PHASE 1 OF SSFA

IMPROVING FUEL QUALITY AND FUEL ECONOMY IN INDONESIA

Cost-Benefit Analysis Fuels Economy

Final Report

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Abreviation

AAQS	Ambient Air Quality Standards
ADB	Asia Development Bank
ADO	Automotive Diesel Oil
AQMS network	Air Quality Monitoring Stations Networks
BKPM	The Investment Coordinating Board
BPLJSKB	Roadworthiness and certification center
CAP	Clean Air Program
CH4	Methane
CNG	Compressed Natural Gas
CO	Carbon monoxide
CPO	Crude Palm Oil
Dirjen Migas	Director of Ditjen Migas
DKI	Special District of the Capital City Jakarta
GDI	Gasoline Direct Injection
HOMC	High Octane Mogas Component
HEV	Hybrid Electric Vehicle
I/M	Inspection and Maintenance
IAQM	Study on the Integrated Air Quality Management by JICA and Bapedal, 1997
IDO	Industrial Diesel Oil
IDR	Indonesian rupiah
IVERS	Integrated Vehicle Emission Reduction Strategy
JICA	Japan International Cooperation Agency
LOMC	Low Octane Motor-gasoline Component
LPG	Liquid Petroleum Gas
MEIP	Metropolitan Environmental Improvement Program
MOPS	Mid Oil Platt Singapore
MPG	Mile Per Gallon
NKLD DKI	Local Environment Balance Reports of DKI Jakarta
NMHC	Non methyl hydrocarbon
NO	Nitrogen monoxide
NO2	Nitrogen dioxide
NOx	Nitrogen oxides
O3	Oxidant
Pb	Lead
PCFV	Partnership for Clean Fuel and Vehicle
PKB	Inspection Center
PM10	Particle less than 10 micrometer in diameter
PSI	Pollutant Standard Index
RAD	Restricted Activity Days
RC	Regional Center
RGDP	Regional Gross Domestic Product
RTRW	Regional Land Use Planning
SITRAMP	Study on Integrated Transportation Master Plan for Jabotabek Phase 1
SO2	Sulfur dioxide
SOx	Sulfur oxide
TDM	Transport Demand Management
THC	Total hydrocarbon
TSP	Total suspended particulate
TT	Unleaded symbol
UN ECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UP	Refinery Unit

UPPDN	Regional Representatives Offices of Pertamina
URBAIR	Urban Air Quality Management Strategy
USD	US dollar
US-EPA	US Environmental Protection Agency
WB	World Bank
WHO	World Health Organization
WWFC	World Wide Fuel Charter

Summary

A policy evaluation is needed by goverment when they want to issue a regulation, particularly if that proposed policy will affect market prices, import duties, taxes, subsidies or other charges imposed on production and distribution process. Costs-benefits analysis as well as Cost-effectiveness analysis are needed by policy makers to evaluate policies about their policy effects on economic efficiency, contribution to the alleviation of poverty, and support for good governance.

This study identified policy options that are expected to give effect to the reduction of emissions and ultimately provide economic benefits for Indonesia. Cost benefit and cost-effectiveness analysis is used to evaluate several policy options and provide recommendations the most appropriate policy options.

Many studies have shown that emissions from motor vehicles have a very significant impact to the quality of life of the people, especiallyin urban areas. A high level pollutant is harmful to public health and can be ultimately reduce people's productivity in work and also potentially required addition cost of living for health maintenance. Jakarta case in 2010 for instance, 57.8% people were suffered by various air pollution-related illness and disease, and paid IDR 38,5 Trillion to tre ating its. Therefore efforts to reduce emissions from motor vehicles produce air pollution as well as green house gas (GHG) is very important action to give impact on public health and the environment, and global warming mitigation. In addition, with the high price of international crude oil and the same time the declining of oil reservesof Indonesia, the need for a reduction in fuel consumption of the vehicle must begin to do by thinking to make an efforts in developing alternative fuels. Fortunately, there effort to reduce vehicle emissions will indirectly affect to the need of fuel subsidy which is quite burden for national budget.

Law no. 22 of 2001 on oil and gas regulate oil and gas operations in Indonesia must be able to balance and guarantee the effectiveness of not only the implementation and control of exploration activities in the upstream sector, but also the effectiveness of the implementation and control of the business of processing, transportation, storage, and trade in the downstream sector.

National Energy Policy included the National Energy Management Blueprint (BP-PEN) 2005-2025 policies as is stipulated in thePresidential Regulation. 5 Year 2006 on National Energy Policy (KEN), aimsto provide guideline for efforts in order to realize the national security of energy supply. There are problems encountered in securing the nation's energy supply is the comprehensiveness ofthe long-term national energy policy both existing conditions and its forecastson energy trends in the future, both in terms of supply and demand of domestic and international. Two main goals of KEN are maintaining national energy elasticity less than one and achieving national energy mix. Energy elasticity isthe ratio between the growth rate of energy consumption to economic growth. National energy mix is the target of the role of the optimal mix of any energy source used.

Minister of Environment DecreeNo.141/2003 stipulates that all new vehicles sold in Indonesia must begin in accordance to the Euro 2 standard in a process since January 1, 2005. This regulations is effective to impose by January 1, 2007after effectively eliminated leaded gasoline throughout Indonesia. The 2 Euro emission standards have not been comprehensively implemented in Indonesia. However, new diesel vehicles sold in Indonesia are not always comply to Euro 2 standard due to the poor quality of diesel fuel sold in the country.

Furthermore, the adoption of fuel efficiency technology will help to reduce energy consumption and CO2 emissions. Furthermore, it also can reduce air pollution from vehicles by reducing emissions per kilometer traveled. However, fuel economy and lower emissions of sulfur and nitrogen oxides or particles do not always go hand in hand. The authorities and manufacturers in Europe and Japan have entered a voluntary agreement to improve their fuel economy. The agreement seeks to accomplish CO2 emissions average about 140 g / km by 2008 for new passenger vehicles. With heavy investment in technology, Japan is currently the top runners in achieving the target of 125 g / km CO2 for passenger cars by 2015, while Europe is still relatively slow going.

Hybrid vehicles is generally a key technology to achieve higher fuel efficiency up to three to four times more efficient than conventionally fueled vehicles. To support the adoption of hybrids in Indonesia, there should be attractive incentives for the automotive industry to do investment in such technology. However, since this type of car is considered as a luxury vehicle, which ensures high taxation, the major barrier to the purchase of this imported hybrids in Indonesia is very higher and so that it can not be sold in Indonesia at competitive prices. In the meantime, if the incentives given to the purchase of imported

hybrids to improve their competitiveness compared to conventionally fueled vehicles, it will not only harm the Indonesian automotive industry, but also loses tax. Such solutions are not effective because the cost of providing tax breaks for hybrid imports out weighed the benefits of fuel savings and CO2 emission reductions. Therefore, to support the implementation of the hybrid in Indonesia, there should be incentives for the domestic auto industry to invest in the production of vehicles with low fuel intensity, either hybrid or other technology such as electric vehicle. If fiscal incentives will be introduced for low-emission vehicles and fuel-efficient, they should not be classified as hybrid vehicles, gas-or oil-fired, but according to the quantity of CO2 emissions.

