:

1. *Overall restructuring and reformulation of urban transport system and management in DKI Jakarta:* This option will need enormous time to be implemented and give result due to the current practices that has created many informal businesses within the system.
2. *Implementation of mass rail based system (monorail system). Based on a number of studies, the investment of monorail is much more expensive than the investment for BRT:* The initiative of having monorail in DKI Jakarta has been launched in the year 2004, even the first phase of infrastructure for the rail has been started but then has to be stopped due to lack of financial resources. Therefore, it is very unlikely that rail based system will be continued in the near future.
3. *The continuation of the current transport system is the most attractive alternative:* However, from the perspective of traffic congestion and its related impacts both environmentally, socially and economically, this option will give less benefit and even will increase loss and negative impacts.
4. *Implementation of Phase V without CDM:* According to the masterplan, phase V was initially not considered to be implemented as a CDM project. However, the current development has shown that at least two barriers will be phased,namely: (i) investment and financial barrier: with the rocketing price of materials as well as fuels and human resources, the total investment and operational-maintenance costs of phase V is predicted to be much higher compare to the previous phases; (ii) political barrier: with the changes in the DKI Jakarta administration, and as 2008-2009 is the first years for the new administration, there is a shift of priority. This has been shown by the pending of budget approval for finalization of phase IV within the 2008 budget.

All the alternatives comply with laws and regulations, yet there are potential barriers for them to be implemented to solve transport problem in DKI Jakarta.

Step 2: Investment analysis

The project activity will not be easily implemented without the CDM revenues mainly due to limited funding of the DKI Jakarta Government. The limited funding might not directly affect the infrastructure development, but in the long run it will heavily affect the level of services and the sustainability of the operation. The pending of budget for finalization of Phase IV sent another sign of the potential pending of Phase V due to financial issue.

By implementing corridor 11, 12, and 13 of TransJakarta BRT as CDM, there will be additional revenue to support maintenance and operations within the respective corridors. However, further detailed financial analysis has to be made and finalized to show this case.

Step 3: Barrier analysis

No barrier analysis need to be done as the investment analysis has shown that CDM will assist Phase V to be developed and operated sustainably.

Step 4: Common practice analysis

TransJakarta BRT is the first BRT in Indonesia, therefore one can yet not consider BRT as a common practice in Indonesia, even in Asia. However, based on study the PDF-B phase of global environment facility (GEF) project for Jakarta it was found that the implementation of TransJakarta BRT has increased the awareness and been shifting the thinking for a reformation of public transport system in urban area in Indonesia. Interest for establishing and operating BRT has been shown by some other big cities such as Surabaya and Bandung. The Indonesian Department of Transportation even has considered BRT as initial step for introducing urban mass public transport in big cities in Indonesia.

3.5 Determination of Baseline Emissions

Using AM00031 the baseline emissions consists of emission of CO₂, CH₄ and N₂O from other transport modes previously used by BRT passengers. For this purpose, detail data of type of transport modes including its population, age and fuel type have to be

gathered. Further data on average fuel consumption and number of passengers and trip length to be served is also needed to calculate the baseline emission. Emission factor for each GHG, each mode and fuel type need to be measured or otherwise use the IPCC emission factor.

Another important aspect for a CDM project is for deciding the project boundary. Project boundary of TransJakarta Busway System Phase V will be the area along the corridors with time boundary from the process of infrastructure development until the operationalization of the corridors. The decision of project boundary will not only affect the emission of the project but also emission of the baseline as well as potential leakage.

Thorough survey and analysis of the baseline condition are keys to be able to calculate the baseline emission. Most of the required data are available but scattered in a number of institutions. Reliable data in relation to the current buses operation along the three corridors would be the most difficult to get due to the undisclosed operational data in most of the existing operators. However, as TransJakarta is DKI Jakarta's program, the traffic office of DKI Jakarta should have clear authority to gather such data from the operators.

Based on limited information, the potential baseline emission on yearly basis is predicted to be around 35,000 ton CO₂ equivalent.

3.6 Calculation of Project Activity Emissions

The calculation of project emission can be done using the total trip length of service, fuel consumption and number of passengers shift from other transport modes. Up to date, detailed feasibility study for Phase V is not yet available. Therefore, it is difficult to calculate the potential emission of the proposed CDM Project. Based on limited information on Phase V planning, annual emission from the project is predicted to be less than 15,000 ton CO₂ equivalent.

3.7 Calculation of Leakage

There are two potential of leakage, namely negative and positive ones. Negative leakage defined as increased of GHG emission outside the project boundary due to the implementation of the project; while the positive one is decreased GHG emission outside the project boundary due to the implementation of the project.

In the case of TransJakarta Busway Phase V, both leakages need to be considered.

Negative leakage will likely happen due to the rerouting of the existing public buses which have partial same route as the respective corridors. Negative leakage might also happen due to rerouting of private motorised vehicles to avoid heavy traffic along the corridors due to the decreasing of number of lanes for private vehicles.

Positive leakage will likely happen due to the increased number of passengers shifting from other transport modes in other corridors connected to the three corridors. Currently, relatively big portion of DKI Jakarta's population decided to keep using the private vehicle due to the limited network of TransJakarta. Therefore, bettering the network by adding Phase V will encourage them to leave their private vehicles at home and shift to TransJakarta fully.

3.8 Emission reductions

GHG emission reductions

Based on brief calculation using the currently limited data and information of Phase V and not including the potential leakage, the predicted emission reduction is around 20,000 ton CO₂ equivalent annually. As mentioned previously, the potential reduction is considered to be very small and there is a possibility to have it as a small scale CDM project.

Air pollution reductions

No calculation has been made for air pollution reduction due to the implementation of Phase V as CDM project. However, a number of air quality improvements due to the implementation of the proposed project are expected as follows.

The operation of buses with overlapping routes will be eliminated if not fully shifted to other routes. Most of those buses are old and aging buses with air pollutant emissions higher than the emission standards in most cases. It means that the pollutants emitted will be lower

The utilization of new fleets to replace the overlapping routes with BRT corridors will affect the combustion performance. The combination of new engines and the utilization

of CNG instead of diesel fuels in new fleets will reduce the emission of CO, particulate matters, SO_x, NO_x and hydrocarbon significantly

The expected modes shifting from private vehicles to BRT will reduce the number of private motorized vehicles operated and therefore will also reduce the total air pollutant emission

3.9 General issues related to methodology

Based on brief calculation, one has to consider the potential cost and potential benefit of having TransJakarta Busway System Phase V as a CDM Project. There is no restriction to have project with small emission reduction to be developed using AM, however the cost implication to prepare PDD as well as for conducting validation, registration, verification and monitoring should be considered carefully. As one of the most valid additionality of having Phase V as a CDM project is basically to solve the investment (and financial) barrier, then one has to consider the final result of total cost and total revenue related to its implementation as a CDM project.

One possibility is to develop Phase V as small scale CDM project to reduce the cost related to transaction. Unfortunately, up to date there is no approved simplified small scale methodology for BRT. It means that new methodology has to be submitted and may have to go through a lengthy process as well. One might want to consider a revision of AMS.III.C by adding the fact of having modes shifting and reroute of the current bus operation.

With the current development of the whole TransJakarta Busway System, it turned out that Phase IV is not yet in operation due to the pending budget from finalizing the infrastructure development, buses purchasing and its operation and management. One can argue the possibility to have Phase IV to be developed as CDM project using investment and financial analysis as the basis for eligibility. On the other side, the development of Phase V and Phase VI has not been started; even detail feasibility studies for both are not yet final. Taking this fact into consideration, there is a possibility to submit the three phases as programmatic CDM in the urban transport sector instead of applying AM00031. However, there might be another argument especially regarding Phase IV as the infrastructure development is partially done.

Developing TransJakarta Busway System as programmatic CDM may reduce the transaction cost especially in relation with development of baseline and monitoring methodology. However, as this might be the first programmatic CDM, one has to get prepared with potential of a lengthy process of getting approval of the methodologies.

