Low Carbon Development Options

for Indonesia

Emissions Reduction Opportunities and Policies

Transport Sector

Technical Report

Acknowledgements. The National Council on Climate Change would like to thank representatives from Government agencies, in particular the Ministry of Finance, representatives from private sector, academia and NGOs who contributed their time and expertise to this effort. The GOI would also like to thank the World Bank, AUSAID and the Netherlands Embassy for the support for this study. In addition to the members of the Working Group on Fiscal Policy for Climate Change and members of the National Council on Climate Change provided advice, guidance and technical inputs on the approach and the report. Dollaris Riauaty Suhadi, Ahmad Safrudin, Khoirunnurofik, Tory Damantoro, Muhamad Agung, and Marc-Antoine Dunais contributed to this report as consultants to Swisscontact and Gary Kleiman and Timothy Brown contributed to this report as consultants to the World Bank.

Emissions Reduction Opportunities and Policies

Transport Sector

Technical Report

Foreword

In December 2007, Indonesia hosted the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties 13 in Bali, and with it a High Level Event on Climate Change for Ministers of Finance. During these events, the President of Indonesia launched the National Action Plan for Climate Change. Ministers of Finance also agreed that it is in the global interest to improve international financing mechanisms and develop innovative approaches for climate financing. As a result, it is now widely understood that climate change is a development issue.

In 2008, Indonesia published its blueprint for integrating climate change mitigation and adaptation into the national planning and budgeting process. The President also formed the National Council on Climate Change as the focal point on climate change and a focus for intra-governmental coordination, and other areas of technical assistance, outreach and capacity building. The National Council has engaged with external partners and key stakeholders, including the Ministry of Finance, on climate change adaptation and mitigation issues, including low carbon development.

Mitigating and adapting to climate change requires macro-economic management, fiscal policy plans, revenue raising alternatives, insurance markets, and long-term investment options. The Ministry of Finance recognizes the need to manage these challenges by adopting budget priorities, pricing policies, and financial market rules. To do this, the Fiscal Policy Office appointed a working group to study and map out fiscal issues for climate change.

The GOI is collaborating with the World Bank and other donors to conduct the technical studies needed to inform the low carbon development strategy. The Governments of Netherlands and Australia have also contributed resources and expertise to this effort. The low carbon work begins with the premise that sound environmental management, reduction of emissions, economic efficiency and growth are compatible goals, important to the sustainability of Indonesia's development path.

These results can serve as an input to the Government's discussions of appropriate fiscal policy instruments to promote low carbon development, carbon markets, and climate finance opportunities.

Head of Secretariat
National Council on Climate Change
Jakarta, April 2010

Abbreviations and Acronyms

AISI	Association of Indonesian Motorcycle Manufacturers	$ktCO_2e$	Thousand Tons of Carbon Dioxide equivalent
ASEAN	Association of South East Asian Nations	MBCD	Million barrel crude per day
BAPPENAS	National Development Planning Board	MDB	Multilateral Development Bank
CAI-Asia	Clean Air Initiatives for Asian cities	MDG	Millennium Development Goals
CDM	Clean Development Mechanism	MEMR	Ministry of Energy and Mineral Resources
CER	Certified Emission Reductions	MoC	Ministry of Communication
CF	Carbon Finance	MoE	Ministry of Environment
CH_4	Methane	MoF	Ministry of Finance
CIF	Climate Investment Funds	MOFr	Ministry of Forestry
CNG	Compressed Natural Gas	MoI	Ministry of Industry
CO	Carbon monoxide	MPV	Multi-Purpose Vehicle
CO_2	Carbon dioxide	$mtCO_2e$	Million Tons of Carbon Dioxide equivalent
CO_2e	Carbon dioxide equivalent	NGO	Non-governmental Organizations
COP	Conference of the Parties	NOx	nitrogen oxide
CPF	Carbon Partnership Facility	NSW	New South Wales
DNA	Designated National Authority for CDM	PM_{10}	Particulate matter smaller than 10 microns
ECE	Economic Commission for Europe	ppm	parts per million
EE	Energy Efficiency	PSO	Public Service Obligation
EPA	Environment Protection Agency	RE	Renewable Energy
EU	European Union	REDD	Reduced Emissions from Forests Deforestation and Degradation
Gaikindo	Association of Indonesian Automotive Industries	RVP	Reid vapor pressure
GDP	Gross Domestic Product	SDR	Social discount rate
GHG	Greenhouse gas	SO_2	Sulfur dioxide
IEA	International Energy Agency	tCO_2e	Tons of Carbon Dioxide equivalent
IPCC	Intergovernmental Panel on Climate Change	UNFCCC	United Nations Framework Convention on Climate Change
kPa	kilo Pascal	WRI	World Resources Institute

Contents

Figures

Tables

Executive Summary

The Indonesian transportation sector is currently the nation's largest consumer of petroleum products and a large source of greenhouse gas (GHG) emissions overall. Without significant actions to reduce the carbon intensity of the transportation sector, GHG emissions are projected to double in less than 10 years. With the growing global focus on climate change issues, as well as increasing urbanization and growth in fuel use in Indonesia, there is now a good opportunity to address transportation sector emissions in a comprehensive manner.

The Government of Indonesia (GOI), in particular the Ministry of Finance has commissioned a Low Carbon Development Options study to evaluate and develop strategic options to reduce emissions intensity without compromising development objectives. The Ministries of Industry and Environment have already identified important sectoral opportunities and the Agency for the Assessment and Application of Technology (BPPT) has prepared a technology needs assessment for climate change mitigation. This paper provides additional support and analysis toward development of a practical and coordinated approach to managing transportation sector emissions. The report focuses on a few key policy options (both within the Ministry of Finance and other Ministries) that could start the GOI on a path to reduced carbon intensity for the transportation sector. This report adds an economic and policy dimension that may usefully complement prior work and engage the Ministry of Finance more actively in the quest for cost-effective emissions reductions.

This report describes the factors affecting transport sector emissions in a simple overview framework. To begin reducing emissions within the Indonesian context (both greenhouse gases and conventional pollutants), simple policies in the transportation sector that promote economic efficiency and incentives could help. In particular, GHG reduction policies that increase fuel savings from cars and trucks would give multiple benefits. Based on international experience, the simplest way to reduce fuel use (and associated GHG emissions and air pollution) is through vehicle emission and fuel quality standards. Specifically, by progressing from Euro 2 to Euro 4 standards for vehicle emissions and fuel specifications, GOI can significantly bring down the rapid projected growth of on-road vehicle emissions. However, the fuel-saving and air quality-improving technologies built into Euro 4 vehicles depend on uniform fuel quality, which requires regulation and enforcement of fuel quality standards. In parallel, compressed natural gas

(CNG) use for high-use public transport vehicles should be revitalized to decrease reliance on higher emitting diesel fuel and gasoline.

Several complementary actions can ease the implementation burden of these measures. Restructuring the vehicle taxation system to include incentives that are based on emissions or fuel consumption levels will allow consumers to contribute to reducing vehicle emissions. The introduction of mandatory labeling of CO_2 emissions from motor vehicles sold on the Indonesian market will help consumers to make informed purchasing decisions. Finally, ensuring adequate uniformly clean fuel supply through expansion of domestic refinery capacity will be needed to enable the Euro 4 transition.

These are all reasonable "no regrets" policies that can be recommended from the point of view of health, pollution, social costs, energy efficiency and security – not just climate or low carbon rationales. In fact, these policy options appear to be extremely cost-effective providing high net benefits as shown by cost-benefit analysis. These recommendations should be considered—and applied—as a whole, rather than as individual actions to be taken in isolation from each other. An integrated strategy that includes tighter vehicle and emissions standards, fiscal corrections and technological improvements is the best path to effectively increase energy security and improve the well-being of Indonesians.

Recommendations are also provided for a follow-up economic analysis to examine mechanisms for implementing these potential policy options and the macroeconomic implications of both the "no regrets" policy options that make sense from the perspective of public health and economic efficiency alone, as well as complementary fiscal policies designed to ease implementation burdens.

In addition to economic analysis, there is a need to coordinate recommendations across ministries responsible for transportation planning and other transportation system stakeholders (clearly a fiscal policy component of planning lies with the Ministry of Finance). The "focus group discussions" or FGD process that has been implemented for other sectors in the low carbon development study can serve as a model for transportation sector planning that would examine both the institutional context for short-term actions and give more thought to options beyond fuel quality and fuel efficiency. These include transport demand management, bus rapid transit (i.e., TransJakarta Busway), expanded rail service, non-motorized transport, alternative fuels, and smart growth strategies. This coordination should serve as a foundation for integrated transportation planning that encompasses climate policy and reduced carbon intensity as a central component of urban planning for sustainable economic development.

Section 1

Introduction and Background

Climate change is a strategic and development challenge facing Indonesia. The Government of Indonesia (GOI) recognizes climate change as a key economic development and planning issue. The GOI also acknowledges that early action to address mitigation and adaptation concerns will be strategically and economically beneficial for Indonesia. As one important step on mitigation, the GOI has embarked on a Low Carbon Development Options Study as an opportunity to evaluate and develop strategic options to reduce emissions intensity without compromising development objectives.

The first phase of low carbon work showed that Indonesia is a relatively large greenhouse gas (GHG) emitter, especially from forests and land use, but also from fast growing fossil fuel use. Among fossil fuels, oil is currently the main contributor of emissions. However, emissions from use of coal have been the fastest growing for the last decade, attributed to its increasing use in electric power generation. Among economic sectors, transportation is the largest consumer of oil and is experiencing rapid increased demand. Road transport is the largest fuel consumer, nearly the only one of consequence. Emissions are roughly split between use of Motor Gasoline and Gas/Diesel. The future projections for transportation demand are an area of great concern if current technology and efficiency trends hold. Electric power generation is the fastest increasing source of emissions, which also has implications for manufacturing which relies on power for many processes. The industrial sector is the largest single source of greenhouse gas emissions from fossil fuel use.

The second phase of the study (ongoing) will help to inform the GOI about the main emissions reduction potentials by source and category of use, to estimate the potential costs and benefits associated with movements toward alternative development paths, and to build consensus toward appropriate approaches for lowering emissions. Other ongoing analyses include a macro policy options element and four sector analyses covering transportation (this study), forestry and land use, power generation, and manufacturing. This study about emissions reductions opportunities in the transportation sector is an important component of the Low Carbon Development Options Study.

Mobility is key to economic development. Economic specialization and trade require the ability to move goods and labor as well as both service providers and consumers. Globally, transport technologies rely primarily on liquid petroleum fuels (95 percent). In 2004 at the global level, the transportation sector was responsible for 6.3 Gtons of CO_2 emissions (about 12% of the total). Road transport is responsible for 74 percent of these emissions.

In 2004 in Indonesia, the transportation sector emissions are much lower at 78 Mtons of CO_2 emissions (representing about 23% of the total). However, road transport makes up an even larger share of the sector emissions, 88 percent. This highlights Indonesia's higher carbon intensity with a much lower fraction of the population served. Future emissions will be even larger because demand for transportation is growing globally at 2 percent per year. In Indonesia, transport emissions are projected to double within 10 years. Freight transport has been growing even faster than passenger traffic and is expected to continue, particularly in developing economies like Indonesia (Kahn Ribeiro et al., 2007).

Within Indonesia, transport is the largest user of liquid fuel, due to growth in vehicle fleet and the low price of liquid fuel products for transportation. Low fuel prices (held down by government subsidies) mask improvements in vehicle efficiency that may be taking place over time. Aside from emissions, road transport is also associated with traffic fatalities and injuries, air pollution, traffic congestion, and oil dependence.

With the growing focus on climate change issues and the potential for carbon market finance and other forms of assistance, there is now a good opportunity to pursue several key initial steps that will lay the groundwork for a comprehensive plan to address transportation sector emissions. Because vehicle emissions from road transport is the largest source of emissions, this initial report focuses mainly on vehicle standards and fuel quality options that can improve emissions, with substantial co-benefits in terms of health effects and costs. However, it is also prudent and timely for Indonesia to begin consideration of broader transport strategies that begin to deal with the numbers of vehicles on the road and the transport options offered to a growing urban population. Shifts in the mode of transport (mass transit options, buses, trains) will ultimately be more effective in providing cleaner transport options. This is an introductory study that will be followed by a more comprehensive effort to evaluate broader transport options and their costs and benefits for Indonesia.

The Government of Indonesia, in particular the Ministries of Transport and Environment and the Agency for the Assessment and Application of Technology (BPPT), has already prepared a technology needs assessment for climate change mitigation and identified important transport sector issues and opportunities (BPPT and KLH, 2009). A detailed description of the current transportation situation, both globally and in Indonesia, is presented elsewhere (Kahn Ribeiro et al., 2007; BPPT and KLH, 2009). This analysis is focused on identifying and prioritizing key fiscal policies and programs that will complement and support other GOI actions in the transport sector. This paper adds an economic and policy dimension that may usefully engage the Ministry of Finance more actively in the quest for cost effective emissions reductions.