Government has also encouraged the use of CNG for tranportation sector. Although CNG has not met its full potential as an alternative to gasoline and diesel fuel, the price is right and the security measures to improve its competitiveness. CNG is an inherently clean fuel in terms of air pollutants such as particulate matter, the most important air pollutants from a health perspective. However, there some burden for CNG adoption related to very low controlled price that unattractive to be CNG-filling station operator. Another issues is safety concern as there have been a number of incidents, in some cases resulting in death, involving CNG vehicles and in particular storage cylinder.

Table.1. Policies Formula

Policy Option	Title	Description
1	Emission Standard	Implement Euro 2 at 2005, Euro 3 at 2015, and Euro 4 at 2020
2	Fuel Efficiency +Option 1	Enhance fuel Efficiency 10 % by 2009
3	CNG +Option 1	Convert to Gas for Passenger Cars and Bus, at least 1 % at 2009, 2 % at 2011, and at 5 % at 2021
4	Catalytic Coverter+Option 1	Use Catalytic Converter to Diesel vehicles (25 % of Passenger Car, Bus, and Truck)
5	Scapped + Option 1	Scrapped the 50 % vehicles that more than 20 years old from 2009
6	Hybrid Technology + Option 1	Use Hybrid technology for Passenger cars and Bus, at least 0.05% at 2009, 0.1 % at 2011,0.5 % at 2016, and 1 % at 2021
7	Biofuel + Option 1	Convert to Biofuel for Passenger Cars and Bus, at least 1 % at 2009, 2 % at 2011, and at 5 % at 2021
8	Public Transport + Option 1	Result passenger car and motor cycle shift to public transport at least 5% and 1% at 2011, 10% and 5 % at 2014, 20% and 10% at 2018 and 40% and 20% at 2025
9	Leapfrog Emission Standard + Option 1	Implement Euro 2 at 2005, Euro 3 at 2013, and Euro 4 at 2016

Transportation sector is known as the most rapidly increasing source of green house gas (GHG) emissions, growing faster than GDP in some developing countries. To forecast vehicle numbers up to 2030, we apply econometric time series model. Vehicle growth has been dominated by motor cycles about 70% of total vehicle numbers, which has increased 4 times from 2000 to 2010, an average growth of 32 percent annually. Fortunately, this phenomenal growth in the number of motorcycles is not parallel to consumption growth of liquid fuels and CO2 emissions produced by since motorcycles consumeless fuel perkilometer than passenger cars and heavy vehicles.

From the growth data1990-2010 vehicles, proving that the growth of fuel consumption in the transportation sector elastic to growth and changes in vehicle fuel prices. An interesting fact is that every time there is an increase in fuel prices would lead to lower growth in the vehicle and will ultimately reduce fuel consumption, as happened in 1998 and 2002 and 2005. Elasticity changes in fuel prices higher than the growth elasticity vehicles, this means that the fuel price adjustment will positively impact the growth rate of vehicle settings in addition to reducing fuel subsidies.

Refinery Indonesia did not have the capacity to produce fuel with less sulfur yet, however Pertamina claimed it refineries have comply to threshold set by the Directorate General of Oil and Gas in producing diesel with sulfur levels. According to Fuels Pertamina improvement plan, Pertamina already has plans to increase production of fuel which comply to Euro 2 (and *higher) emission standards. By establishing a new refinery with required investment as much IDR 4.3billion, and have a capacity of 300 MBCD to produce an additional 4.7 million kL of petrol and diesel 2.3 million kL per year between 2008 and 2010, Pertamina will ability to produce fuel with sulfur level not exceeding 500 ppm. However, this plan depends on the commitment of the government approval to commit in following Euro emission standars..*

The policy types are to be assessed in this paper, there are nine kind of offered solutions to reduce air pollution and CO emissions are identified and initially assessed for their costs and effectiveness in reducing vehicle emissions and the associated benefits. From those type of policies, we can formulate the policy options that may be in form of individual policy type or its combinations. By assuming the euro 2 emission standards has been implemented and now under going to adoption euro 4, leap frog by negated Euro 3 (except for motor-cycle), we then formulate the policy options as Table 1.

1. Economic Analysis

a. Methodology

The methodology to calculate reductions in vehicle emissions and associated public health risks and to estimate monetary values of the benefits and costs of implementing the options was adopted from Geosciences (2003). In the analysis, it was assumed that the costs of a measure or all other measures put together are defined as all costs associated with the implementation of the measure(s), which include government costs and manufacturer compliance costs.

The benefits are defined as reduced public health risks associated with reductions of CO, HC, PM10 and NOx emissions, fuel production and fuel subsidy saving related to fuel consumption reduction caused by technology improvement and emission standard compliance. In the other side, the cost is consisted of capital and operating costs of refinery and technology application. To value of alternative policies, CBA provide a social net benefit as total social benefits deducted by total costs, while CEA makes programs with identical types of outcomes comparable by showing which program yields the greatest outcome per dollar spent but it does not indicate whether a particular policy has positive net benefits overall, ie the cost of reduction each tiype of emission.

To calculate costs and benefit, we need a basis data of the prediction vehicles number until 2030. Then, the comsumption of fuel is estimated by multiplying number of vehicles to travelled distance and fuel efficiency per type of vehicels.

On the benefit side, many researches have shown that there are strong relationship between air pollutant and human health. According to Coffey Geosciences, there are some incremental costs involved in order to change from Euro 3 to euro 4 or directly from Euro2 to Euro 4 with new technology. For instance, a small car would require an additional cost as much IDR 2,4 million to improve from Euro3 to Euro 4 while it may increase become IDR 4,8 million with new technology.

While to estimate the capital and operating costs for refinery improvement, this study employed Pertamina Plan of refinery improvement to achieve fuel standards until 2005. The costs are calculated based on Australian refinery cost as shown in the study by Coffey Geosciences. For example, to improve to Euro2, is would require at least IDR 566 Billion for octane enhancement and 863 for 35% aromatic per refinery, and it costs about IDR 90 per liter of fuel processing.

The estimation of health benefit is started by knowing how much vehicle kilometer travelled. From this data, the amount of emission would be calculated based on emission factor for each type of vehicle and emission standard . For instance, the passenger car –petrol that no compliance to Euro2 is estimated would produce 2.1 gram of CO, 0.62 gram of NOx, 0.26 gram of HC, and 0.028 gram of PM per kilometer.

The reduction cost of health as benefit is calculated from amount of emission reduction and multiplied to valuation health impact of pollutants. The production cost and fuel subsidy saving are simply calculated by multiplying amount of fuel consumption reduction to production cost of a liter fuel in each standards and a series of fuel subsidy per liter (from 2009, it is assumed about IDR 400 per liter, while at 2006 is IDR 1,694, 2007 is IDR 672, and 2008 is IDR 466 per liter).

b. Economic Benefit and Effectiveness Analysis

As the base of comparison, we set option 1 or the only improvement of fuel quality to meet Euro fuel standards as a basis. By following emission standar alone, it will affect to reducing sulfur levels to below 500 ppm, the benefits are: substantial reduction in health costs and productivity losses which are estimated at more than IDR 38,963 billion net present value (NPV) over a period of 2005-2030. This option also provides a NPV in fuel savings of IDR 71,395 billion between 2009-2030.