3.10 Recommendation and further action

As can be seen earlier, to allow the implementation of TransJakarta Phase V as a CDM project the most important aspect is to get the right and reliable data for both baseline as well as for the proposed project itself. Without detailed data, it is impossible to prepare PIN (Project Identification Notes) as well as PDD (Project Design Document). Data collection needs to be done through a combination of activities including workshops and surveys. A detail and thorough feasibility study for Phase V has to be done and finalized in the very near future to allow proper preparation for developing PIN and PDD, including revision of baseline methodology when necessary.

With the progress both in DKI Jakarta as well as internationally in the CDM arena, there is a need to have further detail consideration and assessment of having Phase IV, V and VI to be developed as programmatic CDM (CDM-POA) in urban public transport sector. It is most likely that other cities in developing countries will have a step-wise urban public transport development which might be considered as CDM-POA. Therefore, new methodology for CDM-POA in urban public transport would be important to be developed. Such methodology has to be as much as possible simplified to adapt with the developing countries conditions.

Jinan Case Study: 5×2MW Biomass Gasification for Power Generation

4.1 Introduction

The Jinan 2MW×5 Biomass Gasification for Power Generation (hereafter refers to the JBGP project) is a biomass utilization project which will mainly use local straw from wheat and corn for electricity generation. The final JBGP will be implemented on local scale (2MW) and bundled by five times into a small-scale CDM project. The technology employed is developed by Energy Research Institute of Shandong Academy of Sciences (SDERI). One BGP system was a combination of gasifier, internal combustion engine and generator.

The electricity generated by the JBGP 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, JBGP project will achieve an extra benefit of greenhouse gas (GHG) mitigation derived from a reduction of methane emissions from straw dumping or uncontrolled burning of biomass.

In Jinan, there are many villages which have rich agricultural resources suitable for feedstock of JBGP. The implementation of the JBGP project will realize biomass further comprehensive utilization and serve as a demonstration project in Shandong Province. The development of the JBGP 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 more tax revenues. Meanwhile, the project will generate additional online power capacity from a renewable energy source to meet the strong local electricity demand. Additionally, JBGP project will not only reduce GHG emission and SO₂ emissions caused by local coal-fired boilers, but also to some extent abate air pollution, especially particular matter (PM) caused by direct burning of biomass. Economic growth, social benefits and environmental improvement will be achieved in the region by conducting the project. Besides, the proposed project is consistent with China's national energy policy and sustainable development strategy.

4.2 Technology to be employed by the project

There are two kinds of biomass power generation technologies in China taking purely biomass as its fuel but without any involvement of coal for co-combustion: 1) biomass combustion for power generation (BCPG) and 2) biomass gasification for power generation (BGP). BCPG is mainly exported from advanced international manufactures and installed in large scale. And it is

normally used in combined heat and power system (CHP) or cogeneration system which has higher efficiency of energy utilization per unit of biomass than merely generating electricity.

BGPG is still at the stage of development and demonstration with small-scale installed capacity in China. In our BGPG technology, a combination of gasifier, internal combustion engine and generator was installed in a power generation system. For guaranteeing the stable engine running, a new type gasifier has been contrived carefully, which could gasify the straws and produce tar free gas by violent thermal cracking in the furnace. With waste heat recovered from the engine exhaust, the gasifier could work with high efficiency about 88%. The total conversion efficiency from straw to electricity could reach 28%.

A 200KW demonstration project has been put into operation since 2005. The feasibility and improvement of technology has been proved and developed by SDERI based on experimental results. Shandong Provincial government has partly financed SDERI in 2007 for another 2MW BGPG-demonstration, which now starts with building construction in Huanghe Village.

4.3 *Brief explanation*

Biomass resource is renewable and environment-friendly. More importantly, straws energy, with little sulfur dioxide emission, also can be regarded as CO₂-neutral, because carbon dioxide released to the atmosphere from straws combustion is reabsorbed during growth of new crops. China is one of the largest developing countries in agriculture, and thus has rich biomass resources. The straw production from agriculture is over 720 million tonnes per year, 604 million tonnes of which is available for the purpose of energy supply. Among the straw used for energy purpose, 24% is for stock raising, 15% is for fertilizing, 2.3% is for industry, 40% is for farmers' household fuel and 18.7% is a waste without any utilization. (Outlook analysis of straw power generation in the future, *China Energy*, March, 2005.) Most unused biomass is burned in open air or left decay. Obviously, Biomass resource is plentiful but highly distributed in China and often expensive and energy-consuming to collect and transport them. Therefore, the economic factor drives the potential for small energy systems, which could utilize straws generated on site or in close proximity, rather than the large centralized systems developed in some western countries.

Based on the biomass situation in China, the final scale of one BGPG station we prefer is 2MW, which could be call as local scale. Then it could be bundled by 5 times to meet the requirements of a small scale CDM project.

In this 2MW demonstration project, we got part financial support from Shandong Provincial Government for technology research, and got part financial support from Shandong Jinnuo New Materials Development Co. Ltd. for plant construction.

A basic process was shown as following.

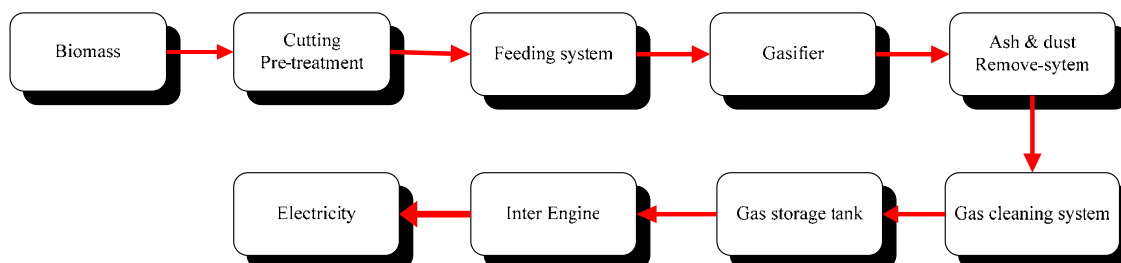


Figure 4.1 Basic process of BGPG

4.4 Introduction of Shandong Jinnuo New Materials Development Co. Ltd.

Shandong Jinnuo New Materials Development Co. Ltd. Was a non-state enterprise, founded on Jan. 7th, 1997. The annual profit of the company could reach 10 million Yuan/RMB by producing and selling mechanical fittings widely used in petroleum industry. In 2004, the company invested 20 million Yuan to establish Jinan Jinnuo Cotton Mill with the scale of 30 thousand spindles which located the south of Huanghe village. This Mill could produce 10 million tons lint annually consuming all cotton produced in 40,000 *mu* cotton field. (*Mu* is a Chinese area unit, equal to 667m²). The scale of the Mill would be enlarged to 50 thousand spindles. The company also invested 4 million Yuan to establish a software company in Beijing for developing new Documents Security Management System.

Introduction of Huanghe Town

Huanghe Town is located at the northeast of Jinan which is named Huanghe because the Yellow River (Huanghe) went through the whole town. The area of the whole town is about 120 km², and the area of plantation is about 6315 hectare (approximately equal to 95,000 *mu*). Huanghe Town includes 72 administration villages with the total population of 54,500. The gross domestic product (GDP) in this town could reach as high as 579 million Yuan. The annual straw yield is 12 thousand tons from cotton, 25 thousand tons from corn, and 12.5 thousand tons from wheat. (*Feasibility Study of Biomass power station by Shandong Jinnuo New Materials Development Co. Ltd. June, 2007*)

4.5 Methodology Applied

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 CO₂ emissions;
- CO₂ emissions from project related fuel and electricity consumption (biomass transportation and boiler starting);
- Optional CH₄ from uncontrolled burning for the baseline and if these are chosen, also CH₄ from biomass residue combustion in the project.

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

4.6 Monitoring Plan

The Biomass project meets all applicability of Monitoring Methodology approved in ACM0006. Because the final case actually is 5 BGPG stations bundled together. So the monitoring methodology can be duplicated from one to the else.

4.7 Additionality

The additionality check follows the “Tool for the demonstration and assessment of additionality”.

Despite of the rich biomass resources, the investment and technology barriers make biomass combustion power generation to be regarded as an unattractive technology by power sector in China.

The proposed project activity is not financially viable without the CER revenue, as there is no obligation required for the project developer to build the plant. Therefore, the emission reductions to be achieved by this proposed project are additional.