The structure of this report is as follows. Section 2 provides important Indonesian context on the current transportation system and the current state of policy development. Section 3 provides a review of global low-carbon transportation options and a sample of best practices that may be applicable in Indonesia now and in the future as part of a more comprehensive low carbon program for transportation planning. In Section 4, this report identifies the set of key mitigation options that make sense for the GOI to pursue in the near-term given the specific issues and options that have been described in the prior sections. Finally in Section 5, we summarize and prioritize those fiscal policies that are most important for the GOI to address now and link MoF options with potential policy goals of other Ministries to lay out a strategic and coordinated low carbon transportation development plan.

Section 2

Indonesian Context

The transportation sector is the largest consumer of primary energy in Indonesia responsible for nearly half (48 percent) of the country's primary energy use in 2005. While there are a variety of modes and fuels that contribute to this energy use, this section demonstrates that cars and trucks running on petroleum-based fossil fuels dominate GHG emission sources. It is recognized that a number of policy approaches, regulations, and laws have been formulated to deal with the complex set of social, environmental, and development issues that arise through modern transportation systems. This section, however, will focus on issues of fuel pricing and quality, which are fundamental bases on which to build improved performance and future, bolder steps. More appropriate fuel pricing will help to send a signal and create an incentive for greater fuel efficiency and stimulate a search for cheaper transport options. Fuel quality improvements will support the introduction of modern fuel-efficient technologies and vehicles, in line with what Indonesia's Asian neighbors have already achieved. These actions will help to move toward emissions reductions with substantial domestic co-benefits. Fiscal policies that support these regulatory efforts can be developed to ease the regulatory hurdle and lay the foundation for broader transportation plans that are integrated with economic development and sustainability issues including climate change, air quality, and public health.

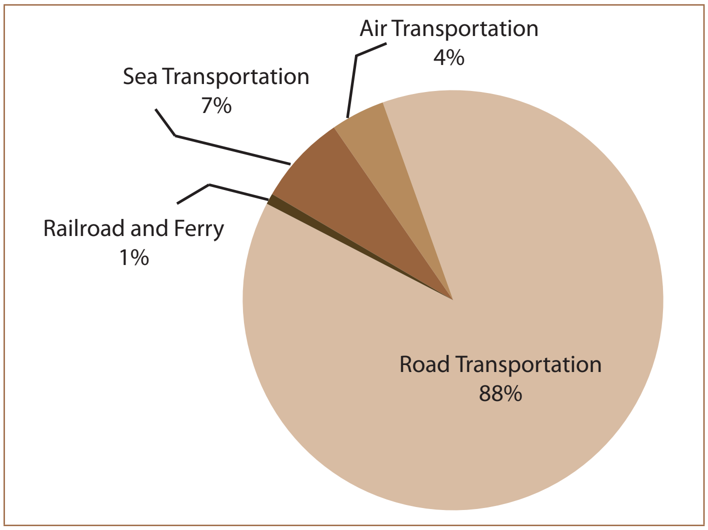
This section provides an overview of the transportation sector, the Indonesian policy framework, regional examples of successful transportation interventions, and reviews opportunities and barriers to improvements in fuel quality and emissions.

2.1 The Indonesian Transportation Sector

This section addresses sources of emissions broken down by the types of fuel, the modes of transport, the types and numbers of vehicles, as well as the emissions from different vehicle types. GHG emissions from fossil fuel combustion in Indonesia are growing very rapidly (six percent per year), faster than GDP (MoF & WB, 2008). Although emissions from the use of coal have been the fastest growing compared to other fossil fuels during the last decade, oil is currently the main contributor to total emissions.

Transport Fuels. Almost all the energy consumed in the transportation sector (99.7 percent) comes from three liquid fuels: gasoline (bensin), diesel (solar), and jet fuel (avtur). Combustion of these fuels leads to about 75 Million tons of CO_2 (KLH, 2008). Gasoline and diesel contribute over 91 percent of this total, dominating the transportation fuel market. This section focuses on these fuels as the primary current source of mobility and emissions. It is recognized, however, that in the future a variety of alternative fuels and technologies – including biodiesel, CNG, electric or hybrid-electric automobiles and even fuel cells – may become more prominent depending on the country's transportation plans and policies.

Figure 1 Share of primary energy use within the Indonesian transportation sector (2005).



Source: Indonesia Technology Needs Assessment (BPPT and KLH, 2009)

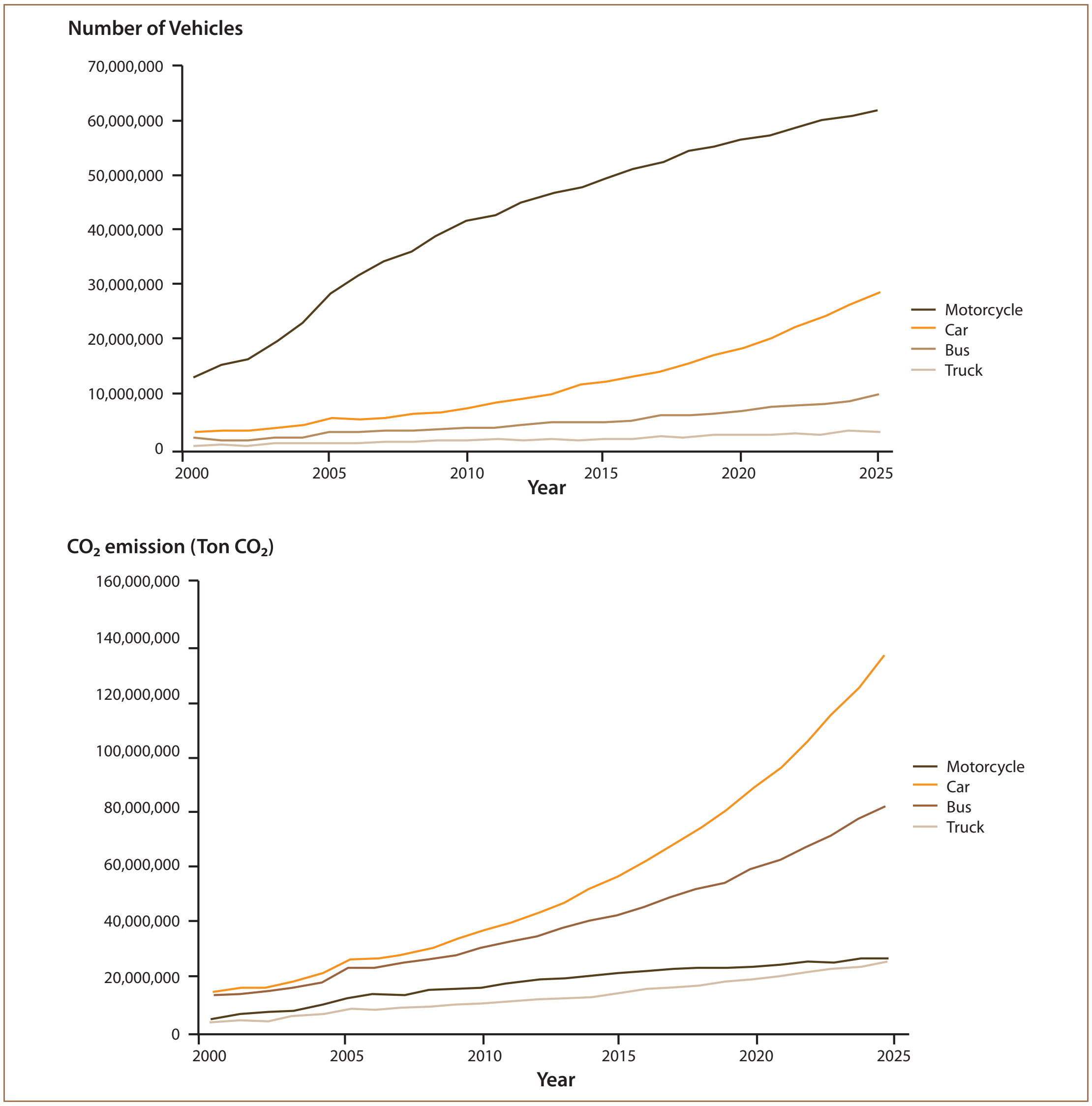
Transport Modes. Relatively few modes of transport utilize the vast majority of these fuels. Primary energy consumption by transportation mode can be seen in Figure 1. Road transportation consumes 88 percent of primary energy consumption in the sector. Sea, air, railroad and ferry transportation consume only moderate amounts: 7 percent, 4 percent, and 1 percent of primary energy consumption respectively (BPPT and KLH, 2009).

Vehicles. Road transportation means vehicles: cars, trucks, and motorcycles. Looking at numbers, 2-wheel vehicles (motorcycles and scooters) dominate with over 34 million in 2007, and projections to grow to 60 million by 2025. In comparison, there were almost 6 million cars and 3 million trucks in 2007. BPPT and KLH (2009) project that 4-wheel vehicle numbers could grow to 30 million cars and 10 million trucks by 2025.

Vehicle Emissions. Vehicle emissions do not follow vehicle numbers. Because of relative fuel efficiency and differences in emissions, the smaller number of cars and trucks actually produce more emissions than the much larger number of motorcycles. The *Technology Needs Assessment for Climate Change* (BPPT and KLH report, 2009) estimates that car and truck emissions are about twice as high as motorcycle and bus emissions in 2005. By 2030, however, based on the projected vehicle numbers above, emissions could be 140 million tons per year from cars, with another 80 million tons per year from trucks, respectively 6 and 4 times the projected motorcycle emissions.

Analytically then, focusing on Indonesia's current portfolio of sources and vehicles, measures to address GHG emissions from transportation should focus on the large and growing share from gasoline and diesel cars and trucks. As we will see in the following section looking at the current policy context in Indonesia, there are good reasons for improving the quality of these fuels in order to build the foundation for comprehensive transportation program to address these large emission sources. Additional options for addressing emissions involve creating options and encouraging the shift to alternate modes of public transit that would reduce dependence on vehicles and provide co-benefits in terms of pollution and city planning. These issues will be taken up in a later report.

Figures 2a and b Projected Indonesian vehicle numbers and CO_2 emissions.



Source: Indonesia Technology Needs Assessment (BPPT and KLH, 2009)

2.2 Indonesian Transportation Policy Framework

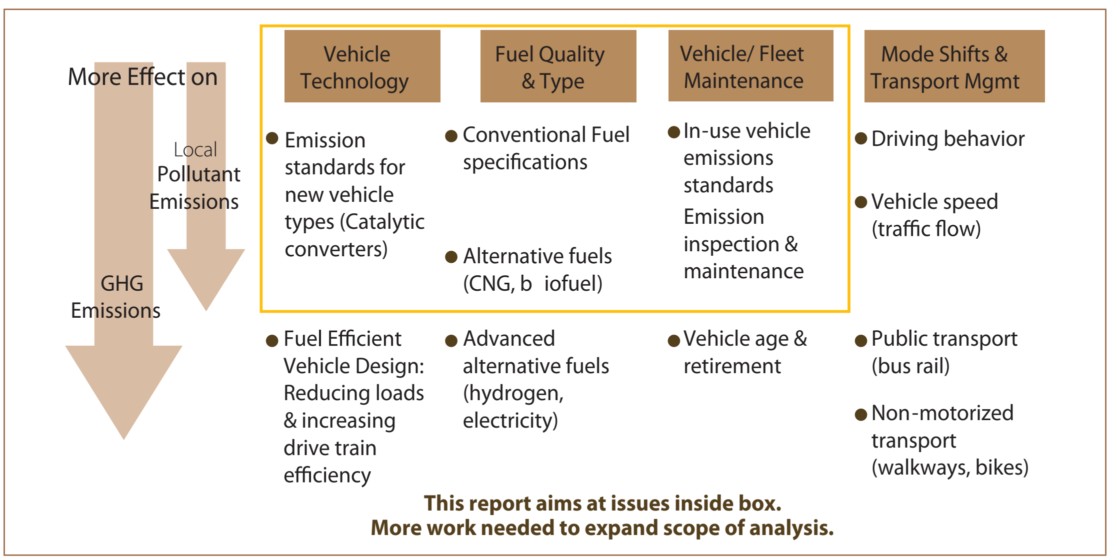
Recently, the GOI has been considering the efficiency and sustainability of its energy policies. Financial sustainability is a well-understood risk, since holding domestic energy prices below global levels creates a budgetary drain of billions of dollars per year and the gap grows as oil prices rise. Transportation absorbs 47 percent of the fuel subsidy, which rose to nearly US$ 15 billion in 2008. This represents approximately 13 percent of the GOI's total expenditure (Abdurahman, 2008; World Bank, 2007). Although the world's crude oil prices have declined sharply as of early 2009, it is projected that as markets recover, fuel prices will again rise putting pressure on the state budget.