The cost benefit analysis indicated scrapped of old vehicele or the 5th option would ultimately promised to result the highest net benefit as much as net present value (NPV) IDR1,563,678 billion or annual average of IDR 260,793 billion during 2005-2030. That policy also offered of potentially fuel saving at the 2009-2030 period as amount of NPV IDR 1,098,827 billion. Although this policy option give the largest economic gain, but this option has a weakness of politically impelementation because mostly older vehicles owned by lower-income people, so the issue of justice and the distribution of wealth will be a challenge. Besides that, this policy also require huge compensation or incentive schemes for people who already have a vehicle older than 20 years and be willing to be compensated. However, because this policy will certainly directly affect fuel consumption, the goverments should have good strategy in convincing people to get into this policy.

As an alternative, the 2rd option is the second largest option which provide net benefit and potential fuel saving. The introduction of fuel efficiency standards result the NPV of net benefit from reduced health costs and impact on CO_2 emissions are estimated about IDR 803.6 trillion over the next 26 years. Additionally, the NPV of net benefit from fuel subsidy savings is IDR 469.5 trillion over 22 years, equaling IDR 74.6 trillion per annum. We consider this policy as the one which is visible to be implemented by government with the scheme of tax incentives for new fuel-efficient or low CO_2-emission vehicles produced by automobile industry.

Interestingly, the option to provide public transportation is the third largets to provide economic gain. This policy is expected to result the NPV of net benefit from reduced health costs and impact on CO_2 emissions are estimated about IDR 599.9 trillion over the next 26 years and the NPV of net benefit from fuel subsidy savings is IDR 388.1 trillion over 22 years. Although this policy really depend upon the behavior and social attitude of people in the country, but the result contend how important public transportation not only to increase quality of life by reducing pollution but also to hugely reduce fuel consumption.

The policies of the use of CNG for transportation, the introduction of hybrid technology, and the use of biofuel for transportation result similar figures. However, the use of CNG for transportation is the largest economic gain among this three and the use of biofuel for transportation is the largest policy of this three to have fuel saving.

The leapfrog policy to speed up the implementation of Euro 4 from 2020 (option 1) to 2016 (option 9) will result net economic gain as much as IDR 8.7 trillion and save fuel consumption as much as IDR 13.3 trillion. From this finding, government's effort to faster implementing Euro 4 by 2014 will get worth result.

We found that a consistent directions between net economic benefit matter or fuel saving concern except between the use of CNG and the use of Biofuel. However, we can conlude that among those policies, the option 2 to standardize fuel efficiency will give best benefit, then the improvement of public transport is become second best option. Furthermore, we can elaborate and carefully compare between the use of CNG for transportation, the introduction of hybrid technology, and the use of biofuel for transportation. All each of this has drawback such as; the use of CNG required high cost for converter and availability of gas supply. The introduction hybrid technology make hybrid car prices in Indonesia are still very expensive and it is estimated odds USD 100 million compared to ordinary vehicles. The use of biofuel has some weaknesses because this policy is still unsubsidized and make biofuels looks like are expensive.

Concerning of cost effectiveness of 9 options, we find that the use of CNG is the most effectiveness. The introduction of hybrid technology and the provison of public transportation are the second and the third best of effectiveness. We conclude that the the provison of public transportation is the best option by considering the net economic gain, fuel saving and the least cost to reduce emission per million ton.

c. Budget Impact

The cost to implement Euro 4 at 2020 need cost of IDR 498.3 Trillion or IDR 21.6 Trillion annually, while IDR 449.1 Trillion or IDR 19.5 Trillion annually is required to push faster implementing Euro 4 at 2016. By speeding-up to implement Euro 4 at 2016, it would potentially save budget of refinery cost about IDR 49.2 Trillion or IDR 2.13 Trillion annually.

Given net economic gain difference between them as much as IDR 8.7 Trillion and also the additional potential saving of refeinery cost, thus the policy to faster the implementation of Euro 4 emission standard by 2016 should be strongly taken to save national budget. However, this strategy needs major regulation of the introduction of new standards through a variety of policy options will require new technologies for vehicles as well as oil refining technologies that meet the new standards towards Euro 4 are needed to process fuel in accordance to standard requirement. By this policy, the benefits of increased air quality imply health care cost savings, the potential for cost reduction of subsidies for fuel and the potential reduction in production costs are expected to be in placed.
Finally, the CBA modeling conclude the best option would be depend on our concern or policy target, whether to have economic profit and to save fuel subsidy or to focus on effectiveness of emission reduction. In the period 2005-2030 is estimated that the average annual economic profit is between IDR 38.8 trillion to IDR 260.8 trillion. While the average subsidy could be saved per year is estimated at between IDR 13.0 Trillion to IDR 209.1 Trillion in the period 2009-2030.

By using a social discount rate of 8%, it is estimated that the net economic benefits over 26 years (2005-2030) ranged from IDR 38.9billion to IDR1.56 Trillion and the total subsidy savings over 22 years (2009-2030) will achieve the range of IDR71.4 billion and IDR1,1 trillion.

Cost Effectiveness

In addition to use traditional cost-benefit analysis, this study also calculate the cost effectiveness required to reduce the emissions of each type of pollutants such as CO, NOx, HC and PM per million tonne. The analys is showed that the cost-effectiveness of each policy is ranged between IDR 43-121 billion to reduce pollutants CO per million tonne, IDR 69-153 billion to reduce the pollutant NOx per million tonnes, IDR 203-441 billion to reduce pollutants HC per million tonne and IDR 667-1.449 billion to reduce PM per million ton.

2. Sensivity Analysis

Given that each policy option is always dealing with risk and uncertainty, hence in this study was also carried out risk analysis and sensitivity of each policy. Risks arising affected by changes such as the level of assumptions used social discount rate, rate of subsidy per liter, power every kind of vehicle mileage per year, vehicle efficiency per liter of each type of vehicle as well as the assumption of health cost savings per gram of any kind of vehicle emissions.

By considering the coefficient of variation of each policy option on the value of the Net Present Value (NPV) of the economic benefits, we shows that the second and third policy have the lowest risk level, meaning that policy will provide a more stable economic advantage than others in term of expected net economic benefits. But if the sole focus is to make savings subsidy, the second policy option has also the smallest degree of risk and it supports the privious finding that this policy also has the greatest potential net economi gain and subsidy savings.

To complete risk analysis, sensitivity analysis of the economic benefits of each policy on a variety of input variables needed to provide information for policy makers in determining what is a variable factor and carrying capacity of the policy will be taken. Ranking results of the variable based on the sensitivity analysis shows Social discount rate is the main factor that affect every policy option except option 5 and option 8. While the cost factor of the health effects of NOx emissions is the next factor affecting economic gain.

Sensitivity testing of major variables demonstrated that net present value of the net benefit of options was sensitive to estimate used. The most sensitive variables are social discount rate and vehicle kilo travelled. However, the price gap that government given away as subsidized to Public Service Obligation (PSO) fuel was not sensitive enough to influence the change of net economic benefit and amount fuel subsidy saving.