- Additionality check

Step 1: Four alternatives for the Jinan BGPG can be explored:

- 1) Construction of a fossil fuel power plant with equivalent amount of installed capacity or annual electricity output;
- 2) Construction of a power plant using other renewable energy resources with equivalent installed capacity or equivalent annual electricity output;
- 3) BGPG without CER credits;
- 4) Supply of equivalent annual power output by the Grid where the proposed project would locate.

Specific analysis on the four alternatives scenarios resulted in the following conclusions:

- 1) A similar installation capacity of a fossil fuel power plant as the proposed project (10 MW) can not happen, because coal-fired plants with a capacity of 135MW or less are prohibited from building in large grid such as provincial grids, and the fossil fuel-fired power units with less than 100MW capacity is strictly regulated for installation according to current regulations in China. Therefore, the alternative fossil fuel power plant with the equivalent power output as the proposed project refers to a fossil fuel power plant of 10MW or less, which is not possibly built either under China's existing regulatory framework. (*Notice on Strictly Prohibiting the Installation of Fuel-fired Generation with the Capacity of 135MW or below issued by the General Office of the State Council, decree no. 2002-6; Interim Rules on the Installation and Management of Small-scale Fuel-fired Generators issued in August 1997.*)
- 2) Besides biomass energy, solar PV, geothermal, hydro and wind energy are the possible renewable energy technologies that could be applied in the Central China Power Grid.

However, solar PV, geothermal and wind energy of the similar installed capacity as the proposed project are technologies far from being attractive investment in the grid in China because of the limited technology development status and the high cost for power generation comparing to fossil fuel technology. Also, hydropower is not a technology attracting investment in the region, due to lack of hydro resource in Jinan area. The low-plate geographic character of Jinan would make it impossible for wind power to be developed by some attracting investment.

- 3) BGPG without CER credits; as mentioned, not viable, see Chapter 6 in which an investment analysis based on IRR with and without CER credits is performed.
- 4) The installed capacity of the Central China Power Grid keeps increasing for many years. Hence, the alternative 4) is a feasible alternative which is also selected as the baseline scenario for the proposed project.

Step 3: Barrier analysis

- *Consistency with mandatory laws and regulations*

With regard to the Renewable Energy Law, although the Government has set the targets for China's renewable energy generation to reach 10 and 12 percent of total generation by 2020 and 2040 respectively, these targets have not become a part of the Law, and it is not yet clear how these targets will be met until all the detailed implementing regulations are stipulated. The newly issued implementation rules of Renewable Energy Law will have a positive impact on the tariff of the proposed project, which means it will be guaranteed an indicative tariff for per kWh that is 0.25 Yuan higher than the average tariff for coal-fired plants in the region. However, as a new technology, the indicative tariff is not sufficient enough to support the development of the proposed project and still requires the backing of CDM to be commercially viable.

Section 4.1 contains the confrontation of the alternatives with China's applicable laws and regulations. A further argument is that the BGPG project activity is consistent with the national policies for environmental protection, energy conservation and sustainable development. However, there exists no binding legal and regulatory requirement for this type of projects yet. It could be concluded that except alternative 1) to power generation, all the other alternatives are in accordance with the existing Chinese laws and regulations.

- *Barrier analysis*

Cost disadvantages and uncertainties in the green electric price policy in China can be listed as the first two barriers. In comparison with coal-fired power plants in China, the costs of building a biomass plant with same power generation capacity are much higher. Currently, although the Chinese central government is encouraging the renewable energy utilization, the price list and transparent supervising system/mechanisms for any renewable energy laws or regulations for this green power generated from biomass power plants are not clear at the moment.

The proposed project will be the first BGPG project in the province even in China. Consequently, the project was approved as a demonstration project in Shandong province evidently representing a technological breakthrough. This innovation implies higher development and operational risks, which are ultimately translated into a higher financial risk for the proposed project.

On the technological barrier side, even having the Shandong government already financing a 500 kW installation, there is a 200 kW installation running since 2005 and the technology is own (SDERI) developed; still the technology is not market ready for commercialisation.

Although Shandong government has given some financial support, it is about 500 million Yuan, still a small part which is mainly used in technology improvement compared with the total required investment.

Since no such grid-connected BGPG project was installed in China, there is a lack of skilled and trained manpower to build and operate this type of facilities. This also represents a technological barrier relevant to the project activity.

A large collecting and management system, including collecting, packing, storage, transportation and dispatch management, etc. is one of the essential elements for the proposed project, which involves the communication with local individual farmers and presents a no-easy mission to the inexperienced project developer. Apart from this, it is also expected that the expenses for collection and transportation will increase due to increased labour and transportation costs.

The biomass price in the local market will continuously fluctuate because of seasonable variations, which results in very unstable expenditures for operation and power generation. Due to the relatively small capacity of the plant, any change in the electricity tariff structure will greatly affect the plant's financial performance.

Step 4: Common practice analysis

Large scale biomass power plant occurred in Shanxian, Shandong province, which developed by National Bio-Energy Co. Ltd. The central boiler system is mainly based on Danish company Burnmeister & Wain Energy A/S where the direct combustion technology and process were developed.

Up to 2005, the biggest biomass gasification power generation demonstration project (Circulating Fluid Bed technology) was put into delivery in Jiangsu Province with an installed capacity of 5MW that is developed by Guangzhou Energy Research Institution under State 863 R&D Program. Therefore, biomass project and especially the BGPG project is evidently not a common practice in China.

4.8 Estimated amount of emission reductions

The emission reduction would be:

$ER_y = E_{Electricity,y} + BE_{biomass,y} - PE_y - L_y$ (equation (1) page 21/63 of the CDM guidelines).

The next section describes in detail the emission reduction generated by the project.

From the basic data from SDERI, the following estimation of emissions and emission reductions has been made as desk study. Values presented here are taken from literature and should be verified by real measured project data and information. The authors are not liable for any further use of these estimates nor can there be any right generated from these calculations.

4.9 Basic data

The biomass gasifier installation capacity will amount to 2000 kW and is expected to run 6500 hours a year, which means an availability of nearly 74%. An own consumption of 8% of the generated electricity is foreseen. As such the installation would generate an available 12 GWh a year (in comparison, China's 2005 annual electricity production according to the IEA energy statistics amounted to 24,97,441 GWh).

4.10 Emissions displaced by BGPG electricity production

The Chinese CDM authority provides the operating and built margin (OM&BM) emission factors per province. For North China to which this project belongs, the values are 1.1208 ton CO₂/MWh and 0.9397 ton CO₂/MWh respectively.

(Source : <http://cdm.ccchina.gov.cn/english/NewsInfo.asp?NewsId=1891>)

According to the simplified methodology for small scale biomass projects, the emission factor for displaced electricity by the project is equal to OM/2 +BM/2, or 1.030 ton CO₂/MWh (or kg/kWh).

This means that the project would reduce CO₂ emissions with 12322 ton CO₂ annually. As additional information, but not needed for the CDM emission credit calculations, the project also reduces CH₄ emissions with 115 kg and N₂O emissions with 159 kg.

4.11 Other emissions avoided by the BGPG installation

Before being able to estimate emissions generated by the BGPG project through the combustion of the gasified biomass, we need to know about which amounts of biomass residues are involved that fuel the BGPG.

Feasibility study data estimate the amount of biomass necessary to run the BGPG at 16900 ton per year, with 9.6% moisture content. This is equivalent to 242.761 TJ per year (at an average energy content of 15.89 GJ/ton).

Open air burning of this amount of biomass residues would generate the following amount of emissions and pollutants (according to information in the Andreae et Merlet article):

Table 4.1: Emissions generated by open air burning of biomass residues

	EF (g/kg)	Emissions (kg)
CH ₄	2.7	45630
N ₂ O	0.07	1183
GHG	78.4	1324960
NMVOC	7	118300
CO	92+/-84	1554800
NO _x	2.5+/-1	42250
SO ₂	0.4	6760
PM 2.5	3.9	65910
TPM	13	219700
TC	4	67600
OC	3.3	55770
BC	0.69+/-0.13	11661

The GHG emissions have to be added to the displaced emissions from electricity production, since they would not occur if the biomass residue is used in the BGPG. According to the CDM guidelines ACM0006, only CH₄ has to be taken into account, so about 72% of the GHG emissions related to open air burning.