Sustainability also refers to environmental and social appropriateness. Bappenas (2007a) describes the importance of fossil fuels and minerals in Indonesia's development, while also noting risks to the sustainability of the country's growth. Relatively low energy consumption per capita and high energy-intensity indicates both Indonesia's relatively low welfare and inefficient use of energy. Over-reliance on natural resources including fossil fuel energy resources negatively impacts the environment and disrupts quality of life and livelihoods of both poor and affluent Indonesians (Bappenas, 2007a).

The following figure provides an overview framework of factors affecting transport sector emissions. Categories of possible actions (across the top) include vehicle technology, fuel quality, vehicle maintenance, and modal shift. Within each category, there are a range of actions that can be taken, some of which have more effect on reducing local, hazardous pollution emissions (e.g., particulates, sulfates); while other actions have more potential effect on green house gas emissions (which are not hazardous in the local environment). In keeping with its development position, Indonesia has made some progress in the areas defined by the yellow box (and these are the focal areas of this section). Within this framework, the actions may be inter-related. For example, improvements in fuel quality may be needed to allow the introduction of certain vehicle technologies (e.g., catalytic converters, a tailpipe device).

Generally, a transportation policy framework that aims to reduce emissions would implement increasing standards and technologies over time, moving from lax emissions controls toward stricter ones. Indonesia has initiated this process by imposing some standards on vehicle performance and fuel quality. However, Indonesia has not been particularly aggressive in continuing to upgrade and improve standards over time, as some neighboring countries have done. These issues of fuel quality and emissions standards are explained in more detail in the following sections.

Figure 3 Factors Affecting Transport Sector Emissions



Source: SwissContact, 2009. Analysis of Fuel Quality and Air Pollution Issues in the Road Transportation Sector. Technical input paper for low carbon options study for World Bank. With modifications from Kahn Ribeiro, et al, 2007.

It is with this perspective that the GOI, faced with a variety of options to mitigate GHG from the transportation sector (See Section 3 for a more complete review), has thus far focused – with modest success on fuel efficiency and quality. More effort could be placed on improved vehicle technologies by introducing tighter standards on both vehicles and fuels. The following sections review opportunities and barriers to further progress along the range of options identified in Figure 3 above: introducing new vehicle technologies, fuel quality, and technologies or fleet compositions changes for existing vehicles.

The table on the following page provides an overview of the key elements of this framework, measures for applying them in Indonesia, and a brief assessment of the opportunities, barriers, and stakeholders involved in undertaking these improvements. The table provides a guide to the following sections, which provide more detail on each of the major approaches for reducing emissions of both conventional and greenhouse gas emissions.

Table 1 Summary of Strategies and Evaluation Criteria for Transportation Improvement Options

Strategy	Measure	Cost-Benefit Considerations	Opportunity / Constraint	Key Stakeholders
1. Improvements in emissions standards (Vehicle Technology)	Improvement and enforcement of emissions standards on new and imported vehicles	- No direct additional costs for the government - Costs are passed on to vehicle owners - Reduced air pollution and CO_2 emissions as cleaner vehicles enter the market	- Most Asian countries have adopted > Euro 2 emissions standards - Can stimulate purchase of cleaner vehicles by giving tax credits to buyers of vehicles - New vehicles can be tested in country of origin	National gov't agencies: MoF, MEMR, MoE, MoI, MoC Automotive industry, fuel industry
	Improvement and enforcement of in-use vehicle emissions standards	- Cost is passed on to vehicle owners - Reduced emissions from polluting vehicles (with routine inspection)	- Should also be tightened as new vehicle standards are raised - Form basis for routine emission inspection	Local governments Vehicle owners Private sector
2. Improved inspection and maintenance	Enforcement of routine emission inspection as part of roadworthiness program	- Cost is passed on to vehicle owners - Reduced emissions from polluting vehicles only if effectively enforced	- Requires enforcement mechanism - Quality assurance and auditing needed to prevent corruption - Co-benefits in safety and conventional pollutants	Local gov'ts Vehicle owners Private sector
3. Cleaner fuels Improvements in fuel standards and quality	Improvements in fuel standards and quality	- Investment is high, but benefits outweigh costs - Cost is passed on to fuel buyers - Significantly reduced air pollution - Allows fuel-efficient vehicle technologies to enter marketplace	- Precondition for introduction of emission control devices and enforcement of new vehicle standards - Harmonization of fuel standards should go with harmonization of emissions standards - Diesel vehicles & low quality fuel (high sulfur) need attention	National gov't agencies: MoF, MEMR, MoE Fuel industry
	Use of alternative fuels (CNG and biofuels)	- Cost is high (esp for biofuels) - May need economic incentives to stimulate use - Reduced air pollution and CO_2 emissions	- Can substitute for diesel oil to reduce GHG emissions & conventional pollutants - CNG preferred to biofuels - Stricter standards for diesel vehicles have worked in Europe (alt to banning diesel vehicles)	National Gov't agencies: MoF, MEMR, MoE, MoC, MoI Fuel industry
4. Improved transport planning and traffic demand management	Land use and transport planning Travel demand management Public mass transport options Non-motorized transport	- Tax incentives, subsidies, pricing policies required - Reduced conventional air pollution and CO_2 emissions - Co-benefits in urban transport management, urban environment	- Integrated approach required - Significant political will and technical capacity necessary - Integration of transport planning and air quality planning - Complex, multi-sectoral activities - High benfits in terms of both GHG and conventional pollutants	National planners and policy makers Local Governments

MoF = Ministry of Finance
MEMR = Ministry of Energy and Mineral Resources
MoE = Ministry of Environment
MoC = Ministry of Communication
MoI = Ministry of Industry

2.2.1 New Vehicle Technology

Indonesia is lagging behind other countries in moving up the Euro emissions standards scale. Asian countries at present do not have harmonized vehicle emissions standards, and most countries in the region, including Indonesia, have linked their emission control programs to European requirements. Decree of the Minister of the Environment No. 141/2003 stipulates that all new vehicles sold in Indonesia must begin complying with the Euro 2 standard in a process that started on January 1 2005. This regulation became effective January 1 2007 after leaded gasoline was phased out across Indonesia. The implementation of Euro 2 requires that gasoline must be free of lead-containing additives, as lead damages the catalytic converter (a tailpipe control device that reduces exhaust emissions by 90 percent). In 2006, 24 percent of new gasoline vehicles sold in Indonesia met the Euro 2 standard. Since 2007, all new gasoline vehicles sold in Indonesia comply with the Euro 2 standard according to the Chairman of Gaikindo, the Association of Indonesian Automotive Industries.

Figure 4 Status of Implementation of Emissions Standards for New Vehicles

Regulation	Plan	Current status
• MoE Decree 2003 No. 141 on Vehicle Emissions Standards for New Type and Current Production Vehicles	• All new vehicle types have to comply with EURO 2 effective January 1 2005 • All current production of motor vehicles and two-stroke motobikes have to comply with Euro 2 effective January 1 2007 • All current production of four-stroke motorbikes have to comply with EURO 2 effective January 1 2006	• All new gasoline vehicles sold in Indonesia comply with Euro 2 effective January 1 2007 (confirmed by Gaikindo) • All new motorcycles sold in Indonesia comply with Euro 2 effective January 1 2007 (confirmed by AISI) • New diesel vehicles sold in Indonesia are not necessarily complying with Euro 2 because of dirty diesel

AISI = the Association of Indonesian Motorcycle Manufacturers

The Euro Emissions Standards

These vehicle emissions standards define the acceptable limits for exhaust emissions from new vehicles sold in the EU. The higher the number, the higher the stringency of the emission standard and for each vehicle type, different standards apply. Compliance is determined by running the engine during a standardized test cycle. No use of specific technologies is mandated to meet the standards, although available technology is considered when setting the standards. Emission standards in developed countries have been implemented in stages, mainly because of the availability of appropriate technology to achieve more stringent standards. In developing countries, the improvement of emission standards depends on government policy, which can require domestic auto manufacturers to invest capital into new technologies.

New diesel vehicles sold in Indonesia do not necessarily comply with the Euro 2 standard because of the low quality of diesel fuel sold in the country. To comply with Euro 2, the maximum level of sulfur in diesel fuel should not exceed 500 ppm (see Table 2). The same sulfur threshold applies to gasoline vehicles. High sulfur content in fuel can damage catalytic converters in diesel vehicles, while lead can also impact catalytic converters on gasoline vehicles. Indeed, catalytic converters are only effective if the fuel sulfur content is below 50 ppm. Because sulfur levels in diesel fuel in Indonesia still exceed 500 ppm, emissions control equipment is not applied to new diesel vehicles sold here.

New motorbikes already comply with Euro 2 standards since January 1, 2007, and are equipped with catalytic converters when they are sold new. The issue with motorbikes is that owners regularly tamper with tailpipes to increase power and noise. Some 20 percent of new motorbikes sold in Indonesia during 2007 have had their tailpipes modified by owners, with the catalytic converter being removed in the process (Bayu Arya, Autocar Magazine, Personal communication, October 5, 2008). Currently, no regulation prohibits the removal of catalytic converters. While mandatory testing of new types of motorbikes is not an issue, enforcing routine inspections of motorbikes that are already in use to ensure that catalytic converters are functioning properly will be a daunting challenge.

Table 2 European standards for gasoline and diesel fuels, which correspond to gasoline and diesel-fueled vehicle emission standard.

Standard	Gasoline		Diesal
	Sulfur (ppm)	Timbal	Sulfur (ppm)
Euro 1	0	NA	Na
Euro 2	0	500	500
Euro 3	0	150	350
Euro 4	0	50a	50[a]
Euro 5[b]	NA	NA	50[a]

ppm = parts per million, NA = not applicable
a 10 ppm is in the late stages of adoption by the European Union
b Heavy duty diesel engines only
Source: ADB, 2006.

Motorcycle Emissions Control Technology

To manage the problem of motorbike owners tampering with tailpipes to remove converters, manufacturers could design motorbikes in such a way that tailpipes cannot be modified. This option is far more cost-effective than making each motorbike subject to routine inspections at stationary inspection centers.

Countries such as China, India and Singapore began implementing the Euro 2 standard before Indonesia (see Table 3). In China, Euro 3 has been effective since 2008, while in Singapore, Euro 4 for diesel fuel has been effective since 2005. India plans to shift to Euro 3 nationwide and to Euro 4 for major cities in 2009. European countries have already applied the Euro 4 standard, which sets a maximum limit for sulfur levels in diesel fuel at 50 ppm, and even to 10 ppm more recently.

Table 3 Application of Euro emissions standards for new vehicles in Asian countries

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Indonesia								Euro 2							
Malaysia		Euro 1							Euro 2				Euro 4		
Singapore[a]		Euro 2													
Singapore[b]		Euro 2					Euro 4								
Thailand		Euro 2			Euro 3								Euro 4		
Vietnam								Euro 2							
India[c]		Euro 1				Euro 2					Euro 3				
India[d]	Euro 2					Euro 3					Euro 1				
china[a]		Euro 1			Euro 2			Euro 3			Euro 4				
china[e]		Euro 1		Euro 2			Euro 3		Euro 1 (Beijing only)						

a gasoline b diesel c entire country d major cities e Beijing, Guangzhou, Shanghai
Source: Clean Air Initiative, 2008.

Diesel Fuel Quality and Local Air Pollutants

New vehicle emissions standards and diesel fuel quality specifications need to be sufficiently stringent to take advantage of technologies to reduce nitrogen oxide (NOx) and particulate pollution. In the absence of such standards, a shift to diesel should be discouraged by fiscal or regulatory measures to avoid worsening air quality problem.

Emissions standards are an example of the friction between the public good and private interest. Lower quality cars can be produced at lower prices, therefore producing greater sales for manufacturers. Standards impose greater costs on manufacturers (and consumers) to change practices to improve air quality, a public good. Most major developing countries in Asia have made improving air quality a goal of public policy and they are willing to set increasingly stringent standards to achieve this. In particular, in China, India, Singapore, Malaysia, and Thailand, the key factors that have helped these countries to enforce increasingly stringent Euro standards are:

1) Comprehensive policy dialogue followed by agreement between the government, the auto industry, and the fuel industry to adhere to a schedule for implementing the Euro standards, allowing the automotive and fuel industries to make technical and financial changes
2) Public pressure from within and outside the country
3) demonstration of fiscal and economic benefits of the measure and awareness of its benefits by key decision-makers, including the national oil company, and
4) Strong political will that led to policy reform in the automotive and fuel sector.