The five major factors to consider is the SDR, health cost savings of NOx emissions, Vehicle Kilo Travelled Bus, healthcare cost savings of PM emissions, and Kilo Travelled Vehicle Truck. This shows that the emissions of NOx and PM are the main pollutants that are harmful to health and the ability of the fuel efficiency of trucks and buses are also a major contributing factor to the emissions compared to other vehicle types.

3. Stakehoder Impacts

The impact of any policy or regulations will affect the behavior of consumers, the auto industry, refinery industry and government. For example, to meet the requirements at each stage of the implementation of emission standards, the refining industry which in this case is Pertamina must make investments to improve the technology and capacity refinery to produce fuel with sulfur content in accordance with the provisions of standardization.

In this simulation, the need for investment into the production line with Euro 4 done gradually by Pertamina according to the work plan of the years 2008-2025.The increase in the cost of investment and production quality improvement will certainly have an impact on fuel price increases will be felt by consumers. However, this negative impact will actually be compensated by an increase in the quality of public health resulting in lower healthcare costs.For the government, any alternative policy would provide the fuel subsidy reduction in the need for more efficient use of the fuel well as improving the quality of fuel or the use of vehicle technology.

For the automotive industry, the impact will be more rely on the scheme of government tax incentives, the increased of costs related to production technologies toward efficient vehicles and environmentally friendly which will increase the price of the vehicle. LPEM (University of Indonesia) studies (2004), suggests that the impact of price changes on demand for cars (price elasticity) by segment have different influences. The study concluded that the class pick ups, trucks and buses are widely used for commercial ventures, the most elastic demand that every 10% price increase, demand will decrease 23.7%. Elastic demand for cars that were then shown the class versatile 4x2, Sedan Sedan Small and medium. Most auto demand is price-inelastic is versatile and Sedan Lux 4x4. Thus the government should also set up various incentive schemes in the choice of policy to maintain the purchasing power since the transport sector has forward and backward linkages are very strong with other economic sectors.

The cost of adopting stronger emission standard would be initially borne by vehicle manufacturers and oil refinery producers in upgrading technology, plant and equipment. Some cost for sure would be passed on to the consumer by way of higher fuel and vehicle price although no information how much share of price change would be transferred to consumers.

Therefore, consumers of motor vehicles would be affected by change of price of new vehicles as a consequence in meeting with the emission standard that requires the development and introduction better technologies. The change of price would influence purchase decision and consumer behavior.

The benefit form avoided health costs would flow to those with pre-existing health condittions, the public health system and families through lower level of sickness and less restricted activity days to be more productive.

4. Coclussion

1. *Base on the costs-benefits and effectiveness analysis, the scrapped old vehicle policy has the largest of net economic benefit and potential subsidy saving, however its not viable policy in near future due to equality issue and required an expensive cost to compensate it.*
2. *The second policy options to introduce fuel efficiency standard is the most rational choice and best option as it result the greatest net economic gain and fuel saving. However this option is not the most cost-effectiveness to reduce emission.*
3. *The next best option is to provide public transportation. Although this policy largely depend on people behavior but this research shows the result as the third greatest of net economic gain and fuel saving. Furthermore, this policy is among the best of cost-effectiveness to reduce emission.*
4. *The use of CNG for transportation and the introduction of hybrid technology are among the lowest cost to reduce emission. However both of them have some draw-backs related to avalaibility of gas supply and expensive cost of gas converter and hybrid technology.*

5. *The different of net economic benefit to faster implementation of Euro 4 at 2016 compare to implement Euro 4 at 2020 is large and imply the higher benefits of increased air quality imply health care cost savings, the lower cost of subsidies and the larger potential reduction in production costs. Therefore, government may consider this exercise in designing roadmap of standard emission in Indonesia.*
6. *The second option of introduction of fuel efficiency standards demonstrate a relatively small degree of risk in terms of economic benefits and savings subsidies. Its sensitivity is relatively stable output with respect to social discount rate, health cost savings, and vehicle kilo travelled. Its relatively easier to implement than the politically and fiscal policy than others.*

5. Recommendation

1. *Timely to improve fuel quality by up grading fuel refineries with possibility through modification and or new design/construction matter, as prepartion and precondition to implement Policy Option 1, and 9.*
2. *To implement fuel efficiency policy in term to reduce fuel consumption, and $CO2$ emissions, by conducting action as follow:*
   a. *Labelling the fuel economy standard (labelling to the fuel quality standard which are comply to fuel economy vehicle): Part of public campaign/education to accelarate Policy Option 1, and 9)*
   b. *Labelling the fuel economy vehicle: Part of public campaign/education to accelarate Policy Option 1, and 9)*
   c. *Policy reformulation on fuel quality and fuel economy (Option 1 and 9):*
      - *Polcy Dialog on Set up Fuel Economy Standard (Fuel and Vehicle)*
        - *Fuel Quality Standard for Euro 4 by 2016 with possibility to proposed Euro 5 by 2016 with consideration within investment cost is insignificant.*
        - *Fuel Economy Vehicle Standard (Euro 4) by 2016*
        - *Fuel Economy Vehicle Standard (Euro 5) by 2022*
      - *Policy Drafting on Fuel Economy Standard (Fuel and Vehicle) refer to the result of Policy Dialog*
      - *Issuing the Policy on Fuel Quality and Fuel Economy*
   d. *Set up Fuel Efficiency Roadmap (Option 2)*
3. *To conduct Policy Dialog on acceleration to achieve the most optimal national fuel efficiency targets by addopting anothers 6 of 9 policy options:*
   a. *Appropirate fiscal incentives*
      a. *Tax differentiation with possibility of tax exemption for lower emission vehicles with better fuel economy*
      b. *Tax differentiation with possibility of tax exemption for vehicles comply with higher/ advanced EURO standards*
      c. *Incentives for consumers to use higher/ better fuel quality (lower charge or exemption for registration tax/ annual vehicle tax/carbon tax)*
   b. *Non fiscal incentive:*
      a. *Trade in or financial incentive to regenerating car ownership with advance/lower emission and better fuel economy*
      b. *Contracyclical policy*
      c. *Monetery policy:*
         a. *The credit scheme for car ownership*
         b. *Interest rate of car ownership credit scheme*
4. *To strengthen National Stakeholder Forum to escort policy reformulation, and its implementation.*

1. Background

The national energy demand tends to increase by time to time. There is no exception for the energy needs of transportation sector that is dominated by liquid fuel, the demand tends to increase. Factors such as the increased need for travel, and logistic needs encourage the transportation equipment use thereby increasing the need for fuel. Another factor that can not be denied is the abuse of the utilization of fuel, and the inaccuracies calculation needs. Thus, the high demand of fuel did not create opportunity for the oil and gas industry, instead it could be a burden for national economy, especially the government provision on fuel subsidy, in addition to creating a social cost which has significance pressure to the national economic growth.