In order to quantify the health impacts of the other pollutants, specific local variables have to be taken into account, the data from literature (e.g. from the European ExternE study) may not apply for the Jinan situation.

4.12 Emissions generated by the BGPG installation

Even fuelled with CO₂ free biomass residues, the running of the installation also generates emissions which have to be subtracted from the displaced emissions calculated above. The first emissions occur upstream in the process, namely from transporting the biomass residues to the BGPG site.

As informed by SDERI the biomass residues would originate from corn, wheat and cotton growing. US data on biomass residues yields for corn, wheat and cotton crops are given below, as well as the necessary area to provide such amounts and the radius of those areas (assuming they are circular and continuous). The indicative distance of 5 km mentioned by SDERI is well in range of these calculations.

Table 4.2: Comparable crop data for biomass residue generation

US data on residue yield	Ton/ha	Area needed for 16900 ton (ha)	Radius of area needed (km)
Corn	8.15	2073	2.6
Cotton lint	2.47	6839	4.7
Winter wheat	2.97	5700	4.3
Spring wheat	4.69	3600	3.4

We assume that the biomass residues will be collected by diesel fuelled trucks. In addition we assume an average capacity of 8 ton per truck, taking into account that activity will take place in a rural area without very heavy equipment (20-30 ton trucks) readily available. This results in 2112 trips per year to transport the 16900 ton of biomass residues. As the trucks will not drive in a straight line between the collection points and the BGPG site, we assume that the average return trip distance is 10 km; annually 21125 km are then driven.

The emissions associated with this fuel consumption are estimated using default IPCC emission factors for US heavy duty vehicles with moderate control measures and an assumption about the Sulphur content of the diesel fuel used:

Table 4.3: Emissions from biomass residue transport

Emissions	EF (g/km) IPCC1996 table 1-32)	Annual emissions (kg)
CO ₂	1011	21357
CH ₄	0.05	1.06
N ₂ O	0.025	0.53
GHG	1019.80	21543
NMVOC	1.13	24
CO	5.01	106
NO _x	7.96	168
SO _x (0.5%S)	0.0033	0.07

In the BGPG diesel is used for co-firing or starting up, about 10 tonnes per year (à 41.9 GJ/ton) are estimated by the project developer to be needed.

Table 4.4: Emissions from co-fired fuel

Emissions	EF (g/GJ) (IPCC2006 table I2.2 and IPCC 1-9,1-10,1-11)	Annual emissions (kg)
CO ₂	74100	31048
CH ₄	3	1.3
N ₂ O	0.6	0.3
GHG	74349	31152
NMVOC	5	2.1
CO	15	6.3
NO _x	200	83.8
SO _x (0.5%S)	0.2	0.098

As no information is yet available about biomass residue treatment, as far as they are not included in the 8% own use of the BGPG plant, we restrict further emission calculation to the biomass residue combustion.

IPCC and the CDM guidelines provide the following emission factors to be used; for only some non GHG emissions information on emission factors for other pollutants is available.

Table 4.5: Emissions from biomass residue combustion in the BGPG

Emissions from BGPG	EF kg/TJ (IPCC1996, IPCC2006 and ACM0006)	Emissions (kg)
CO ₂	0	0
CH ₄	41.1	11037
N ₂ O	5.48	1472
GHG	2561.9	687975
NM VOC	50	13427
CO	1000	268541
NO _x	100	26854

4.13 Leakage

From the Feasibility Study it was investigated that the annual straw yield is 12 thousand tons from cotton, 25 thousand tons from corn, and 12.5 thousand tons from wheat. The biomass demanded by plant in one year is 16900 ton in one 2MW plant. This means that about 16900/ (12000+25000+12500) =34% would be used as feedstock for a single plant.

Despite the fact that no official data is available, SDERI has carried out an investigation about the biomass situation in the towns around Jinan. More than 50% of the total biomass resource would be left unused annually (This data would be a conservative estimation). Now 34% would be used as feedstock of plant in the Haunches Town. That means the biomass supply is far more than the demand by the plant.

4.14 Summary

The BGPG installation would thus reduce CO₂ or GHG emissions as presented in the following emission balance table. Emission reduction are realised through the displacement of grid electricity and by avoiding open air burning of the biomass residues. The project will 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, only CO₂ and CH₄ are taken into account.

Table 4.6: Overview of emission reductions and increases by a 2 MW BGPG project

	Kg	CO ₂	CH ₄	GHG
Emission reduction	avoided electricity	12,321,790	Not required	12,321,790
	avoided biomass burning	0	45,630	9,58,230
Emission generated	biomass transport	21,357	Not required	21,357
	BGPG biomass consumption	0	11,037	2,31,778
	BGPG diesel consumption	31,048	Not required	31,048
Total	Annual emission reduction	1,22,69,385	34,593	1,29,95,837

A 2000 kW BGPG would reduce CO₂ with 12269 ton per year (or 12996 ton GHG per year as illustrated below). Or, expressed in kWh delivered by the BGPG, 860 g CO₂ or 921 g GHG per kWh will be avoided.

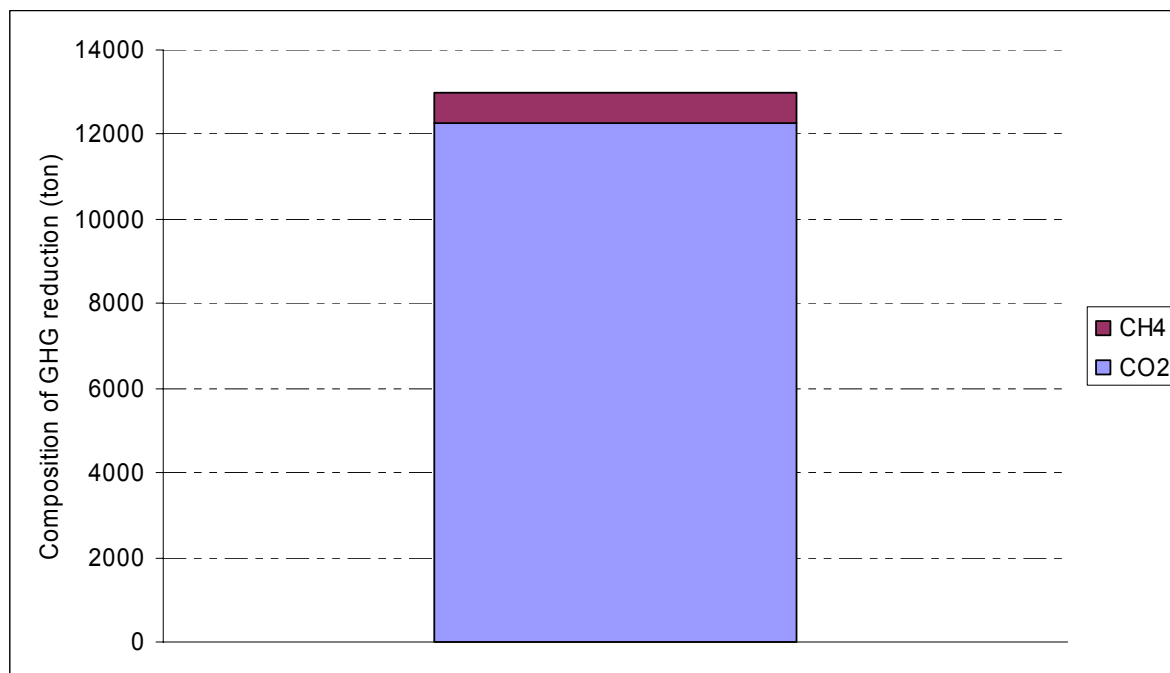


Figure 4.2: Overview of GHG reductions by the Jinan 2 MW BGPG project

The (preliminary) reduction of the other pollutants based on the difference between emissions from open air burning and from transport and use of biomass and the diesel used in the BGPG, would be as follows:

Table 4.7: Overview of other emission reductions

Kg	Open air burning	Truck transport	Biomass use	Diesel use	Reduction
NMVOC	118300	24	13427	2	104847
CO	1554800	106	268541	6	1286147
NO _x	42250	168	26854	84	15144
SO ₂	6760	0		0	6760
PM 2.5	65910				65910
TPM	219700	9	5370	0.8	214319
TC	67600				67600
OC	55770				55770
BC	11661				11661

4.15 Economics

- Introduction

An investment analysis of the Jinan project for a 2MW BGPG is made, similar as has been done in the two PDD of Shandong based projects (Shanxian and Yuncheng) in which a brief economic investment analysis is made in order to prove the non-viability of the project without CER revenues.