Emissions Standards and Regional Competitiveness

By aligning its emission standards with other Asian countries, Indonesia can keep a competitive edge in the automotive industry. This can be achieved by sending the national auto industry a clear signal to invest in clean and fuel- efficient vehicles. Such a policy should be integrated with a policy on fuel quality, so that the automotive industry and fuel producers can begin planning ahead of time.

Fuels and vehicles are parts of an integrated system and must be addressed together. Indonesian exports of Multi Purpose Vehicles (MPV) to ASEAN countries and to Japan reached a total export value of US$ 2 billion in 2007. This figure highlights that the Indonesian automotive industry is capable of producing motor vehicles that meet the higher vehicle standards applicable in countries of export. Hence, the harmonization of vehicle standards is critical. The Indonesian automotive industry intends to leapfrog from the Euro 2 to Euro 4 emissions standard for cars and light-duty vehicles in 2012, and at the same time a majority of Asian countries will be upgrading to the Euro 4 standard. However, there is a risk that this effort will not be successful if fuel specifications and quality in Indonesia do not already meet the Euro 4 standard.[1]

Over the past decade, diesel technology has made tremendous advances. The higher efficiency of diesel engines compared to spark-ignite engines has the potential to reduce worldwide global warming and oil consumption.[2] Diesel vehicles consume 20 percent less fuel than comparable gasoline engines (Bandivandekar and Blumberg, 2008). On the other hand, modern diesels produce significantly more NOx and particulate pollution than their gasoline counterparts. However, cost- effective technologies exist that can reduce NOx and particulate emissions from new diesel vehicles, such as the use of catalytic converter.

1 A recent study in China demonstrated that after operating for 20,000 km, a Euro 4 vehicle which uses lower fuel quality than intended for this type of technology will deteriorate significantly (Sheng, 2008).

2 Some countries may be interested in increasing the deployment of more efficient diesel vehicles to decrease oil imports as part of an energy security strategy.

Table 4. Properties of Pertamina fuels compared to Euro 2 reference fuel

Properties	Pertamina	Euro 2
Gasoline		
Lead content, g/L	0	
Research Octane Number	88	97
Benzena, % vol	5	2,5
Aromatik, % vol	50	42%
Olefin, % vol	NA	18%
Total sulfur, ppm	200	500
Reid Vapor Pressure at 100 F, kPa	62	65
Diesel		
Total sulfur, ppm	2000	500

NA: data not available
Source: Pertamina, 2006; ECE fuel reference, 2006.

According to Gaikindo, the sale of diesel vehicles is predicted to reach 56 percent of total vehicle sales in Indonesia by 2010. If low quality diesel fuel remains available on the market in the near future, then a shift to diesel vehicles should be discouraged. The benefits of improving new vehicle emissions standards and diesel fuel quality specifications dramatically outweigh costs (see Annex A). From the point of view of climate change mitigation, diesel does provide higher combustion efficiency. Pursuing such synergies between fuel quality standards, urban air quality management strategies, and climate change mitigation strategies can help strengthen the support for all three objectives and improve the chances for successful implementation.

2.2.2 Fuel Quality

A reduction in diesel fuel sulfur levels would allow motor vehicles to meet the Euro 2 standard—reducing overall emissions by 90 percent— and to reduce negative health impacts. This would require government incentives to help Indonesian refineries produce fuel with less sulfur.

> "If the government gives a firm mandate to Pertamina with a clear timeframe to improve fuel quality to respond to the Euro 2 vehicle emissions standards, Pertamina will be ready and able to implement it."
> - Mr. Suroso, former Director of Processing, Pertamina.

Decrees of the Director General for Oil and Gas in 2006 set the maximum lead content at 0.0013 g/L and the sulfur content in diesel fuel at 5,000 ppm. Although fuel in Indonesia is now lead-free, specifications are still loose for sulfur content. This is a matter of concern because sulfur is oxidized to sulfur dioxide (SO_2) and sulfate compounds that form particulate matter, the air pollutant most dangerous to human health. Impacts from this pollutant range from respiratory problems to increased risks of cancer (e.g. McGranahan and Murray, 2003).

In several countries such as China, India, Vietnam, and Singapore, sulfur levels are already below 2,500 ppm and generally range between 300 and 1,500 ppm. In Indonesia, where sulfur content varies between 500 and 4500 ppm, a reduction in sulfur levels in diesel fuel will achieve two objectives: first, allow motor vehicles to meet the Euro 2 standard and reduce conventional pollutant emissions by 90 percent, and second, reduce negative health impacts. A recent study revealed that short-lived pollutants such as black carbon emitted from diesel vehicles are also known to have significant influence on the global climate (U.S. National Oceanic and Atmospheric Administration, 2008). In addition to lead and sulfur parameters, other fuel parameters are regulated, such as Reid Vapor Pressure (RVP) and hydrocarbons (benzene, aromatics, and olefins). Of these four parameters only lead, RVP, and sulfur in gasoline currently conform to the Euro 2 reference fuel in Indonesia. Hence it is also important to reduce the hydrocarbons content in gasoline after reducing sulfur content in diesel.

Indonesian refineries do not have the capacity yet to produce fuel with less sulfur, and government incentives are necessary to make this happen. Monitoring of fuel pumps in Indonesia shows that average sulfur levels in several cities in 2007 was 2,000 ppm (see Appendix). However, Pertamina's refineries have already successfully produced diesel fuel with sulfur levels that are below the threshold set by the Directorate General for Oil and Gas (but not the threshold required for Euro 2 emissions standard).

Progressive Improvements in Fuel Quality

There is a need to revise fuel specifications so that they initially conform to the Euro 2 standard and progressively evolve to Euro 3 and/or Euro 4 fuel standards. As fuel consumption continues to increase in the future, this will eventually create opportunities for Indonesia to either a) add to its refining capacity by upgrading existing refineries or constructing new ones capable of producing cleaner fuels, or b) to import cleaner fuels.

According to Pertamina, the capacity of refineries can be improved to produce fuel with slightly lower levels of sulfur compared to current fuel production. For example, fuel sulfur levels at the Cilacap refinery can be reduced from 3,500 to 2,500 ppm. However, because Pertamina also imports diesel fuel of inferior quality (with sulfur content of 5,000 ppm following the specifications set by Director General of Oil and Gas), the overall sulfur level in fuel remains high in Indonesia. While such an adjustment does not require additional investment, it will lead to reduced fuel volume/quantity. According to Pertamina, as long as the fuel quality meets current standards set by the government (Directorate General for Oil and Gas), the firm has no incentive to provide cleaner diesel that is more expensive to produce.[3] With 70 million barrels of diesel fuel being imported per year, switching to cleaner diesel would require an additional US$ 140-210 million per year. This is a relatively small amount relative to the amount currently allocated to fuel subsidies, about US$ 15 billion for 2008.

Planning Future Refinery Technology

Planning for the introduction of cleaner fuels needs to account for the specifications of such new refineries as well as for the specifications of existing refineries that will continue to produce transportation fuels in years to come.

Pertamina already has a fuel improvement plan to conform its products to Euro 2 (and higher) emissions standards. According to this plan, to meet the Euro 2 fuel standard (especially sulfur levels that do not exceed 500 ppm) there will be a need for new refineries with a capacity of 300 thousand barrel crude oil per day (MCBD) to produce an additional 4.7 million kL of gasoline and 2.3 million kL of diesel annually between 2008 and 2010. This will require an estimated US$ 500 million. Pertamina's implementation of this plan hinges on the government's commitment. Should the government provide Pertamina with the mandate to conform to the Euro 2 standard according to a specific timeframe, Pertamina will comply. However, increased refinery capacity and the importation of clean diesel will eventually increase fuel price and subsidies. The incremental costs of meeting the recommended level of fuel sulfur in Asia averages US$ 0.2-0.8 cents per liter for gasoline and US$ 0.5-0.8 US cents per liter for diesel (ADB, 2008).

2.2.3 Vehicle / Fleet Maintenance (Existing Vehicles)

As a growing number of new, cleaner vehicles become available on the Indonesian market through the implementation of the Euro 2 emissions standard for gasoline vehicles, the share of polluting emissions from the large number of older, uncontrolled vehicles will increase. Vehicle replacement policies have focused on replacing high-use, older vehicles (e.g. taxi and vans), while retrofit policies have favored heavy-duty vehicles (e.g. trucks and buses) because of their long lifespan and the relative ease for replacing their engines. Retrofit programs around the world such as in China, Germany, and Sweden have showed significant efficiency in reducing emissions.

3 The difference in price between imported diesel fuel with sulfur levels of 500 ppm and 5,000 ppm is US$ 2-3 per barrel.

> Improving diesel quality will have a multiplier effect not only on the use of diesel fuel in road transportation, but also for electricity generation, sea transportation, and agriculture.

However, increased refinery capacity and the Hybrid vehicles use two types of power sources, fuel and electric. The engine efficiency is achieved by making the best use of those two power sources. Electric power is used at low speeds and for abrupt movements that require high flexibility of power supply for the engine, while fuel power is used for high speeds. Hybrid cars are designed to automatically shift power from fuel to electricity depending on vehicle speed and road condition. This results in a one fourth reduction in fuel consumption compared to conventional vehicles. Less fuel means fewer emissions.

However, with the current diesel fuel quality in Indonesia, the retrofit of diesel vehicles may not be cost-effective. Besides, retrofit programs should also be complemented by robust inspection and maintenance systems to ensure that the catalytic converter devices continue to operate properly. In Indonesia, enforcement and awareness is very weak, making it even more challenging to implement a retrofit program successfully. As for gasoline vehicles, from a technical point of view retrofitting is not recommended because it can affect the overall engine performance. Moreover, the cost of catalytic converters used for retrofits is increasingly expensive because of the high price of the materials to manufacture the catalytic converters. Finally, global demand for retrofitting is also declining as older and dirtier vehicle fleets are gradually phased out. Therefore, a retrofit program may not be a cost-effective solution in the long run, even if coupled with tax incentives.

2.2.4. Beyond Carbon Benefits: Local Pollution Reduction

There will be significant co-benefits of fuel quality and fuel efficiency improvements. In addition to GHG emissions, transport is also the primary source of air pollution in cities in developing countries (Colville *et al.*, 2001). In four Indonesian cities (Jakarta, Surabaya, Bandung, and Semarang), transportation contributes 45-65 percent of the total emissions of PM10 (particulate matter smaller than 10 microns), an air pollutant that is harmful to health (Bappenas, 2006). Current levels of air pollution in Indonesia exceed the World Health Organization's air quality standard. The impact of air pollution on human health and the environment is an issue of growing concern as it inflicts substantial costs to the government and to society. The health costs due to air pollution are estimated at US$ 500 million per year in Jakarta alone and US$ 100 million per year in Surabaya (Bappenas, 2006).

Co-Benefits of Reducing Fuel Use and Reducing Pollution: Beyond Low Carbon

Indonesia's low carbon approach is to look first at the actions that make the most sense economically, socially and environmentally in accordance with its development path. In the case of transport improvements and emissions reductions, there are substantial benefits beyond carbon and climate change. Important co-benefits from reducing pollution emissions and investing in public transit improvements include:

- Reducing air pollution can reduce both common respiratory health problems and the more severe effects of toxic pollutants (e.g., cancer).
- Reducing health problems also lowers spending on health costs, freeing up funds for other beneficial activities.
- Increased public transit (bus and rail) availability can reduce congestion and improve travel time, contributing to improved quality of life, at the same time reducing productivity losses.
- More convenient and efficient public transit options and improved spatial planning can also create more walkable cities and contribute to community cohesiveness.

Key pollutant levels in Indonesia are high compared with other Asian countries. Excessive use of petroleum fuels has been identified as one of the key reasons. During the 1990s, it was estimated that vehicle fuel consumption caused over three quarters of sulfur dioxide and nitrogen oxide, 90 percent of carbon monoxide, and two-thirds of particulate emissions. In a major positive step, Indonesia removed lead from gasoline in 2006. Lead has a particularly negative developmental impact on children.

For the entire country, one study estimated health costs due to air pollution at 1.2 percent of GDP in 2006, or about $3.4 billion per annum in environmental health damage. (Method based on contributions from three pollution-related diseases, attributable deaths and lost years-of-life, and risk coefficients from a large US cohort study, and conversion into dollar value of morbidity and mortality losses). In 1998, economic costs of outdoor air pollution were estimated for Jakarta alone at about $181 million.

Sources: World Bank. 2009. Country Environmental Analysis. 2009.
Pandey, et al. "The Human Cost of Air Pollution: Estimates for Developing Countries." 2003. Washington DC: World Bank.