The social cost includes the cost of health impacts of air pollution following the impact effects such as labor productivity reduction, health costs to be paid by the society and the destruction of infrastructure and buildings, disruption of agriculture, etc. The current issues are also social cost must be borne by the global community with the presence of the facts of climate change, the greenhouse emissions factors also contributed by the transport sector. Impacts include increased temperatures lead to melting of ice at the poles and in the mountains/mountain peaks such as the Himalayas, Kilimanjaro (Africa), Sudirman Mountains (Papua), rising sea levels, changes in the pattern of the spread of illness/disease, energy depletion, catastrophic nature (El-Nino, La Nina, storms, weather changes complicate farming, aviation, shipping).

Meanwhile, in the last ten years the growth of energy consumption in the sector of transport in Indonesia reached approximately 5.7% per year. The increase is in-line with the needs of economic and population growth. In 2010, almost all of the energy consumed by the land transportation sector is the fuel, followed by gas (CNG/LGV) and electricity. From the type of fuel, the consumption of gasoline (Premium, Pertamax and Pertamax Plus) is the largest (61.66%) followed by diesel fuel (37.5%) and the bio-fuel, which includes Bio-diesel, bio-ethanol (.84%). As for subsidized fuel (Premium and Reguler Diesel), the consumption of Premium is the largest (61.29%) followed by Solar (37.85%), the rest bio-fuel (0.86%).

Fuel subsidy budget in 2010 reached nearly IDR 61 trillions ~ USD 6.5 billions. National subsidized fuel consumption in 2010 reached 38.4 millions KL consisting Premium (23.0 millions KL), Diesel Fuel (12.8 millions KL), and kerosene (2.4 millions KL), and Bio-fuels (0.2 millions KL). When the trend of rising oil price continues, the fuel subsidy would further burden the state budget.

At the context of co-benefits in order to solve the problem of air pollution, fuel consumption savings, reducing the burden of government on fuel subsidy, as well to contribute to the mitigation of greenhouse gas emissions, it is time to consider the policy for improved fuel quality as a prerequisite for co-benefits application. In the fact, failure to provide appropriate fuel quality (low aromatic/benzene/olefin gasoline, and low sulfur diesel) led the automotive industry sputtered the investment schedule to addopt an advance technology (low emissions, and low fuel consumption). As a result, auto industry in Indonesia fail to fullfill global demand on cleaner car with higher fuel efficiency, and the most of their products are only sold to domestic market segments. The fact, Thailand has adopted the automotive industry since 1996 (Euro 1), and Euro 2 to Euro 4 in 2001 and 2012. Malaysia also did not want to miss, applying Euro 1 in 1997, Euro 2 to Euro 4 in 2000 and 2012. While Vietnam and Laos have each entered on Euro 1 in 1998 and 2000 and is poised to enter the Euro 4 in 2014. As a result, opportunities and market share of Indonesian automotive industry in Southeast Asia to be very narrow, and absorbed by neighbors countries auto industry which more advanced. In the pass Indonesia is leading on market share of automotive market, but today Indonesia is follower behind Thailand, and Malaysia.

Fuel quality not only affects the failure of urban air pollution reduction but also causes a decrease in the adverse competitive advantages of the Indonesian economy. Of course, the competitive advantage is not just only for the national automotive industry but also applies to oil and gas industry. If it does not start improving the fuel quality, certainly a niche market needs of quality fuel will be taken by foreign oil and gas industry.

It is time for the government and stakeholders to draft a policy paper based on the cost-benefit analysis to consider issuing a regulation or policy interventions to improve fuel quality paralel with fuel economy requirements policy implementation through (1) reduced levels of sulfur (sulphur) on fuel up to 50 ppm, and (2) to promote fuel economy standards in Indonesia. Interventions such policies are expected to lead to a positive impact in improving air quality, national fuel consumption savings, reducing the burden of government on fuel subsidy, the growth of the automotive industry with products of lower emission vehicle, and high fuel economy (lower fuel consumption), open market on clean fuels, growing of cleaner fuel industry alternative, and contribute to mitigating climate change, and increased export of motor vehicles.

2. Ambient Air Quality Status

Air pollution is still being a major threat for Indonesia, especially in its major cities which have crowded traffic. According to data from ambient air quality monitoring on the decade of 2001 - 2010, people of most major cities in Indonesia only have no more than 2 months in a year to enjoy good air quality, thus in 2005 for instance, Jakartans only have 18 days in a year to breathe good air. In 4 Indonesian cities (i.e. Jakarta, Surabaya, Bandung and Semarang), transportation contributes 45-65 percent of the total emissions of PM10 (particulate matter smaller than 10 microns). Current levels of air pollution in Indonesia exceed the international environmental standard. Also, Jakarta areas currently exceed its ambient air quality standards (AAQS) particularly for key pollutants. The parameter of pollutant exceeded standard air quality stipulated by government, especially parameter of nitrogen-oxide (NO_x), particulate matter (PM10), oxidant (O3), and carbon-monoxide (CO). Of course, such condition has caused various illnesses and dieses suffered by public especially respiratory, hypertension, kidney dysfunction, intellectual decrement for children, coronary heart until earlier death.

Post Unleaded Gasoline Policy

People movement successes to escort Government of Republic of Indonesia, oil company, auto-industry, and related stake holder in relation to keep the sustainability of ULG policy in the country of Indonesia, after implemened it in the Greater Jakarta (2001) and nation-wide (2006). The movement conducted simultaneus activities such research (like BLL test, fuel quality test, survey, etc), introducing catalytic converter, maintenance public campaign on ULG, and working on octane replacement.

In term to keep sustainability of ULG, beside the background on high sulfur content in diesel fuel, and unfortunately not all car manufacturers were prepared to uphold the mandatory Euro 2 Standard completely with various reasons e.g. unavailability low sulfur fuels, it is time to harmonize among related stake holder in order to reduce mobile source emissions through synergize in formulating the roadmap on cleaner fuel and vehicle.

The Necessity to Synergize Cleaner Fuels for Cleaner Vehicles

In 2008, The ASEAN Auto-manufacturer Federation (AAF) established the schedule that the auto-manufacturer in the sub-region of South East Asia will adopt Euro 4 Standard by 2012. It meant, the AAF members have a plan to produce lower emission vehicle with lower fuels consumption that will be marketed by 2012, a challenges effort to response the needs on urban air quality improvement, and climate change issue through mitigate green house gas of transport sector. The effort must be supported by availability of cleaner fuels comply to the Euro 4 Standard with the prior parameter for Indonesia is lower sulfur fuels. In this term, it is importance to encourage policy reform on providing cleaner fuel, a pre-condition to implement cleaner, and fuels economy vehicle.

According to the needs on above (1) better air quality improvement program, (2) saving the climate through mitigate green house gas from transport sector, and (3) the next step of Unleaded Gasoline Policy in Indonesia, it is importance to promote fuel economy policy in Indonesia, through match-making/harmonize between cleaner fuels and vehicles implementation of "low sulfur fuels" as main strategic agenda to solve the problems of urban air pollution, and the burden of green house gas to the climate.

3. Objective of Study

The objective of this cost-benefit analysis (CBA) study is to examine the benefits and costs of regulatory or policy interventions for 1) reducing Sulphur levels (targeting 50ppm Sulphur level) and 2) introducing vehicle fuel economy standards in Indonesia, to contribute to the global goal of 50% improvement in the average fuel efficiency for the global fleet. This study would provide various options that could form the basis of a national clean fuels and vehicle fuel economy strategy in Indonesia. Scenarios will be developed and assessed for their costs, benefits and effectiveness in reducing emissions and improving fuel efficiency.