The same boundary conditions are taken for the Jinan case, i.e. a minimum IRR of 8%. Before actually undertaking the Jinan calculations, a check was made if the presented values in the two PDDs could be reproduced with the information given in the document. Calculations are done using the ready made formulas in Excel (NPV and IRR).

For the Shanxian case this was not possible, calculations lead to very different values compared to the ones in the PDD, see Table 1 below.

Table 4.8: NPV and IRR for the Shanxian project

	NPV		IRR	
	As reported in PDD	As calculated	As reported in PDD	As calculated
Without CER revenues	-41.3 million RMB	-87.0 million RMB	5.6%	3.5%
With CER revenues	58.5 million RMB	-23.8 million RMB	11.0%	6.8%

In contrast, for the Yucheng case, the IRRs (the only value reported, no NPV) can be reproduced closely. The fact that the value for the case with CER revenues is different may be caused by the fact that in the calculation only for the first year less CERs are taken (100774 ton CO₂ eq, see page 6 of the PDD) and for all other years the full amount (201549 ton CO₂ eq).

Table 4.9: IRR for the Yucheng project

	As reported in PDD	As calculated
Without CER revenues	3.5%	3.6%
With CER revenues	12.6%	14.2%

This approximation gave enough confidence to also reproduce the sensitivity analysis that was performed in the PDD. The same variables and ranges were used, namely a -15% to +15% difference for static total investments, for annual operational costs and for the tariffs (income).

The figure below shows the results of the calculations and is almost identical of the one presented in the PDD. Also the values show a high correspondence, the rows with suffix no CER correspond to the figure. In addition to the mentioned sensitivity, an additional one was calculated in order to see the variation in the IRR if the CER price would vary with -15% to +15%. (CER with CER)

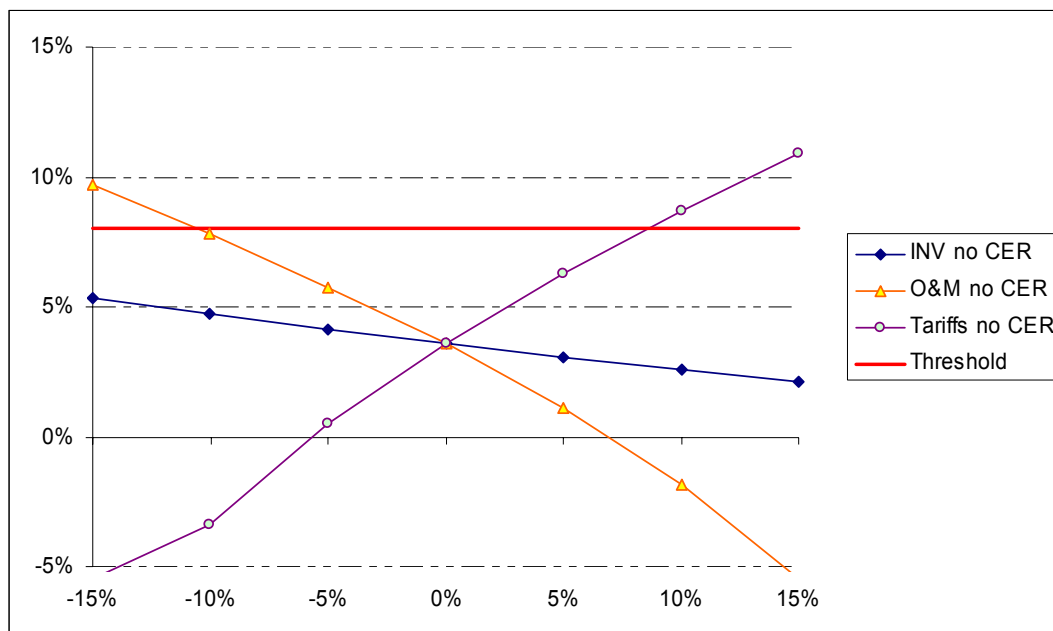


Figure 4.3: IRR sensitivity calculations done by ECN for the Yucheng project

Table 4.10: Calculated IRR sensitivity for the Yucheng project

IRR	-15%	-10%	-5%	0%	5%	10%	15%
INV no CER	5.4%	4.7%	4.1%	3.6%	3.1%	2.6%	2.1%
INV with CER	17.1%	16.0%	15.1%	14.2%	13.4%	12.7%	12.0%
O&M with CER	19.0%	17.4%	15.8%	14.2%	12.6%	10.9%	9.1%
Tariffs no CER	-5.5%	-3.4%	0.5%	3.6%	6.2%	8.7%	10.9%
Tariffs with CER	7.8%	10.1%	12.2%	14.2%	16.2%	18.1%	20.0%
CER with CER	12.8%	13.3%	13.8%	14.2%	14.7%	15.1%	15.6%
Threshold	8%	8%	8%	8%	8%	8%	8%

These results justify performing the same kind of analysis for the Jinan case.

4.16 Investment analysis for the Jinan 2MW BGPG case

As basic data for the calculations performed through Excel, the following values have been used:

Table 4.11: Data for the Jinan case analysis

Data	Value	Unit
capacity	2	MW
operation hours	6500	hours/year
own consumption	8	%
total production	11960	MWh/year
tariff	0.426	RMB/kWh
tariff subsidy	0.25	RMB/kWh
Lifetime of project	21	years
Income tax rate	33	%
CER price	80	RMB/ton CO ₂ eq
Income	8,084,960	RMB/year
	1,039,667	RMB/year
costs	5,070,000	RMB/year

	54,118	RMB/year
total costs	5,124,118	RMB/year
INV	15,520,000	RMB/year
O&M	776,000	RMB/year

For the calculation the following formula has been used for the annual net revenue of the project as was also used for the Yucheng calculations:

$$(R_t - C_t) \times (100 - \text{income tax rate}) / 100$$

with:

R_t = revenues in year t and is equal to the income for electricity sales (sum of tariff and tariff subsidy, 11960 MWh x (0.426+0.25) RMB/kWh) in the “no CER” cases and with the CER value added (12996 ton CO₂ eq x 80 RMB/ton) in the “with CER” cases

C_t = costs in year t, equal to the costs for biomass (16900 tons x 300 RMB/ton), for diesel (10 ton à 4.6 RMB/litre) and the O&M costs, it is assumed that the cost for biomass covers all costs incurred to bring the biomass to the site, i.e. market price plus transportation costs

This leads to an annual net revenue of 1 463 844 RMB/year in the “no CER” case. This has now to be compared with an expenditure of 15 520 000 RMB during 21 years.

The use of the Excel formulas NPV and IRR lead to the following values for the Jinan case.

Table 4.12: NPV and IRR for the Jinan case

	NPV	IRR
Without CER revenues	-793,481 RMB	7.3%
With CER revenues	5,667,143 RMB	12.8%

The as such calculated value of the IRR, 7.3%, lies quite close to the threshold level of 8% commonly used by industry for such projects. If for instance other costs need to be included, this value will become lower. It also needs to be mentioned that if only the tariff subsidy may be taken into account, the NPV remains negative and hence the project may have to be considered as not viable, not even with the CER revenues.

Similar to the Shanxian and Yucheng cases, a sensitivity analysis has been performed with the same -15% to +15% variations of the following parameters in the IRR calculation:

- investment costs
- tariffs
- O&M costs
- CER price
- biomass price
- electricity produced

The latter is more complicated because changes in electricity production also affect biomass consumption, ton CO₂ eq avoided from open air burning; ton CO₂ from biomass transport and ton CO₂ eq from the BGPG.

The following table summarises the outcomes of the calculations.