Section 3

Greenhouse Gas Emissions and Transportation: Global Best Practice

Section 2 reviewed the largest sources of greenhouse gas emissions from the transportation sector and examined the current efforts to address fuel quality, air quality, and vehicle efficiency. In this Section, a comprehensive review of low carbon transportation options is presented based on international practices with Indonesia-specific context provided where appropriate. The objective is to identify additional measures and options that may complement fuel quality and vehicle efficiency in a comprehensive, long-term transportation development plan. This will enable GOI decision-makers to consider near-term fiscal policy options in the context of broader program options that may be implemented in the coming years.

As noted in the prior section, mitigation options in the transportation sector have generally been categorized by mode (i.e., road travel, rail, aviation, and shipping). In Indonesia, road travel is responsible for 88 percent transport sector greenhouse gas emissions and is the only sector of consequence with respect to short-term measures that will have a significant impact on reducing carbon intensity. Within road travel, several categories of mitigation potential exist. These include (Kahn Ribeiro et al., 2007; also summarized in Figure 3 above)[4]:

1. Reducing vehicle loads (i.e.,making cars and trucks lighter and more aerodynamic)
2. Increasing drive train efficiency (i.e.,increasing fuel economy for a given weight)
3. Alternative fuels (e.g. CNG, biofuels, hydrogen, electricity)
4. Mode shifts and Transport Demand Management (TDM)

For the first three options, it is critically important that full lifecycle analysis of various options take into account GHG emissions associated with upstream activities required to produce alternative fuels or technologies. Section 3.1 deals with both reducing vehicle load *and* increasing drive train efficiency as

4 Driving practices are also mentioned as a potential area for mitigation. Studies have shown that a change in driving habits (e.g. smoother acceleration, keeping engine revolutions and speeds low, etc.) can lead to 5 to 20 percent improvement in fuel economy; however, it is challenging to motivate participation in a program of improvement and to maintain practices long after training takes place. Providing personal fiscal incentives to participate in such programs may be considered in later stages of a comprehensive transportation program that first introduces clean fuels and more efficient technologies. However, this option is not seen as a strong candidate for immediate action in Indonesia and is not discussed further.

two different aspects of overall vehicle efficiency. Section 3.2 tackles the alternative fuel question and Section 3.3 deals with mode shifts and TDM efforts. Finally, section 3.4 returns to other, non-road modes of transportation that will be a consideration for Indonesia in the future.

3.1 Improving Fuel Efficiency (Vehicle Technology, Loads, and Drive Train)

Reducing vehicle loads and increasing drive train efficiency both deal with the entrance of new, more efficient technologies to the market. From a manufacturers' perspective, there is a great distinction between these two options (and the alternative fuel option of hybrid-electric and electric vehicles). From a regulatory and fiscal policy standpoint, governments tend to avoid selecting technological "winners and losers." These two options should not be viewed independently since manufacturers are in the best position to decide how to satisfy consumer demand and to meet efficiency standards within a given regulatory framework. Historically, manufacturers have been able to "engineer to the standard" in such a way as to guarantee that efficiency and emission requirements are just met, but not exceeded. This highlights the great need for strong and improving national standards to ensure that progress is realized. The key issues are how much efficiency is feasible over what timeframe and at what cost.

At present, Japan and Europe continue to lead the world with the most stringent passenger vehicle greenhouse gas and fuel efficiency standards. Japan's recent strengthening of their regulations will increase the stringency of that program while the European Union, which had initiated a voluntary program, has not reached the desired targets. In 2007 the EU formally approved the shift to mandatory standards (with some complementary measures) that are expected to achieve the desired level of efficiency (ICCT, 2007).

Meanwhile California's greenhouse gas emission standard for passenger cars is expected to achieve the greatest absolute reductions from any policy in the world. The rest of the United States continues to lag behind other industrialized nations with respect to passenger vehicle standards, although options being considered now could move the U.S. ahead of Canada, Australia, South Korea, and California by 2020 (ICCT, 2007). Two actions being taken by Canada and China bear special mention since they are related specifically to fiscal policies. Canada has established the world's only active "feebate" program that provides incentives for highly fuel-efficient vehicles and assesses a levy or fee to vehicles that do not meet fuel efficiency criteria. Similarly, the Chinese Government has significantly reformed the passenger vehicle excise tax to encourage production and purchase of small-engine automobiles and eliminates the preferential tax rate for SUVs (ICCT, 2007). These sorts of fiscal policies would greatly ease and complement implementation of emissions standards as discussed in Section 4.

A review of specific efficiency options is provided in the Indonesian Technology Needs Assessment (BPPT and KLH, 2009) and is outside the scope of this study. As Section 2 indicates, a necessary first step toward achieving increased fuel efficiency is the introduction of cleaner fuels that enable advanced technologies. This may entail additional refinery capacity for low sulfur and other clean fuels. Fiscal policies such as tax structures that encourage high efficiency vehicles or fiscal incentives for expansion of clean fuel refinery capacity are explored in the next section.

3.2 Alternative Fuels

Alternative fuels must be considered separately from other transportation technology options to reduce greenhouse gas emissions and in a much broader policy context due to their significant external linkages on agriculture, forestry, national security, and the broader economy through fueling infrastructure. Transportation is responsible for over 60 percent of national petroleum consumption, which is now an expensive *import* commodity due to recent demand growth. In addition, over half of the government fuel subsidy (as part of the public service obligation) goes to transportation fuels. Consideration of alternative fuels and fiscal incentives to encourage their use is an integral step toward reducing the carbon intensity of the transport sector.

Biofuels. "Biofuels" refers to a class of alternative fuels that include a variety of fuels derived by extracting vegetable oils or fermenting sugars. Ethanol and biodiesel are the only two products that are currently in wide-spread use (ethanol for blending with gasoline and biodiesel for blending with petroleum diesel fuel), but research on other potential fuels is ongoing. Ethanol is primarily produced and used in Brazil using sugarcane as a crop feedstock and in the U.S. where corn is used. Biodiesel is produced from vegetable or animal oil and is of more interest in Asia where palm oil and *jatropha* are being grown. Palm oil is the cheapest available feedstock for biodiesel production and it can be used relatively directly. A blended fuel containing up to 20 percent biodiesel can be used in unmodified engines, but production costs are roughly twice the cost of petroleum-based diesel fuel.

Biofuels have generated considerable interest as a "renewable" source of fuel. More recent studies, however have identified important downside risks – life cycle emissions costs and competition with food crops – that need full investigation. The net GHG benefit of biofuel use is an area of considerable debate due to the complexity of conducting a full lifecycle analysis for production of these fuels. The manner of growing oil palm trees is one area of concern. If oil palm plantations are replacing natural forest or disturbing peat swamp areas (important land uses that can store or emit carbon depending on how they are managed), then the GHG benefits of this "renewable" resource can be lost (Kahn Ribeiro et al., 2007). Palm oil is an important staple food in Asia. As with corn, use of food crops as a feedstock for diesel or ethanol production puts fuel in direct competition with food production. Biofuels remain expensive, especially when environmental costs are factored in. Only at sustained high oil prices are biofuels likely to be produced commercially, otherwise they require tax subsidies.

Production of biofuels in Indonesia has been primarily motivated by energy policies with the aim to substitute imported and/or subsidized oil with biofuels. More recently, support for biofuels has become part of national policies for reducing CO_2 emissions from the transportation sector. However, as mentioned above, all biofuels are not equally effective in substituting for oil or in cutting GHG emissions. Local biofuels produced from sugar cane and cassava (for ethanol), and palm oil and jatropha (for biodiesel) have GHG abatement efficiencies that can vary between 30 and 50 percent (Zah *et al*., 2007) and is strongly dependent on lifecycle carbon balance of the land used for growing biofuel feedstock. Biofuels, and the palm oil industry specifically, will be explored more fully in a forthcoming companion low carbon development options report.

Compressed Natural Gas or CNG is another alternative to liquid fuels and has some historical precedent for use in Indonesia. However, wider application of CNG is constrained by supply issues. Currently, there are insufficient filling stations and poor service. In part, this is due to controlled prices that producers and distributors consider too low to make a profit. As a consequence, the low price of CNG is increasingly offset by the time taken to travel to the decreasing number of filling stations, the time taken to refuel, and additional maintenance as a consequence of oil and water in the CNG cylinder. Other forms of natural gas (liquefied natural gas or LNG and liquefied petroleum gas or LPG) are also alternatives, however a significant energy penalty is incurred during the gas-to-liquids conversion and thus GHG benefits are more modest. CNG has been popular in polluted cities because of its good emission characteristics. However, in modern vehicles with exhaust gas after-treatment devices, the non-CO_2 emissions from gasoline engines are similar to CNG, and consequently CNG loses its emission advantages in term of local pollutants; however it produces somewhat less CO_2 (Kahn Ribeiro et al., 2007).

Hybrid and Electric Vehicles. While electric vehicles and hybrid-electric vehicles are technically using alternative fuels (electricity), the models that are readily available now are hybrid-electric vehicles that simply improve the efficiency of traditional gasoline powered vehicles (see section 2.1 above). Hybrid vehicles use two types of power sources, fuel and electric. The engine efficiency is achieved by making the best use of those two power sources. Electric power is used at low speeds and for abrupt movements that require high flexibility of power supply for the engine, while fuel power is used for high speeds. Hybrid cars are designed to automatically shift power from fuel to electricity depending on vehicle speed and road condition. This results in a one fourth reduction in fuel consumption compared to conventional vehicles. Less fuel means fewer emissions. Given the higher costs and technical requirements, it is not clear that use of these vehicles will become widespread in Indonesia any time soon.

Hydrogen as Fuel. The use of liquid hydrogen to power fuel cells is also an area of active research, but given the cost, the long time frame for deployment, and the complications associated with new fueling infrastructure, this is not likely to be viable for Indonesia soon.

3.3 Mode Shifts and Transport Demand Management

Growth in GHG emissions can be reduced by restraining the growth in personal vehicle ownership. Such a strategy can, however, only be successful if high levels of mobility and accessibility can be provided by alternative means (Kahn Ribeiro et al., 2007). Rail is attractive and effective at generating high ridership in cities with high population density. Light-rail transit systems are more effective where land-use planning is integrated with transportation planning. Bus Rapid Transit, or BRT, is 'a mass transit system using exclusive right of way lanes that mimic the rapidity and performance of metro systems, but utilizes bus technology rather than rail vehicle technology' (Wright, 2004). Upgrade of rail transport for urban mass transit can be cost effective in an area with substantial existing lines and rights of way (for example, Jakarta). Development of new rail systems can be very capital intensive. Bus Rapid Transit, in contrast, can be developed for about 1/10th the cost (Kahn Ribeiro et al., 2007).

Non-motorized transport can also be effective in reducing transport demand (along with public transportation alternatives) when land-use and urban development planning is integrated with transportation planning to ensure that residential development is created within walking and bicycling distance of commercial activities. Intelligent transportation systems (ITS) could potentially add information and communication technologies to the existing transport infrastructure and vehicles in an effort to manage factors that typically vie with each other (e.g. vehicles, loads, and routes) to improve safety and reduce vehicle wear, transportation times, and fuel consumption (BPPT and KLH, 2009).

TransJakarta Busway: Indonesia's Flagship Public Transport Initiative

Jakarta is growing fast and so are the challenges of traffic congestion and harmful pollution that result from the increasing use of cars and motorcycles. The TransJakarta Bus Rapid Transit system (opened in December 2004) represents an urban transport breakthrough as the region's first full BRT system with physically separated bus-only lanes, at-level boarding platforms, pre-paid ticketing, clean, Compressed Natural Gas (CNG) fuels, and other features. (BRT systems are more common in Latin America.) By April 2009, the system had expanded to eight corridors and served about 250,000 passengers a day. Travel time across the entire corridor has dropped by one hour during the peak period. Over 20% of TransJakarta passengers have switched from using private cars for some trips, and carbon dioxide emissions are being reduced at the rate of 20,000 metric tons a year. Motorized vehicle ownership is growing at 9 percent every year, with more than 1,500 new registrations being filed a day for motorcycles and 500 a day for cars. In contrast, one bus carries about 100 passengers, resulting in faster movement with lower emission per capita compared to private cars.

The Jakarta city administration is working with ITDP, Instran, Pelangi and UNEP on a GEF financed project to strengthen the system with enhancements to design, operation, fares, and routing, as well as non motorized transit options. The Jakarta administration strives to improve the busway's level of service to produce greater efficiency, cleaner air and more reliable and comfortable transportation. The Busway has had some important successes, say project proponents, but the city also needs to integrate different public transportation modes to facilitate greater use and convenience. Busway user groups have been involved in a public education campaign to promote a more user-friendly and livable city.

In a later stage, the Low Carbon Transport Sector analysis will further investigate the benefits and barriers to expanding modal shift opportunities, such as BRT, to other urban centers in Indonesia.