4. Urban Air Quality and Health Economict Effect

4.1. Evaluation of Ambient Air Quality

Figures 4 to 8 show trend and annual average ambient Sulfur Dioxide (SO2), Oxide Nitrogen (NOx), Carbon Monoxide (CO), Ozone (O3) and Particulate Matter (PM-10) respectively between 2001 – 2010 in the DKI-Jakarta.

4.2. PM10

From 2001 to 2010, the annual average concentration of PM-10, SO_2, NO_2, NO, CO and Ozone analyzed by comparing to WHO Standard and National Ambient Air Quality Standard (NAAQS) No. 41/1999 of Indonesia. The monitoring value exceeded WHO standard in all of the year monitoring and also five PM-10 monitoring stations in Jakarta city. And still below the National Ambient Air Quality Standard (NAAQS) No. 41/1999.

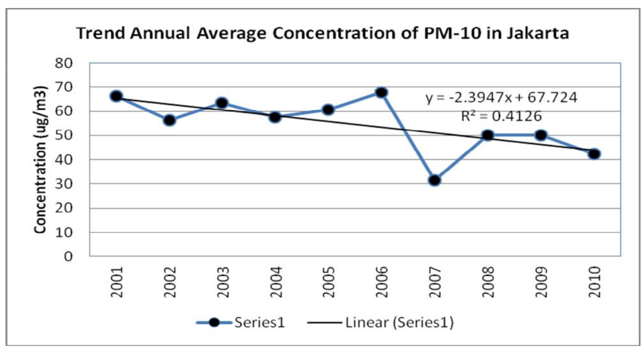


Figure 1: Annual Average PM-10 Concentration in DKI-Jakarta

The concentration of PM-10 measured in 2006, it was highest compare to other year. In 2007, 2008 and 2009 the concentration seems constant or almost not increased the PM-10 concentration while in 2011 increase may cause by motor vehicles sources. This value of PM-10, which is almost three times the WHO guideline value (20 µg/m3), was attributed to the presence of motor vehicles. Based on analysis conducted on samples it collected from its monitoring stations, PUSARPEDAL identified fuel burning and soil (re-suspended solid) as the major sources of PM-10 in Jakarta area.

4.3. Sulfur Dioxide

Annual average concentration of year 2001-2010 exceeded NAAQS No: 41/1999 (60 µg/m3) at 2003 and 2009 in the Jakarta City based on monitoring data from five stations by PUSARPEDAL/DKI-Jakarta.

On the other year 2001 to 2002 and 2004 to 2008 and 2010 monitoring data also showed the annual average of SO_2 concentrations were below the NAAQS No: 41/1999 (Figure 2).

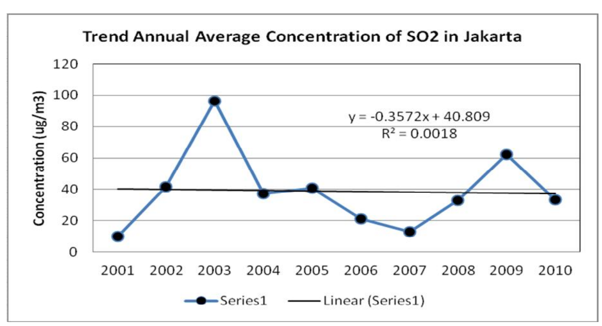


Figure 2: Annual Average SO2 Concentration in DKI-Jakarta

The relatively higher SO_2 concentrations can be attributed to higher number of diesel vehicles burning sulfur-containing diesel fuels and industrial facilities that burned high sulfur fuel oil in these areas. Trends of SO_2 concentration from 2006 to 2009 was increased and decreased at 2010. Daily average SO_2 concentrations were higher during the dry season (February to June) compared to the rest of the year.

4.4. Nitrogen Dioxide (NO2)

Annual average concentration of NO_2 from 2001 to 2010 was not exceeded the NAAQS based on monitoring data from the PUSARPEDAL Observatory as shown in Figure 3. But was exceeded WHO guideline standard at year 2003. In 2010 the annual average concentration almost exceeded the WHO standard.

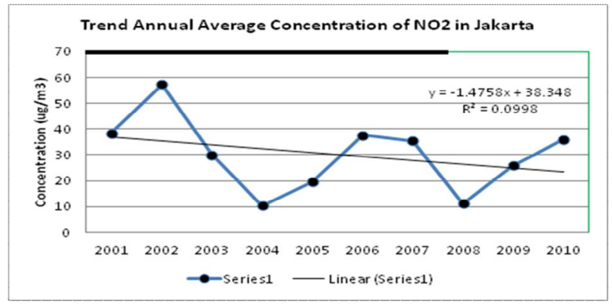


Figure 3: Annual Average NO2 Concentration in DKI-Jakarta

This condition may effect of increasing the growing of motor vehicles. NITROGEN OXIDES, which include NO and NO_2, are produced when air is subjected to high temperature and high pressure such as in diesel engines. NAAQS Guideline Values for NO_2 = 150 µg/Nm3 (24-hour). Trends of daily average of NO_2 concentration from 2001 until 2010 as follows. During February 2001 to march 2003 it is show the higher concentration of NO_2 compares to other.

4.5. Carbon Monoxide (CO)

Carbon Monoxide is a product of incomplete combustion in motor vehicles and factory. Its principal source is gasoline engine. NAAQS standard for CO: 30 mg/Nm3 (1-hour), and 10 mg/Nm3 (8-hour). Figure 7 and 7-1 show the daily and annual average of CO concentrations at Jakarta City.

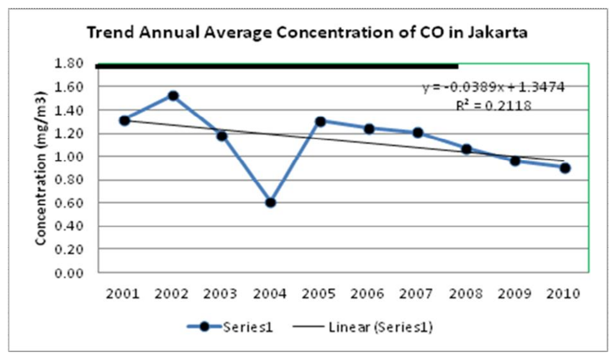


Figure 4: Annual Average CO Concentration in DKI-Jakarta

Trend daily and annual average concentration of CO from 2006 to 2009 slightly decreased and below the WHO standard and NAAQS (for 8-hour) based on monitoring data from the PUSARPEDAL and BPLHD-DKI Observatory as shown in Figure 4. In 2010 the annual average concentration increase respectively, it is supposed to the number of motor vehicles increased and caused heavy traffic volume. Trends of daily average CO concentrations were seems constants during the dry season (February to June) compared to the rest of the year.