Table 4.13: IRR sensitivity analysis for the Jinan 2MW case

IRR	-15%	-10%	-5%	0%	5%	10%	15%
INV no CER	9.4%	8.6%	7.9%	7.3%	6.7%	6.1%	5.6%
INV with CER	15.6%	14.6%	13.7%	12.8%	12.0%	11.3%	10.7%
O&M no CER	7.9%	7.7%	7.5%	7.3%	7.0%	6.8%	6.6%
O&M with CER	13.4%	13.2%	13.0%	12.8%	12.6%	12.4%	12.2%
Tariffs no CER	-1.1%	2.1%	4.8%	7.3%	9.5%	11.6%	13.7%
Tariffs with CER	6.3%	8.6%	10.7%	12.8%	14.8%	16.7%	18.6%
Biomass costs no CER	11.4%	10.1%	8.7%	7.3%	5.8%	4.2%	2.5%
Biomass costs with CER	16.5%	15.3%	14.1%	12.8%	11.5%	10.2%	8.8%
CER with CER	12.0%	12.3%	12.6%	12.8%	13.1%	13.3%	13.6%
E-production no CER	4.5%	5.5%	6.4%	7.3%	8.1%	9.0%	9.8%
E-production with CER	9.7%	10.7%	11.8%	12.8%	13.8%	14.8%	15.8%
Threshold	8%	8%	8%	8%	8%	8%	8%

Graphically, the sensitivity results for the cases without CER revenues are illustrated below. If the investment costs would be about 5% lower than assumed, the project would already reach an IRR of 8%; also a biomass price decrease of 5% makes the project viable, given that all other parameters remain constant. If the project would generate an additional 5% of electricity (through e.g. longer running time than 6500 hours), the IRR is just above 8%. The steepest curve occurs for the tariffs, not surprisingly because this is the major component of the income part in the annual net revenue. O&M cost in contrast show a rather flat curve, so the IRR is not very sensitive to this parameter.

If, as stated above, the biomass price would be somewhat higher (e.g. 20-30 RMB/ton to take into account the costs of biomass transportation), then the IRR drops considerably to 6 or 4%.

Additional tests (not represented here) showed that in the case of multiple variations at the same time, the effects - i.e. the difference with the basic value of 7.3% - of the singles ones as given in the table can be more or less added.

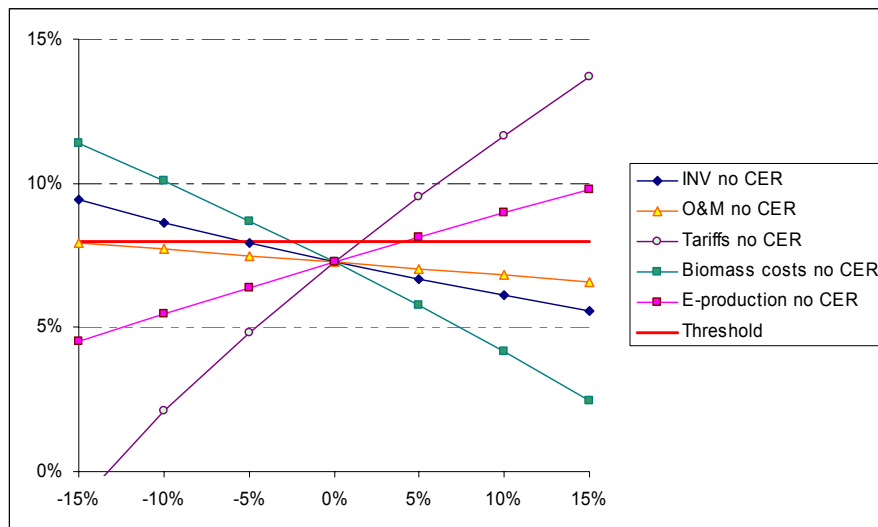


Figure 4.4: IRR sensitivity calculations for the Jinan project

Looking at the IRR variations when taken the CER revenues into account, the picture is quite similar. A reduction of about 10% in the tariffs makes the project not viable; the other parameters can vary quite broadly without dropping under the threshold level. Only if biomass price would rise to about 350 RMB/ton, the projects IRR drops below 8%. For this case an additional sensitivity has been performed to look at the impact of a variable CER price. As can be seen, the impact is limited, mainly caused to the small share in annual income from the CER revenues compared to the revenue from electricity sales.

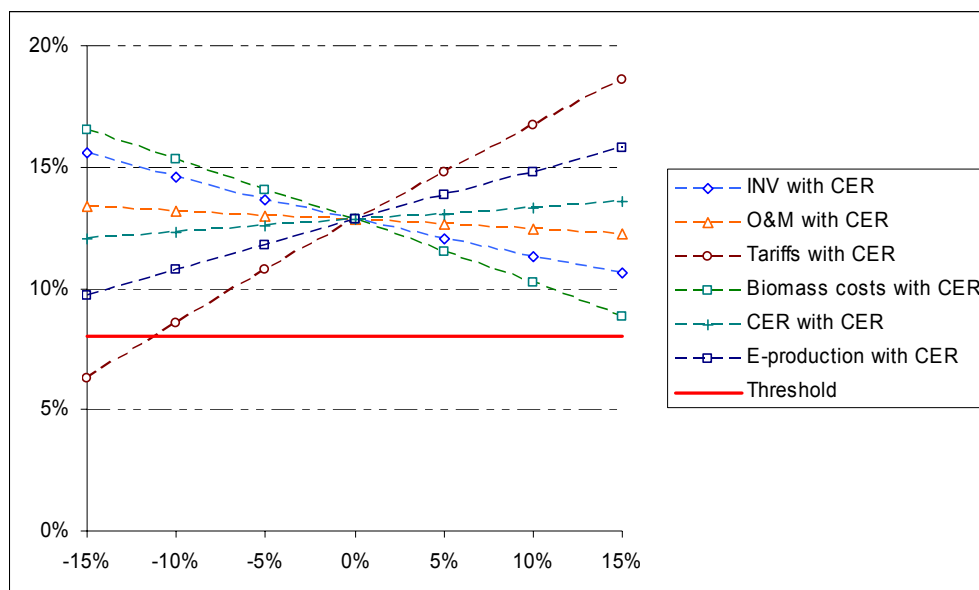


Figure 4.5: *IRR sensitivity calculations including CER revenues for the Jinan project*

4.17 Conclusion

The Jinan 2 MW BGPG project is just under economic feasibility at an IRR of 7.3%, given the estimated values as presented in Table 6.1 and given the threshold level of 8%. Project investors may choose to use other values or thresholds in order to justify internally this project.

Form a CDM point of view, the calculations show that the project is (marginally) additional since the IRR threshold level is just not reached (7.3% in stead of 8%), but small deviations (e.g. a 5% increase of biomass price or a 5% reduction in electricity tariffs) cause considerable drops in IRR. Given the uncertainty in such values, the simplified approach, similar to other CDM projects, for this small scale CDM project is defendable.

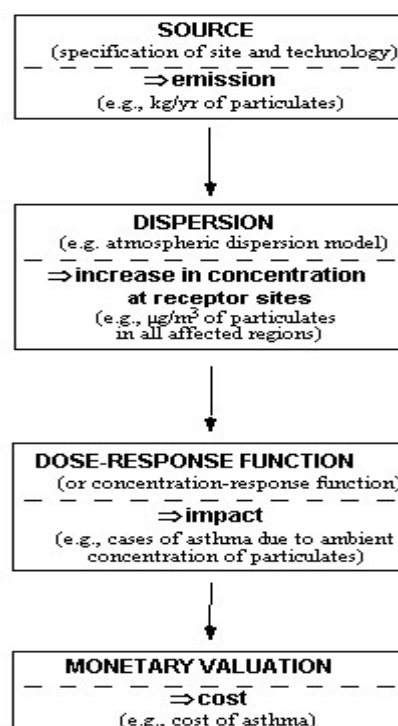


Figure 4.6: *Externalities concept*

4.18 Impact of other pollutants

▪ Introduction

For the impact of the other pollutants which are reduced by the project by replacing open air burning of biomass residues with the combustion in the BGPG, a suitable methodology is needed. One of the best known possible examples is the European ExternE project in which

a methodology and values were developed to estimate the (health) impacts of pollutants from electricity generation and others by means of external costs. These external costs are not included in any economic or market pricing but do carry a monetarised effect on human health, crop yield, building materials and others.