Source: http://www.itdp-indonesia.org/index.php

3.4 Rail, Air, and Marine Transport

While these transport categories currently represent only 12 percent of Indonesia's total transportation emissions, they may be important planning considerations for the GOI over the long term. These options are included here to raise awareness that additional steps may be needed to maintain a decreasing trend in carbon intensity. Rail transport options include reducing aerodynamic resistance, reducing train weight, use of regenerative braking, and increasing efficiency of the propulsion system. Aviation options include engine efficiency, airframe advances, aviation potential practices (e.g., taxi-time, altitude changes, minimize distance between departure and destination, and reduce holding/stacking at airports), air traffic management, and reduced flight speeds. For shipping, near term options involve operational emission abatement measures on existing ships given the relatively long in-use lifetime of maritime equipment. Such measures include speed reduction, load optimization, maintenance, and fleet planning. (Kahn Ribeiro et al., 2007).

Fiscal policy options that could be considered to complement and advance such measures include accelerated depreciation for railcars that are replaced with state-of-the-art aerodynamic, hybrid-diesel engines with optimal air pollution control devices. Aviation policy is typically not within the purview of an individual nation like Indonesia, but Indonesia can lobby for more progressive efficiency standards with the UN's International Civil Aviation Organization (ICAO). Similarly, efficiency standards and standard operating procedures for marine vessels and ports are typically under the jurisdiction of the International Maritime Organization (IMO).

World Bank's Regional Energy Flagship Study

The Regional Energy Flagship Study has analyzed the security and sustainability of energy supply in the East Asia Pacific Region. The objective was to identify potential changes in government strategies, roles and policies to achieve a secure supply of clean energy resources and energy services at reasonable prices to sustain economic growth and mitigate adverse local and global environmental effects. One aspect of the study focused on fuel consumption and emissions from on-road transport in selected cities.

On-road transport is a significant consumer of energy in the urban environment and the sector most closely linked to petroleum products. Energy consumption for road transport is expected to grow significantly in coming years, especially in countries where increasing household income and urbanization contribute to private vehicle ownership and use. The study examined alternative policy and technology scenarios and evaluated their impact on energy consumption and pollution levels, including both local pollutants and greenhouse gases.

Indonesia's Low Carbon analysis in the transport sector has benefitted by learning from and building on the results of the energy flagship study.

Source: siteresources.worldbank.org/INTEAPINFRASTRUCT/Resources/EAP_Strategy.ppt

Section 4

Low Carbon Options in the Indonesian Context

Sections 2 and 3 reviewed both the current transportation situation in Indonesia and globally, from both an emissions and policy perspective. This section turns to the question of what the GOI could do to reduce the carbon intensity of the transportation sector in the near-term while laying the groundwork for a more comprehensive transportation plan moving forward. As with other low carbon development reports, options are presented through the lens of fiscal policy as a point of entry for the Ministry of Finance to engage with the many other planning agencies and ministries that deal with the transportation sector.

There is a direct causative link between improved fuel quality, fuel efficiency and GHG emissions, and air quality and public-health benefits. There are three reasons for focusing solutions on policy measures that are related to vehicle emissions standards and cleaner fuels. First, improving vehicle emissions standards, fuel standards, and fuel economy can be addressed relatively easily to reduce both vehicle emissions and fuel consumption, while achieving substantial development benefits in terms of health and economic efficiency. Appropriate policies can provide strong incentives for improvement. By comparison, improved public transport and compact land use planning are clear priorities, especially in Indonesia's rapidly growing cities, but implementation cannot be effected in the immediate short term or through policy change alone. Second, emissions and fuel standards are considered a higher priority than inspection and maintenance of in-use vehicles. Inspection and maintenance system can be rendered ineffective through lack of compliance or lack of capacity of local governments responsible for implementing these measures. Third, new emissions and fuel standards will help to catalyze the implementation of other measures and benefits, including the introduction of further improvements in vehicle technology.

The link between GHG emissions and fuel efficiency is obvious. However, the link between *improving* fuel efficiency and *reducing* GHG emissions is less so. Experience in some countries reveals that improvements in fuel efficiency have actually resulted in increased transport mileage and higher emissions (Ewing *et al.*, 2008). If increased fuel efficiency lowers fuel cost overall or per trip, people may feel able to take longer trips or use the vehicle more (the rebound or conservation effect). Still, there are substantial co-benefits of fuel and vehicle standards that also reduce sulfur, particulate matter and other conventional pollutants (though fuel economy and lower pollutant emissions do not necessarily go together). For example, authorities and producers in Europe and Japan have made a voluntary agreement to improve their fuel economies. The agreement seeks to achieve average CO_2 emissions of 140 g/km by 2008 for new passenger vehicles. In Europe, which has adopted ultra low sulfur diesel, the fuel economy target is being pursued through a shift from gasoline engines to diesel. Currently more than 50 percent of vehicles in Europe are diesel-fuelled. In Japan, the target is being approached through the introduction of smaller, more efficient cars. With heavy technology investments, Japan is currently the top runner in reaching a target of 125 g/km of CO_2 for passenger cars by 2015. In Europe, progress remains relatively slow.

Thus, lessons learned in Europe show that fuel economy standards are just one of the tools that can be relied upon to meet oil reduction goals. Other approaches include reforming the rail system, land use change, and promoting other transportation modes as reviewed in Section 3. Consumers have the flexibility to respond to high oil prices through short-term incentives, such as reducing commutes, and improving vehicle maintenance, and medium-term incentives such as purchasing fuel-efficient vehicles. The full burden of fuel savings should not be necessarily placed on vehicle technology. While fuel economy standards provide the greatest certainty in achieving fuel savings goals, purchase incentives and fuel taxes provide incentives for continuous improvement of the fuel economy. The caveat is that in Europe, as vehicles have become more efficient, people drive larger distances, and opt for bigger, more powerful cars, which translates into higher fuel consumption.

Leverage Japan's Investment in Fuel Efficient Cars

If mandatory fuel economy standards are introduced, Indonesia should take advantage of Japan's role as the leading manufacturer of vehicles in the country by encouraging the introduction of fuel-efficient cars for the Indonesian market as well as Europe or Japan. A clear policy to achieve these goals, involving air quality and fuel savings, will compel the automotive industry to invest in the production of fuel-efficient technologies.

Besides Japan, other countries in Asia that have introduced fuel economy standards are China, Korea, and Taiwan. International experience suggests that there is good reason to combine fuel economy standards, labeling (consumer information), and fiscal measures to prevent increase in size and weight of vehicles and combine these measures to prevent trade-offs between efficiency and harmful emissions (e.g. diesel).

Consumer demand is also an important factor in vehicle sales and it can be influenced through fiscal policy interventions. A study by the University of Indonesia in 2004 identified the following factors that affect consumers' decision when they buy a car (ranked in order of importance):

1) Price	5) Technology
2) Resale Value	6) Brand
3) Durability	7) Design
4) Capacity	

According to the study, the most elastic car demand was for all purpose vehicles or 4x2 Multi Purpose Vehicles (MPVs), followed by small sedans and medium sedans. The least elastic car demand was for 4x4 MPVs and luxury sedans. Low purchasing power led to consumers' preference for 4x2 MPVs, with a price range between US$ 7,500 and US$ 15,000.

In Europe, high income and high vehicle prices suggest that additional vehicle costs of US$ 2,000 to US$ 2,500 (10-12 percent of price) can improve the fuel economy by 35 to 40 percent without having major disruptive effects on markets. In a price-sensitive market like Indonesia, however, such additional costs may have a major effect on sales (Duleep, 2008). Price sensitivity may be a substantial barrier to Hybrid-electric technologies from achieving significant market penetration without fiscal incentives. Still, there are many other high-efficiency technologies that can meet Euro efficiency standards at lower cost.

Incentives for Domestic Manufacturers

To support the adoption of higher efficiency vehicles in Indonesia, incentives for the domestic automotive industry to invest in the production of low fuel intensity vehicles would help. If fiscal incentives are to be introduced for low-emission and fuel-efficient vehicles, they should not be classified as hybrid, gas- or oil-fueled vehicles, but according to their level of emissions or level of fuel consumption.

Countries like China, and Singapore provide a tax break for vehicles that meet more stringent Euro emissions standards than those required. Along with Thailand, both countries also provide a tax incentive for vehicles that use alternative fuels such as CNG and for electric and hybrid vehicles.

In Indonesia, new vehicles are imposed a luxury good value added tax. Exemptions include vehicles for specific purposes such as public transport, hospitals, fire departments, state protocol, military, and motorbikes with engine sizes up to 250 cc. The tariff varies according to vehicle class, weight, and engine size (Government regulation No. 43/2003). Annual vehicle registration fees are determined by local (provincial) governments with reference to Law No. 34/2000 on regional tax and retribution. The annual vehicle fees, which are calculated based on the vehicle sale value, vehicle class, and engine size, are a major source of regional income, contributing 25 percent of provincial tax revenues on average. Table 5 presents a comparison of vehicle tax structure between Indonesia and Thailand.

Table 5 Comparison of vehicle tax structure between Indonesia and Thailand, and calculation for on-the- road imported car price

	Indonesia	Thailand
Import tariff for completely built-up	65%	113%
Import tariff for completely knocked-down	35%	33%
Luxurt good VAT	30%	7%
Excise & interior tax	10%	20%
Calculation for completely build-up car (figures are in US$):		
World price	6.772	6.772
Before value added tax	15.880	20.106
After value added tax	4.358	1.313
Off the road price	20.238	21.419
Excise & interior tax	2.024	4.284
on the road price	22.262	25.703

Source: Ministry of Commerce Thailand, 2008.

A revision to the existing regional tax and retribution law was considered in November 2008. Some of the key changes proposed include the imposition of reduced tariffs for vehicle registration fees, an increase in fuel sales tax which is already included in the fuel pump price and is distributed to the provincial governments, differentiated fuel tax tariffs between public and private vehicles, and imposition of a progressive vehicle ownership tax (a higher tax accrued to the second and third vehicle owned by the same person).

However, overall the proposed tax regime does not address sustainable transportation issues. Tariffs are not based on certification of emissions or the level of fuel consumption of new vehicles when they are manufactured. While a progressive ownership tax is a step in the right direction, the vehicle use tax is equally important as the more kilometers are driven, the more emissions are generated and the more fuel is used.

China, Singapore, and Thailand have adopted an incentive-based approach in enforcing Euro emissions standards and fuel standards by providing tax-neutral incentives for low-emission vehicles and low fuel intensity vehicles. For example, Singapore imposes different registration fees for liquid-fuelled/CNG-fuelled vehicles and electric/hybrid vehicles, which are 110 percent and 70 percent of the open market value respectively. The registration fees are even lower for Euro 4 taxis and CNG-fuelled taxis (30 percent), Euro 2 diesel heavy-duty vehicles (5 percent), and Euro 4 diesel buses and goods vehicles (0 percent). China and India responded to the issue of limited supplies of cleaner fuel by prioritizing distribution in large cities where most motor vehicles are found.

Looking at mode shift and alternative fuel options, the Agency for the Assessment and Application of Technology (BPPT has investigated a number of transport and emissions issues in its recent Technology Needs assessment (2009). BPPT focused on CNG and mode shift as two important opportunities for Indonesia in the transport sector. The Technology Needs Assessment shows that specific efforts to reduce travel time on long journeys would be environmentally beneficial (the calculations are based on data from the Ministry of Transport's regular studies of transport habits, coupled to modeling simulations of travel time). BPPT proposes the following strategies:

- Improvement of conditions for long journeys, i.e., trains and regional bus routes, especially in combination with increased speed. Improvements would be viable if the increased frequency is offset by introduction of shorter trains.
- Significant improvement for long journeys could be achieved through better coordination between bus and train schedules.
- Efforts should be made to improve the frequency of urban buses, specifically aimed at achieving better coordination with regional traffic.
- The introduction of smaller buses would be environmentally beneficial in cases where service is currently poor, for example in rural areas.
- Introduction of "upon-request" services would allow greater adaptation to customer demand and time savings, with less effort.
- Use of "intelligent transport systems" (ITS) to help coordinate public transport.

There are also many opportunities for fiscal policy implementation to create incentives for choices that move toward a low carbon path. As discussed in Section 3, Canada has introduced a "feebate" program that includes both an increase in taxes or fees for low efficiency vehicles as well as a rebate from the government to consumers that invest in high efficiency vehicles. The program has not been running long enough to definitively state its success, but it may – over time – represent a model for a revised tax regime in Indonesia. More study of fiscal policy options would be beneficial.