4.6. Ozone (O3)

Ozone is the secondary pollutant, and produced through the chemical reaction of nitrogen oxides (primary from diesel engines), volatile organic compounds (VOC) (primary from gasoline engines), hydrocarbon (HC) and UV rays (from the sun). As the ozone secondary pollutant it was experienced, the high concentration of ozone (over 0.1 ppm) occurred around 30 – 40 kilometer distance from the sources.

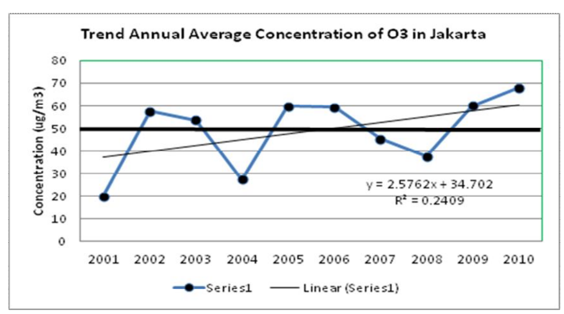


Figure 5: Annual Average O3 Concentration in DKI-Jakarta

In Jabodetabek area the location of air pollution sources mainly in the north part and east part of Jakarta city.

Wind rose of Jakarta city also conclude that the dominant wind speed and wind direction from north to south so it is confirm the high concentration of ozone will monitor at Serpong (south part Jakarta) at the time 11 – 15 pm.

The annual average concentration of Ozone was high on year 2006 and 2010 and exceeded NAAQS No: 41/1999. Trend Ozone concentration was monitored in DKI-Jakarta almost no change. Figure 5 show the daily and annual average concentration of Ozone in DKI-Jakarta. Trends of daily and annual average Ozone concentrations 2001 to 2010 were seems increased during the dry season (February to June) compared to the rest of the year. It is supposed effected by dry season because could re-suspend soil.

4.7. Air Quality Data by Passive Sampler

The data ambient air quality monitoring by using of passive sampler method in the period of 2005 – 2010 show us that NO_2 in residential and industrial areas were is still bellow National Standard (annual average 100 $\mu g/m^3$), and just the monitoring on October were exceeded the National Standard. Meanwhile, by using WHO Standard (annual average 40 $\mu g/m^3$), above mentioned parameter were exceeded standard, include for parameters SO2 in 33 of provincial capital cities[1].

5. Economic Valuation of Health Effects caused by Air Pollution

In the last 10-20 years epidemiology has dealt extensively with the effect of outdoor air pollution on human health. A considerable number of case studies in different countries and under different exposure situations have confirmed that air pollution is one of various risk-factors for morbidity and mortality.

In general, air pollution is a mixture of many substances (particulates, nitrogen oxides, sulfur dioxides). Knowing that several indicators of exposure (eg. NO2, CO, PM10, TSP etc.) are often highly correlated, it is not accurate to establish the health impact by a pollutant-by-pollutant assessment, because this would lead to a grossly overestimation of the health impact.
Based on various epidemiological studies, in the present study PM10 (particulate matter with an aerodynamic diameter of less than 10 micron meter) is considered to be a useful indicator for measuring the impact of several sources of outdoor air pollution on human health[2].
For the assessment of the health costs it was not possible to consider all health outcomes found to be associated with air pollution. Only those meeting the following three criteria were considered:

- there is epidemiological evidence that the selected health outcomes are linked to air pollution;
- the selected health outcomes are sufficiently different from each other so as to avoid double counting of the resulting health costs (separate ICD[3] codes);
- the selected health outcomes can be expressed in financial terms.

This study is an economic valuation study to present the monetary value estimates for the adverse human health effects resulted from ambient air pollution.

Both the studies on short-term effects of ambient air pollution on public health revealed that, similar to other foreign studies, there were significant correlation between the concentrations of air pollutants and the morbidity rates of certain types of respiratory and cardiovascular diseases. It is assumed that the impacts of the four selected criterion pollutants, namely nitrogen dioxide (NO_2), sulphur dioxide (SO_2),

[1] Environmental Monitoring Center – Ministry of Environment Republic of Indonesia
[2] Künzli N. et al (2000), Public Health Impact of Outdoor and Traffic-related Air Pollution: A Tri-national European Assessment, in press.
[3] ICD: International Classification of Diseases.

particulate matters less than 10 micrometer (PM10), and ozone (O_3), on diseases under the broad categories of respiratory and circulatory diseases have already been ascertained by the previous studies.

This report presents the economic costs of the effects of ambient air pollution on health by the cost of illness (COI) approach. The available quantitative data was fitted into an epidemiological model constructed to represent the economic impact of air pollution in Jakarta with respect to morbidity. Data available on medical costs was used for the measurements of the value of morbidity.

The concept of COI had been adopted in a number of studies for the economic evaluation of health impacts associated with ambient air pollution. For example, one study showed that there is an association between the US 1980 mortality rates and respirable particulates and/or toxic fraction of the aerosols(Ozkaynak and Thurston, 1987). In another study, it was concluded that the measurable costs of air pollution are high enough to justify substantial expenditures to control vehicle emission rates (Small and Kazimi, 1995). There are also several studies relating to the cost of disease and premature death due to air pollution using the concept of willingness to pay (WTP) and actual cost calculation (Tolley et al., 1994; HMSO, 1996). Two research COI in Indonesia has also been carried out in 1994 (Ostro et al '94) and 1998 (Resosudarmo et al '98). Both of these research results will be used as comparators in the findings in this research. In this study, we evaluate the monetary values associated with the morbidity related to air pollution based on hospital admission data in Jakarta.

5.1. Methodology

Disaggregated data was used for estimating COI for the individuals. For this study, hospital admission (morbidity) data provided by two hospitals, in-patient and out-patient were used in the COI evaluation.

The estimates were then used to extrapolate the total amount of illness caused by air pollution and here we shall assume that the population is subject to the same exposure.

5.2. Data/statistics used for estimation of economic cost

Data were collected from the Hospital medical record. The information includes morbidity both in-patient and out-patient by the diseases-related to air pollution, such as asthma, bronchopneumonia, cancer nasopharyngeal, acute respiratory infection, chronic lung obstructive disease, pneumonia, and coronary heart diseases. Cost of treatments was collected from hospital administration office based on the patient's payment. Number of population DKI Jakarta 2000 and 2010 from BPS: 26 Mei 2011 09.22 www.bps.go.id/aboutus.php?tabel=1&id_subyek=12

2000	8,389,443
2010	9,607,787

Table. 2. Incidence of diseases related to air pollution
in Persahabatan Hospital and Hospital of Sulianti Saroso DKI Jakarta 2010

Health Impacts	ICDs Code	Incidence (%)	
		Persahabatan	RSPI
Asthmatic bronchiale	J.45.9	1.8	2.0
Bronchopneumonia	J.18.0	0.4	1.6
Acute respiratory infection	J.06.2	0.5	0.8
Pneumonia	J.18.9	0.4	7.5
Chronic Obstructive Pulmonary Disease	J.44.9	0.5	1.6
Coronary artery diseases	I.25.2	13.0	-