The methodology is based on the sequence of emissions - dispersion - concentration changes - dose response functions - impacts and finally monetarisation of these impacts. This sequence is illustrated below.

Of course, a lot of uncertainties are involved in each of the steps of this concept; therefore the European research is continuing in order to improve the methodology. As far as known, no specific methodology or parameters for China or the Jinan region in particular are available.

Nevertheless an indication is given based on the European methodology using the EcoSenseLight on-line tool

(http://ecoweb.ier.uni-stuttgart.de/ecosense_web/ecosensele_web/frame.php)

- A straightforward approach

To estimate the impact of air pollutants emissions, monetarisation is quite often used to quantify this impact. From the EU ExternE project, Rabl & Spadaro (2000) derived average damage costs of pollutants from the energy system (Table 4.14).

Table 4.14: Damage costs based on Rabl & Spadaro (2006)

Pollutant	Damage (€/kg)
CO	0.002
NO _x	16.0
SO ₂	10.2
PM10	15.4
VOC	0.9

The emission levels of the Jinan situation without and with the project are recapitulated in Table 4.15. The reduction of most pollutants is very high, above 80%, except for NO_x for which the estimated emissions from combustion in the BGPG are still quite high. If the installation would have a NO_x reducing device, these emissions could come further down. Also, there is no information available about SO₂ emissions from the BGPG, which would probably occur during the gasification of the biomass residues. The associated costs and cost difference is given in Table 4.16.

Table 4.15: Air pollutant emissions

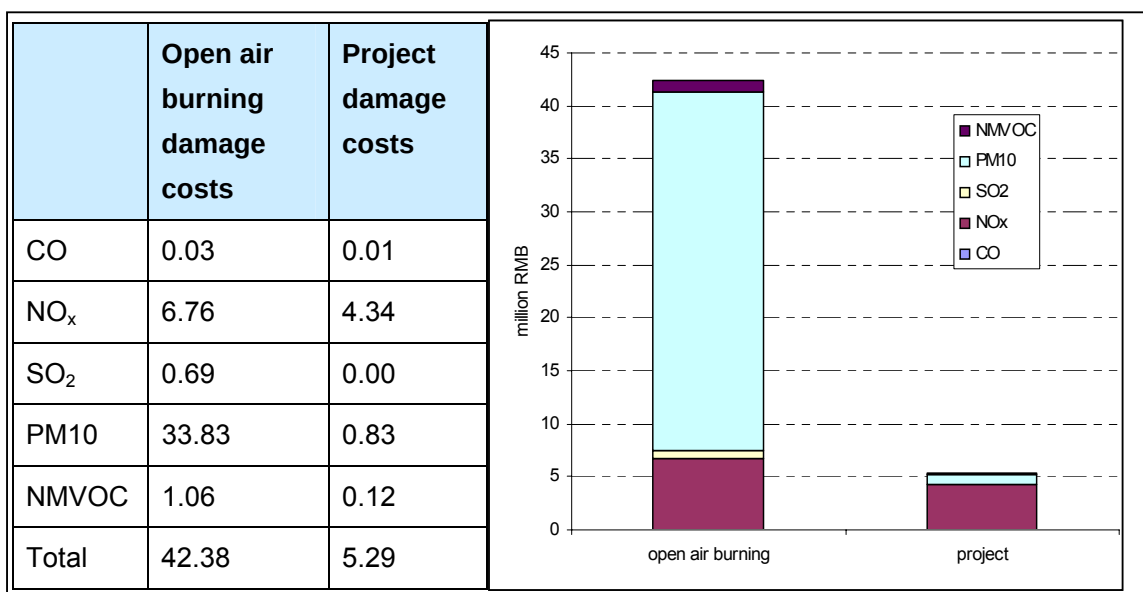
Emissions (kg)	Open a air burning of biomass residue	MW BGPG Project emissions				Emission reduction	
		Truck transport	Biomass use	Diesel use	Total	Kg	%
CO	1554800	105.8	268541.0	6.3	268653	1286147	83%
NO _x	422501	168.2	26854.1	83.8	27106	15144	36%
SO ₂	6760	0.1	-	0.1	0.2	6760	100%
Pm	219700	8.9%	5370.8	0.8	5381	214319	98%
Voc	118300	23.9	13427.1	2.1	13453	104847	89%

Applying the damage cost values to both situations, the situation with open air burning would lead to a cost of about 4.24 million € (or 42.4 million RMB). With the project in place, the damage costs would reduce to 0.53 million € (or 5.3 million RMB), an eightfold reduction compared to the open air burning situation.

Even if the used damage cost would not apply for Jinan, these cost calculations give a clear picture of the size of environmental impact reduction that could be achieved by the project, which is about 88%.

The largest cost reduction is due to the reduction of particulate matter (PM) (33 million RMB out of 37 million RMB), followed by the NO_x reduction contribution. However, damage by NO_x emissions remains the major item in the remaining damage costs (82%).

Table 4.16 Damage costs (million RMB)



Again, if these emissions, by applying NO_x reduction techniques on the BGPG plant, could be reduced further, the environmental and human health damage would reduce further, increasing the indirect benefits of the project for its surrounding area and people.

- The EcoSenseLight approach

A more detailed approach and calculation of the human health and environmental damage can be performed by using the EC developed EcoSenseLight methodology. Although the methodology is developed for Europe, some comparison for Jinan can be made. Again as in the previous section, the focus will be on relative damage reductions, not so much on the absolute values - although these will be given as well to indicate the order of magnitude.

4.19 Brief methodological description

The EcoSenseLight on-line calculation tool allows calculating damage effects on human health (mortality and morbidity), on crops and on building materials (seeing http://ecoweb.ier.uni-stuttgart.de/ecosense_web/ecosensele_web/ERF_and_MonVal_for_EcoSenseLE_V1.3.pdf for a detailed description). These calculations can be performed for all 25 EU member countries as well for groups of EU countries.

For the air pollutants, NO_x, SO₂ and VOC emission levels need to be given as well as the height on which they are emitted and the area where they occur. To simulate the Jinan case, calculations with emissions at ground level and in a rural area are performed for each member state. For the impacts, only the impacts within the members state's borders is taken into account since emissions in one member state do not only affect environment and health

within that member state but also in surrounding ones. These last effects are not taken into account because the focus is on the impact on the direct and local surroundings of the Jinan situation.

For the monetarisation, the default value of 75 000€/YOLL (Year of Life Lost) is maintained.

The effects of the pollutants are translated to effects by ozone (O₃), particulate matter (PM₁₀) sulphates and nitrates on human health and by N and S and related acids' depositions on crops and buildings.

4.20 Comparison between impacts by open air burning of biomass residues and the Jinan BGPG project

A first series of on-line calculations was performed with the emission levels generated by open air burning of 16900 ton of biomass residues. The second series covered the emissions by the 2MW Jinan BGPG project (see Table 4.15).

The table 4.17 gives a summary of the results, and it should be noticed once more that not the absolute levels are the most important, the relative changes and differences are. The variations of the impacts among the member states are quite large, with PM having the largest contribution to the impact on mortality and morbidity. If for other substances (like ozone) negative values occur, these are explained by the fact that the concentrations of secondary pollutants may decrease according to chemical transformation due to some emission of primary pollutants. Total health damage varies between 4.9 and 7.3 million € (or 49 to 73 million RMB) with mortality having the largest impact shares almost twice the one from morbidity.

Table 4.17: Health impacts from open air biomass residue burning according to EcoSenseLight calculations

€	Mortality			Morbidity			Total health impacts		
	Min	Reference	Max	Min	Reference	Max	Min	Reference	Max
O ₃	-150	4150	4360	-467	13000	13600	-617	17150	17960
PM10	3190000	4310000	4730000	1640000	2210000	2430000	4830000	6520000	7160000
Sulphate	266	12500	13900	137	6400	7150	403	18900	21050
Nitrate	644	84800	87900	331	43600	45200	975	128400	133100
Total rounded	3250000	4410000	4830000	1670000	2280000	2490000	4920000	6690000	7320000

In the figure 4.7 below, the variation compared to the results for all countries - i.e. the case where the emissions would occur somewhere in the EU and therefore no effects outside occur and represented by the reference values in *Table 4.17* - is shown. As can be seen, the PM impact and total health impact lay closely together, yet another indicator of the large contribution of PM to the health damage.