Canadian Auto Feebate Program

Canada's feebate program combines two fiscal instruments. The fee part levies a tax on fuel-inefficient vehicles. The rebate part offers a substantial refund on the purchase price of a fuel-efficient vehicle. Feebate programs are designed to shift buying habits toward more favored transportation options. Other familiar fiscal policy interventions in the transport sector (which may aim to reduce travel, emissions, and congestion) include: fuel taxes, vehicle registration fees, congestion charging, and road pricing. The feebate program builds an incentive into the price of a more efficient automobile. Some argue that higher fuel charges would provide greater incentives for drivers to reduce travel and switch to more fuel-efficient cars.

Many support the feebate concept in Canada, but note that it could be more efficient or acceptable if it were phased in over time and allowed for greater coverage of more auto models in the fleet. Currently, limited applicability reduces the effectiveness and reach of the policy, and limits the incentive for manufacturers to make continuous improvements. Greater dialogue with manufacturers and a pre-announced schedule for expanding the program and tightening the requirements would allow more time for manufacturers to adjust auto models in the most cost effective manner. Feebates are a type of fiscal policy that can be integrated into a comprehensive strategy for the transport sector. More investigation is needed in next phase of work.

Sources: www.greencarcongress.com/2007/11/study-canadian.html
www.oilendgame.com/pdfs/Implementation/WtOEg_FeebatesUpdate.pdf

Section 5

Conclusions and Next Steps

This report has attempted to synthesize information on Indonesia's transportation sector and policy options that can help planning agencies reduce the carbon intensity of transport over time. The study finds that several key initial steps will lay the foundation for a more comprehensive low carbon development plan to be analyzed and implemented over time. These first key steps are summarized here with a rationale for why they apply to Indonesia, specifically. The section then concludes with thoughts on a continued program of evaluation, coordination, and policy development that will usefully complement these first steps and serve to inform the National Council on Climate Change, Ministry of Finance and other GOI ministries and stakeholders.

Key First Steps

Given Indonesia's low incomes, capital scarcity, weak enforcement of emission control regulations, high on-road GHG emissions, urban air pollution, and continuing fuel subsidies, simple policies in the transportation sector that do not require controlling emissions of in-use vehicles, but rather promote economic efficiency and incentives are called for. In particular, Indonesia's current status as a net oil importer suggests that an increasing global price of crude oil will lead to greater fuel subsidies and reduced fiscal sustainability. These facts points to the need for GHG reduction policies that increase fuel savings from cars and trucks.

Based on international experience, the simplest way to reduce fuel use (and associated GHG emissions and air pollution) is through vehicle emission and fuel specification standards. By progressing from Euro 2 to Euro 4 standards for vehicle emissions and fuel quality, GOI can significantly bring down the rapid projected growth of on-road vehicle emissions without the need for complicated enforcement programs (i.e. inspection and maintainence for individual vehicles). However, it must be stressed that a necessary precondition for this policy to be effective is to ensure and enforce (at the refinery level) the fuel quality provisions of this program. The fuel-saving and air quality-improving technologies built into Euro 4 vehicles depend on consistent fuel quality. In parallel, CNG use for high-use public transport vehicles should be revitalized through removal of barriers (e.g. gas supply and pricing issues, gas quota and distribution, infrastructure, safety regulation enforcement) to decrease reliance on higher emitting diesel fuel and gasoline.

Key Short-term Actions:

Improve fuel quality, especially through a reduction in sulfur levels in diesel, in a strategic and consistent way.

Leapfrog from Euro 2 to Euro 4 standards for vehicle emissions and fuel specifications.

Revitalize CNG use for high-use public transport vehicles by removing barriers (supply, pricing issues, gas quota and distribution, infrastructure, safety regulation enforcement)

Restructure the vehicle taxation system to include incentives that are based on emissions or fuel consumption levels.

Introduce mandatory labeling of CO_2 emissions from motor vehicles sold on the Indonesian market, so that consumers can make informed purchasing decisions.

Invest in expanded and improved refinery capacity to ensure that plenty of clean fuel supply exists to meet new demand for low-sulfur petroleum products as tighter vehicle standards are introduced. This brief study does not address the financing requirements.

Several complementary actions can ease the implementation burden of these measures. Restructuring the vehicle taxation system to include incentives that are based on emissions or fuel consumption levels will allow consumers to contribute to reducing vehicle emissions. The introduction of mandatory labeling of CO_2 emissions from motor vehicles sold on the Indonesian market will help consumers to make informed purchasing decisions. Finally, ensuring adequate uniformly clean fuel supply through expansion of domestic refinery capacity is needed to enable the Euro 4 transition.

These are all reasonable "no regrets" policies that can be recommended from the point of view of health, pollution, social costs, energy efficiency and security – not just climate or low carbon rationales. In fact, three policy options appear to be extremely cost-effective providing the highest net benefits as evidenced by the cost-benefit analysis provided in Appendix A. These measures include: (1) improvement of fuel quality to meet stricter Euro fuel standards, (2) introduction of fuel economy standards, and (3) revitalization of CNG use (See Appendix A). Leapfrogging from Euro 2 to Euro 4 emissions standards demonstrates no significant difference of expenditure, while increasing the capacity of the national oil refinery to produce clean diesel is more beneficial than merely importing clean diesel. Economically, vehicle taxation is considered as the most powerful tool to influence consumer purchasing. By introducing such a differentiated tax system, the policy would encourage the market introduction, purchase and use of fuel-efficient and low-emission vehicles.

These recommendations should be considered—and applied—as a whole, rather than as individual actions to be taken in isolation from each other. An integrated strategy that includes tighter vehicle and emissions standards, fiscal corrections and technological improvements is the best path to effectively increase energy security and improve the well-being of Indonesians.

Building Toward a Low Carbon Program

Key Next Steps:

Carry out further cost and policy impact analysis and prepare action plans followed by investment plans for the key options identified: improvement of fuel quality, revitalization of CNG use, and introduction of fuel economy standards. Examine complementary policies that will ease implementation of these measures, such as consumer education and labeling programs, refinery investments, and efficiency-based tax incentives.

Coordinate across Government to ensure that a comprehensive, long-term transportation plan that explores public transit options, mode shifting, and transportation demand management elements is integrated into a broader sustainable economic development plan, supported by all agencies and stakeholders.

Looking ahead to the next phase of analysis of low carbon development options, it is clear that a more detailed economic analysis is needed to examine potential fiscal policy mechanisms and macroeconomic implications of proposed options in the context of the Indonesian economy. The essential study design should include an analysis of "no regrets" Indonesian transportation policies that make sense from the perspective of public health and economic efficiency alone. This could serve as a policy baseline and might include improvements to fuel quality or investment in CNG infrastructure and fleets. A low carbon scenario could then build on this analysis to explore the incremental costs and benefits of adopting Euro 4 standards, implementing tax incentives, or providing refinery investment. This analysis should explore the timing of various path dependent options (e.g. widespread deployment of diesel versus gasoline technologies) to avoid issues of "lock-in" that might result in significantly different GHG or public health outcomes. The follow on study should also examine the distinction between broader socio-economic benefits of the policy options and their monetary or fiscal benefits.

In addition to economic analysis, there is a need to coordinate recommendations across ministries responsible for transportation planning and other transportation system stakeholders (clearly the fiscal policy component lies with the Ministry of Finance). This coordination should serve as a foundation for integrated transportation planning that encompasses climate policy and reduced carbon intensity as a central component of overall sustainable economic development. Fiscal policy has been identified as a key incentive for shifting consumer preferences and serves as an important factor in determining the economic viability of several program options. Thus inclusion of the MoF in transportation planning should be mainstream practice. During the coming year, key stakeholder agencies and industry groups should be brought together to explore fiscal and low carbon aspects of transportation planning similar to the "focus group discussions" or FGD process that was implemented for other sectors in the low carbon development study.

This process would have a two-fold purpose to examine the institutional context for the short-term action steps identified above and to give more thought and attention to options beyond fuel quality and fuel efficiency. With respect to the institutional context of short term measures, the Ministry of Finance's role is primarily limited to complementary actions that would support fuel and efficiency requirements. It is essential that the level and timing of complementary tax or financing measures are coordinated with regulatory changes implemented by other Ministries and with the buy-in of other transportation sector stakeholders (refiners, automobile manufacturers, distributors, etc.).

The coordination process can also provide an entry point to discussion of Transport Demand Management, bus rapid transit (e.g., TransJakarta Busway), expanded rail service, and non-motorized transport. Alternative fuel strategies include biofuels from palm oil, CNG for public transit and – in the future – hybrid-electric automobiles and fleet trucks powered by a clean electric grid. Smart growth strategies can complement Transport Demand Management and efforts to reduce vehicle trip length. Finally, fiscal policy options – examples include feebate, subsidy reduction, and other differential taxation policies – are another important part of an integrated approach. The harmonization of views among different agencies and levels of government (local vs. regional or national) on the major options available for consideration and the criteria for choosing among them (not just carbon, but also market trends, economic development, etc.) will be an ongoing need.

Initial steps in this direction could include a study to map out how to go from centralized versus decentralized transportation planning (by individual agencies with competing priorities) to a system that recognizes inter-regional needs and interdependencies among local and national systems (bus to rail, for example). It will be useful to examine the characteristics (and international examples) of future transportation planning approaches that have coordinated goals and objectives, complemented by central government plans and fiscal policies that create an enabling environment for improved local and individual decisions about transportation.

References

Abdurahman. (2008). Government policy related to subsidy and fuel prices. *Presented at seminar Fuel Efficiency to Address Raising Fuel Prices, Jakarta, Indonesia*.

AISI. (2008, February). Motorcycle and exhaust emissions in Indonesia. *Proceedings JARI- Indonesia Roundtable*. Jakarta

Asian Development Bank (ADB). (2002). *Integrated vehicle emission: Reduction strategy for Greater Jakarta* (RETA 5937). Manila, Philippines: ADB.

Asian Development Bank (ADB). (2003). *Policy guidelines for reducing vehicle emissions in Asia: Reducing vehicle emissions in Asia*. Manila, Philippines: ADB.

Asian Development Bank (ADB). (2008). *A road map for cleaner fuels and vehicles in Asia* (TA 6144 REG: Better Air Quality Management in Asia). Manila, Philippines: ADB.

Badan Pusat Statistik. (2007). *Statistik Perhubungan* [in Indonesian]. Jakarta, Indonesia: BPS.

Bandivandekar, A. & Blumberg, K. (2008, November). Diesel passenger cars: Safeguarding air quality and global climate in a shifting market. *Presented at Better Air Quality Conference, Bangkok, Thailand*.

Bappenas. (2006). *National strategy and action plan for urban air quality improvement*. Jakarta, Indonesia: Bappenas.

Bappenas (2007a). *Indonesia country natural resource environment analysis*. Jakarta, Indonesia: Bappenas.

Bappenas (2007b). *National development planning response*. Jakarta, Indonesia: Bappenas.

Bear, T (2002). Valuation of pollutants emitted by road transport into the Australian atmosphere. *Proceedings of the 16th International Clean Air & Environment Conference, Christchurch, New Zealand*.

Blumberg, K., Kebin, H., Yu, Z., Huan, L. &Yamaguchi, N. (2006). *Costs and benefits of reduced sulfur fuels in China*. The International Council on Clean Transportation.

Boardman, A.E., Greenberg, D.H., Vining, a.R., & Weimer, D.L. (1996). *Cost benefit analysis: Concepts and practice*. New Jersey, USA: Prentice-Hall, Inc.

BPPT and KLH, 2009. *Technology Needs Assessment for Climate Change.* The Agency for the Assessment and Application of Technology (BPPT) and Ministry of Environment. March 2009.

Clean Air Initiative for Asian Cities (CAI-Asia) (2006, October). Urban air quality and its management in Asia Status Report 2006. *Presented at the Regional Dialogue of Air Quality management Initiatives and Programs in Asia, Bangkok*.

Colville, R.N., Hutchinson, E.J., Mindell, J.S., & Warren, R.F. (2001). The transport sector as a source of air pollution. *Atmospheric Environment*, *35*, 1537-1565.

Cruz, R.V., Harasawa, M., Lal, S., Wu, Y., Anokhin, B., Punsalmaa, Y., Honda, M., Jafari, C., Li and N., Huu Ninh (2007). *Asia: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.K. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK.

Dixson-Declève, S. (2005). *Fuel quality best practice overview: Application to Vietnam's fuel quality strategy*. USAID Asia.

Duleep, K.G. (2008, November). Technology for fuel efficiency: A global outlook. *Presented at Better Air Quality Conference, Bangkok, Thailand*.

Ewing, R., Bartholomew, K., Winkelman, S., Walters, J., and Chen, D. (2008). *Growing cooler: The evidence on urban development and climate change. Executive Summary*. Urban Land Institute.

Gaikindo (2008, February). Vehicle demand and environment issues. *Proceedings JARI-Indonesia Roundtable*. Jakarta.

Geosciences (2003). *Fuel quality and vehicle emissions standards cost benefit analysis prepared for Motor Vehicle Environment Council (MVEC) review of vehicle emissions and fuel standards post 2006*.

German, J. (2007, October). Advanced Technologies: Diesels and hybrids. *Presented at Workshop on Fuel Economy: Technology Trends and Policy Options*. Washington DC: the International Council on Clean Transportation.

Gordon, D. (2005). *Fiscal policies for sustainable transportation: International best practices*. The Energy Foundation and the Hewlett Foundation.

Ho, M.S. & Jorgenson, D.W. (2008). *Greening China: Market-based policies for air-pollution control*. Harvard Magazine September October 2008.

Hwang, R.J. (2004, April). The US experience with CAFÉ fuel savings and lessons learned. *Presented at Workshop on Fuel Efficiency Opportunities in Mexico*. Mexico City: the International Council on Clean Transportation.

International Transport Forum (2007). *Biofuels: Linking support to performance*. Joint Transport Research Center-Roundtable. Paris, France: OECD.

ICCT, 2007, *Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update*, International Council on Clean Transportation, Washington, DC, July 2007.

Kahn Ribeiro, S., S. Kobayashi, M. Beuthe, J. Gasca, D. Greene, D. S. Lee, Y. Muromachi, P. J. Newton, S. Plotkin, D. Sperling, R. Wit, P. J. Zhou, 2007: Transport and its infrastructure. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

KNLH, 2008. *Emisi Gas Rumah Kaca Dalam Angka*, Kementerian Negara Lingkungan Hidup, Jakarta, Indonesia.

LEMIGAS (2004). *Clean vehicle fuels for blue skies*. Auckland, New Zealand: Maunsell Limited. source of air pollution. *Atmospheric Environment*, *35*, 1537-1565.

McGranahan, G., & Murray, F. (2003). *Air pollution and health in rapidly developing countries*. United Kingdom: Earthscan.

Ministry of Environment (2008). *Air quality monitoring data 2001-2007*. Jakarta, Indonesia: KLH.

Ministry of Finance and the World Bank. (2008). *Indonesia low-carbon development options: Country case strategy*. Jakarta, Indonesia: WB

NSW EPA. (2003). *Clean cars for NSW*. Sydney, NSW.

Pertamina. (2008). *Fuel consumption in Indonesia*. Jakarta, Indonesia: Pertamina.

Roychowdury, A. (2008, November). Global approaches to fuel economy regulations: Lessons for Asia. *Presented at Better Air Quality Conference, Bangkok, Thailand*.

Schipper, L. (2004, April). Improving fuel economy and saving fuel in Mexico: Experience in Europe. *Presented at Workshop on Fuel Efficiency Opportunities in Mexico*. Mexico City: the International Council on Clean Transportation.

Sheng, H. (2008, November). Fuel economy standards: China perspective. Presented at *Presented at Better Air Quality Conference, Bangkok, Thailand*.

U.S. EPA. (2003a). *Draft 2003 report to Congress on the costs and benefits of Federal Regulations*. Federal Register 68:22.

U.S. EPA (2003b). *Clean Fuels and Vehicles Partnership – Sulfur Working Group – Q&A on sulfur in gasoline and diesel fuel*.

Walsh, M.P. (1999). *Pollution from diesel vehicles worldwide survey on retrofit catalyst technology*. The Hong Kong Environmental protection Department.

World Resources Institute (WRI). (2008). *Climate and atmosphere, CO2 emissions: Indonesia*.

Wright, L., 2004. *Bus Rapid Transit Planning Guide*. GTZ, Eschborn,
Germany, 225 pp.

Zah, R., Böni, H., Gauch, M., Hischier, R., Lehmann, M., & Wäger, P. (2007). *Life-cycle assessment of energy products: Environmental assessments of biofuels*. Gallen, Switzerland: Empa Technology and Society Laboratory.

Annexes

Annex A Costs And Benefits Of Options For Reducing Air Pollution And GHG Emissions

Based on the discussion of key issues and solutions in this policy note, six options for reducing air pollution and GHG emissions were identified:

1. Improve fuel quality to meet the Euro emissions standards
2. Revitalize CNG use
3. Provide tax incentives for fuel-efficient or low CO_2 emission vehicles
4. Retrofit catalytic converters
5. Introduce hybrid vehicles
6. Phase-out polluting vehicles

Initial assessments of those options concluded that catalytic converter retrofits, introduction of hybrids, and phasing out polluting vehicles are not recommended because retrofit programs require the enforcement of a robust inspection and maintenance system which is currently lacking, and policies that require control of vehicles that are already in use should not be favored. Although introducing hybrids has high potential in reducing fuel use and CO_2 emissions, the incentives should not be based on technology but on CO_2 emission levels, which is already included in Option 3.

It may be cost-effective to phase out older polluting vehicles in the ten Indonesian provinces that account for more than 50 percent of the total vehicle distribution, but this would be a politically sensitive option as older vehicles are mostly owned by low-income people. This leaves the first three options that are proposed, namely 1) improvement of fuel quality to meet the Euro fuel standards, 2) revitalization of CNG use, and 3) provision of tax incentives for fuel-efficient vehicles. These options were assessed in terms of costs, benefits, and effectiveness in reducing air pollution and GHG emissions. Cost-benefit and cost- effectiveness analysis is needed by decision makers to evaluate the impact of policies on economic efficiency, contribution to poverty reduction, and support of good governance. The cost-benefit analysis methodology used in this study is detailed at the end of this Appendix. Assumptions used in the analysis are defined in Table A-1.

Table A-1 Scenarios for three policy options

Policy option	Action	Assumption
0	No action	Base scenario
1	Improve fuel quality to meet Euro standards	Compliance with Euro 2 in 2005, Euro 3 in 2008, and 4 in 2012
2	Revitalize CNG comversi + Opsi 1	Conversion from oil to gas fuelled vehicles (for passenger cars and buses) at least 1% in 2009, 2% in 2011, and 5% in 2021
3	Introduce fuel efficiency + Opsi 1	Enhanced fuel efficiency of 10% in 2009

A.1 Improve fuel quality to meet Euro fuel standards.

This option takes into account the adoption of more stringent Euro emissions standards (from the current Euro 2 to Euro 3 and Euro 4), assuming improvement of fuel quality specifications takes place. Therefore, the cost of improved vehicle technology was also incorporated, e.g. a small car would require an additional cost of US$ 250 to improve from Euro 3 to Euro 4. The incremental cost to meet the Euro 2 fuel standard was estimated at US$ 9 per liter (Geosciences, 2003).

By improving fuel quality to meet Euro fuel standards, the net benefits are estimated at more than US$ 95 billion net present value (NPV) during 2005-2030. This option also provides a NPV in fuel savings of US$ 460 million between 2009 and 2030 (see Table A-3). If clean diesel is refined domestically to meet the Euro 2 fuel standard, it will be more costly compared to imported diesel. However, in the long term—provided other factors remain unchanged—the cost of importing clean diesel will be double the cost of refining it locally (see Table A-2).

Table A-2 Additional cost if clean diesel is refined vs imported

Year	Standard	Additional cost from current (US$ million/year)	
		Refined	Imported
2008-2010	Euro 2	454	246
2011-2015	Euro 3	182	131
2016-2020	Euro 3	188	400
2021-2025	Euro 4	442	808

A.2 Revitalize the use of CNG and improve fuel quality.

By deregulating CNG use in the transportation sector, the NPV of net benefits from reduced health costs is estimated at more than US$ 108 billion over the next 25 years. Additionally, the NPV of net benefits from fuel subsidy savings is estimated at more than US$ 10 billion over 21 years, equaling US$ 1.5 billion per year.

A.3 Provision of tax incentives.

By providing tax incentives for new fuel-efficient or low CO2- emission vehicles, the NPV of net benefits from reduced health costs would be about US$ 100 billion during 2005-2030. Meanwhile fuel subsidy savings resulting from the tax incentives would exceed US$ 2.5 billion over 21 years (US$ 360 million per year).

Cost benefit analysis results

Of the three options discussed, Option 3 (introduce fuel efficiency and improve fuel quality) produced the highest net benefit and fuel saving. This finding was confirmed by the result of the cost-effectiveness analysis which demonstrated that this option causes the least cost per ton of emission reduction. Option 1 (improvement of fuel quality) caused the highest cost per ton of reduced emissions. In terms of CO2 emissions reduction, Option 3 was the most effective, i.e.,2.3 million tons over 25 years as compared to 500 thousand
tons and 100 thousand tons for Option 2 (revitalize CNG and improve fuel quality) and Option 1 respectively.

Table A-3 Summary of policy impact of 3 options (2005-2030)

	US$ million		
	Option 1	Option 2	Option 3
Cost			
Refinery production	20.640	19.110	12.062
Technology utilization	18.905	37.810	51
Total cost	39.546	56.920	12.112
Benefit			
Health risk reduction	345.072	376.550	329.445
Production cost saving	161	773	3.377
subsidy saving	1.648	8.091	35.494
Total benefit	346.881	385.414	368.316
FY 2005-2030			
Net benefit	307.335	328.494	356.203
NPV, SDR 8%	95.455	99.500	108.465
Net benefit averange	11.821	12.634	13.700
FY 2009-2030			
Fuel saving	1.648	8.091	35.494
NPV, SDR 8%	461	2.522	10.629
Net benefit average	75	368	1.613

Risk and sensitivity analysis of major variables demonstrated that the NPV of the net benefit of options was sensitive to the estimate used. The most sensitive variables are the social discount rate and the kilometers that vehicles traveled. However, the price gap that the government has given away as subsidies through the Public Service Obligation (PSO) fuel was not sensitive enough to influence the net economic benefit and fuel subsidy saving.

In terms of impact on stakeholders, the cost of adopting a stronger emission standard would be initially borne by vehicle manufacturers and oil refiners for upgrading technology, plants and equipment. Some cost would be passed on to the consumer by way of higher fuel and vehicle price, although it is not known what that cost would be.

Hence, consumers of motor vehicles would be affected by changes in new vehicle prices as a result of a tighter emission standard that requires the development and introduction of improved technologies. The change of price would influence purchasing decisions and consumer behavior. The benefit from avoided health costs would flow to people with pre-existing health conditions, the public health system and families through reduced levels of sickness, and fewer restricted activity days.

Table A-4 Budget impact for shifts between Euro fuel standards

Period	Shift	US$ million per year					
		Cost			Saving		Budget impact
		Capital	Operation	Vehicle	Production	Subsidy	Expenditure
2005-2007	From Current to Euro 2	0	548	1.792	0	0	548
2005-2011	From Euro 2 to Euro 3	91	512	1.016	0	0	603
2005-2030	From Euro 2 to Euro 4	49	729	741	6	63	708

Cost Benefit Analysis methodology

The methodology to calculate reductions in vehicle emissions, associated public health risks, and to estimate the monetary values of the benefits and costs of implementing the options was adopted from Geosciences (2003). A full cost-benefit analysis was not feasible due to the lack of comprehensive data and related studies in Indonesia. To estimate health costs avoided per ton of pollutant reduction, the methodology drew from Bear (2002) in Geosciences (2003). The relationship between ton of pollutant and vehicle kilometer driven or liter fuel consumed—defined as the emissions factor—was adopted from previous work by NSW EPA (2003), US EPA (2003), and Geosciences (2003). The number of motor vehicles was projected using a time series analysis until 2030.

In this analysis, the cost of each option was estimated by combining all costs associated with the implementation of the option, including manufacturer compliance costs (capital and operating costs). The benefits included diminished public health risks and reduced production costs and fuel subsidy as a result of lower emissions and fuel consumption.

While the cost-benefit analysis provides information of social net benefits (benefits minus costs), the cost- effectiveness analysis compares (usually mutually exclusive) options on the basis of reductions of emissions per dollar spent.

There are some limitations to this cost benefit analysis:

- The estimation of vehicle technology costs and refinery fuel improvement costs did not consider price change over years, but simply used current appraisal costs when the study was conducted. It could over or under estimate costs due to inflation or diminishing economies of scale when technology matures and production volume increases.
- Costs information was mostly sourced from Australia's experience, where there may be different purchasing power parity compared to Indonesia.

This report was prepared as part of the Low Carbon Development Options for Indonesia

National Council on Climate Change
Gedung Kementerian BUMN, 18th Floor
Jalan Medan Merdeka Selatan No. 13
Jakarta 10110
Tel: +62-21-3511400
Fax: +62-21-3511403

Supported by the World Bank, using funding from several sources

THE WORLD BANK | BANK DUNIA

The World Bank
Indonesia Stock Exchange Bldg
Tower II, 12-13th Floor
Jalan Jendral Sudirman Kav. 52-53
Jakarta 12910
Tel: +62-21-52993000; Fax: +62-21-52993111
www.worldbank.org/id