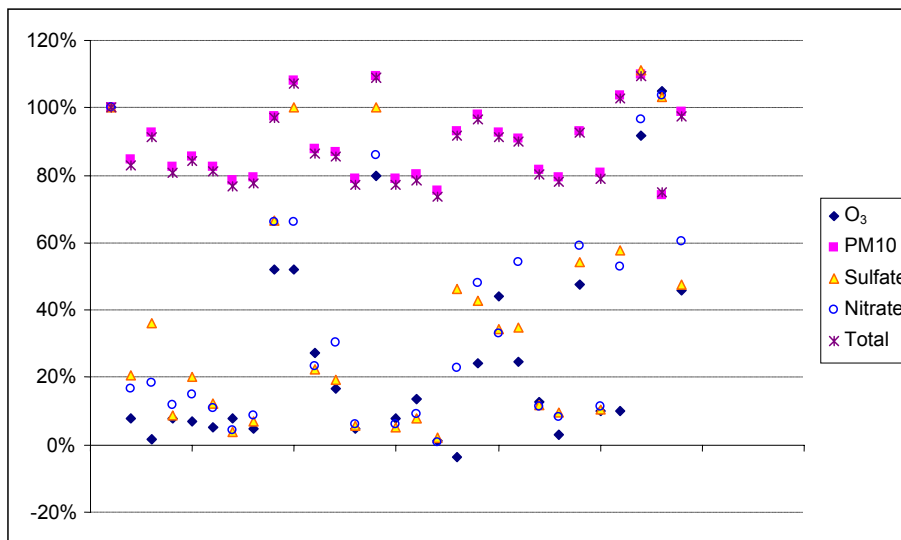


Figure 4.7 Variation in health impacts from different substances compared to the reference value for all countries (valid for both mortality and morbidity)

In order to review the robustness of the results, a number of sensitivity cases have been run with YOLL values varying between 5000 and 125 000€. These runs showed that the mortality impacts of the different substances are directly proportional to the YOLL values, for morbidity only the PM impact is directly proportional, the impact of the other substances is constant.

Table 4.18: Impact of variable YOLL values on health impacts by substance

	Mortality					Morbidity				
YOLL value	Ozone	PM10	Sulphate	nitrate	Total	Ozone	PM10	Sulphate	nitrate	Total
7%	7%	7%	7%	7%	7%	100%	7%	100%	100%	9%
13%	13%	13%	13%	13%	13%	100%	13%	100%	100%	16%
33%	33%	33%	33%	33%	33%	100%	33%	100%	100%	35%
67%	67%	67%	66%	67%	67%	100%	67%	100%	100%	68%
100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
133%	133%	133%	133%	133%	133%	100%	133%	100%	100%	133%
167%	167%	167%	166%	166%	167%	100%	167%	100%	100%	165%

A similar analysis has been done for the impacts on crops and building materials exposed to the effects of the pollutants' emissions. The damage on these elements is however an order of magnitude smaller than the health impacts - now about 0.06 million € or 0.6 million RMB on Reference - and with a much wider range. Negative values for yield losses on crops may occur because of fertilising effects of SO₂ and N deposition. The minimum and maximum of the total impact is not equal to the sum of the minimum and maximum of crops and materials separately because these extremes do not necessary coincide for the same EU country.

Table 4.19: Crop and material damage impacts from open air biomass residue burning according to EcoSenseLight calculations

€	Crops			Materials			Total impacts		
	Min	Reference	Max	Min	Reference	Max	Min	Reference	Max
Deposition of N and related Acids & O ₃	-232	56100	13800	19	2670	3140	58	58770	138831
Deposition of S and related Acids & SO ₂	-260	-86	34	62	1580	2040	60	1494	2048
Total (rounded)	-238	56000	138000	81	4240	5180	267	60240	13950

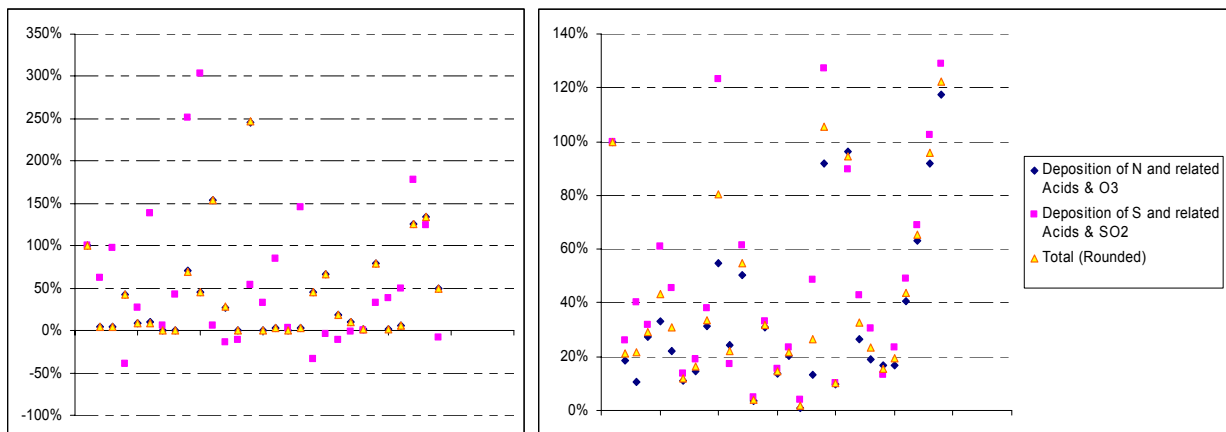


Figure 4.8: Variation is damage impacts from different substances compared to the reference value for all countries (crops left and materials right)

The second series of runs comprised the pollutants' emission impact from the 2 MW Jinan BGP project. Table 4.20 contains the outcomes of the runs. The damage reduction on health is more than 96%, on crops and materials it is more than 80%. The fact that PM emissions are reduced considerably by the project explain this large reduction in health damage, the reduction in crop and material damage is less clear to allocate to a single emission source. Again, the impacts on crops and materials are much less than the health impacts.

Strangely enough, the project creates also health benefits from sulphates, but this may be due to methodological shortcomings of the simplified on-line calculations or to the fact that chemical transformations take place in the path between emissions and impacts. For each of the substances, the damage reduction is well over 90%, except for nitrates. As explained in the previous section, this may be due to the fact that the project generates still a considerable amount of NO_x emissions.

Table 4.20: Health and other damage impacts from the Jinan BGPG project according to EcoSenseLight calculations

€	Mortality			Morbidity			Total health impacts		
	Min	Reference	Max	Min	Reference	Max	Min	Reference	Max
O ₃	-1250	233	368	-3900	727	1150	-5150	960	1518
PM10	78100	105000	116000	40200	54200	59500	118300	159200	175500
Sulphate	-1830	-1330	-2.08	-942	-683	-1.07	-2772	-2013	-3.15
Nitrate	417	55100	57300	214	28300	29400	631	83400	86700
Total (rounded)	80100	159000	168000	41100	82600	85500	121200	241600	253500
€	Mortality			Morbidity			Total health impacts		
	Min	Reference	Max	Min	Reference	Max	Min	Reference	Max
Deposition of N and related Acids & O ₃	-2640	10300	27500	12	1710	2020	-1949	120	27920
Deposition of S and related Acids & SO ₂	-0.006	-0.002	0.001	0.002	0.039	0.050	0.001	0.037	0.051
Total (rounded)	-2640	10300	27500	12	1710	2020	-1949	120	27920

4.21 Conclusions

The Jinan BPGG 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, etc. 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 reduce with 88% following the simplified approach. If a more detailed analysis is followed using the on-line EcoSenseLight tool, health damage would decrease with 96% and material (crops and building materials) with 80%. In both cases the largest share of damage reduction is caused by a significant reduction of particulate matter emissions by switching from open air biomass residue burning to the BPGG project.



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