Incidence of disease and health disorders associated with air pollution in Jakarta in this study is taken from the medical record in 2 hospitals, i.e. Sulianti Saroso Hospital and Persahabatan Hospital. The data of diseases incidence and health disorders associated with air pollution are identified based on the WHO Code of ICDs-10 involving Asthmatic bronchiale, Bronchopneumonia, Acute respiratory infection (ARI), Pneumonia, Chronic obstructive pulmonary disease, and Coronary artery diseases. The results are shown in above table 2. Based on data in-patient and out-patient at the finances of both hospitals, the costs to be paid by the patients for the diseases are as shown in table 3 below:

Table. 3. Range of treatment cost per-patient on diseases related to air pollution in Persahabatan Hospital and Hospital of Sulianti Saroso Jakarta 2010

Health Impacts	**Range of Treatment Cost per patient**			
	Persahabatan		**RSPI**	
	IDR (x1000)	**US $**	**IDR (x1000)**	**US $**
Asthmatic bronchiale	173 – 3,576		863 – 4,419	
Bronchopneumonia	91 – 905		1,591 – 3,651	
Acute respiratory infection	92 – 1,586		87 – 4,775	
Pneumonia	110 – 5,185		2,067 – 5,455	
COPD	164 – 5,276		1,102 – 4,589	
Coronary artery diseases	149 – 14,648		-	

Calculation of the estimated cost of illness for residents of Jakarta use the method of:

COI = Incidence of disease per 100,000 population x hospitalized costs

The latest incidence health impacts related to air pollution in DKI Jakarta based on the report of Subdirectorate of surveillance epidemiology, Ministry of Health is as the followings table 4:

Table. 4. Incidence of diseases related to air pollution in Jakarta per 100,000 population**

Health Impacts	**2008**	**2009**	**2010**
Asthmatic bronchiale	-	12600.0*	-
Bronchopneumonia	1500.0	1500.0	1600.0*
Acute respiratory infection	25500.0□	-	-
Pneumonia	90.0	2400.0	3500.0*
COPD	1500.0	1500.0	1600.0*
Coronary artery diseases	-	-	12970.0*

* Selected incidence rate for COI estimation
**Source: Subdit Surveilans Epidemiologi, Dit Sepimkesma, Ditjen PPPL, MOH 2008-2010

Table. 5. Estimation cost of illness on diseases related to air pollution in Jakarta 2010 (in IDR)

Health Impacts	**Incidence Per 100,000**	**Cost per patient**		**Estimated cost in Jakarta**	
		Minimum	**Maximum**	**Minimum**	**Maximum**
Asthmatic bronchiale	12,600.0	173,972	4,418,618	210,607,225,915	5,349,095,712,874
Bronchopneumonia	1,600.0	91,500	3,650,813	14,065,837,500	561,221,228,425
ARI	25,500.0	92,142	4,774,843	225,746,580,987	11,698,296,998,123
Pneumonia	3,500.0	109,738	5,455,359	36,901,876,543	1,834,489,937,007
COPD	1,600.0	164,161	5,276,800	25,235,582,747	811,176,080,000
Coronary artery diseases	12,970.0	148,763	14,647,900	185,378,033,307	18,253,187,244,690
Total				**697,935,136,999**	**38,507,467,201,119**

In Jakarta 2010, there were: 1,210,581 people suffered by asthmatic bronchiale (compare with 500,000 population founded by Ostro 1994); 153,724 people with bronchopneumonia; 2,449,986 with ARI; 336,273 people with pneumonia; 153,724 people with COPD, and; 1,246,130 people with coronary artery diseases. This shows that in 2010, a total of 57.8% of the Jakarta population suffered by various air pollution-related diseases (Table 3). The rate of cost of illness estimation health impacts related to air pollution in Jakarta is shown on the above-table 5.

Table. 6. Estimation cost of illness on diseases related to air pollution in Jakarta 2010 by median and mean (in IDR)

Health Impacts	Incidence Per 100,000	Cost per patient		Estimated cost in Jakarta	
		Median	Mean	Median	Mean
Asthmatic bronchiale	12,600.0	568,500	1,445,074	688,215,390,597	1,749,379,362,096
Bronchopneumonia	1,600.0	132,500	330,539	20,368,508,440	50,811,972,915
ARI	25,500.0	132,000	243,736	323,398,110,420	597,149,710,919
Pneumonia	3,500.0	310,750	2,011,523	104,485,726,836	676,419,958,536
COPD	1,600.0	613,000	2,180,985	94,233,174,896	335,271,029,283
Coronary artery diseases	12,970.0	779,750	1,818,698	971,669,847,149	2,266,334,091,272
Total				**2,202,370,758,338**	**5,340,430,366,767**

Estimation of the costs to be paid by Jakarta population to treat their various diseases related to air pollution in 2010 was minimum of Rp. 697,935,136 .999,- and a maximum of Rp.38,507,467,201,119 (median = Rp. 2,202,370,758 .338,- and the average = Rp.5,340,430,366,767,-).

Table. 7. Estimation cost of illness on diseases related to air pollution in Jakarta 1990, 2001, and 2010 (median) (in IDR)

Health Impacts	1990			2001	2010
	WB Report	URBAIR	Reso-sudarmo		
Asthmatic bronchiale	5,263	11,165	5,000	78,500	5,349,096
Bronchopneumonia	33,680	22,330	17,500	323,000	561,221
ARI	842	4,466	850	320,000	11,698,297
Pneumonia	-	-	-	-	1,834,490
COPD	-	-	-	-	811,176
Coronary artery diseases	-	-	-	-	18,253,187
Hospital admission	547,300	346,165	1,515,000	1,790,500	-
Total	**587,085**	**384,096**	**1,538,350**	**2,512,000**	**38,507,467**

Table. 8. Estimation cost of illness on diseases related to air pollution in Jakarta 2010 and estimation of previous studies in 2015 (median in IDR)

Health Impacts	2010	2015 (Resosudarmo '98)
Asthmatic bronchiale	5,349,096	3,158,993
Bronchopneumonia	561,221	71,883
ARI	11,698,297	26,809,908
Pneumonia	1,834,490	-
COPD	811,176	-
Coronary artery diseases	18,253,187	-
Hospital admission	-	290,588
Total	**38,507,467**	**30,331,372**

6. Fuel Quality in Indonesia

The United Nations Economic Commission for Europe (UN ECE) has initiated the Global Harmonization on Transport Regulation in 1958 with the purpose of encouraging the production of vehicles that provide safety assurance and are environmentally friendly. The harmonization was only intended for auto manufacturers in Europe. However, other non- European auto manufacturers have also developed vehicles complied with that standard. As a result, Europe, the U.S., Japan and other Asia Pacific countries have adopted the Euro standards since 1998. The Euro Standards consists of several ratings include Euro 1, Euro 2, Euro 3 and Euro 4. Higher rating means that vehicles comply with it have better safety assurance and exhaust emissions.

The government of Indonesia (GOI) has tried to adopt Euro 1 emission standards in 1998. It sought to establish an agreement with the local automotive industry. However, the agreement was not reached until 2003 when the implementation of Euro 2 emissions standards was agreed. Thus, local auto manufacturers have been obliged to comply with this standard starting from Jan. 1, 2005 (Decree of the Minister of Environment of Indonesia No. 141/2003).

However, the local automotive industry including the authorized sole agents and brand holders (ATPM) were not fully ready to implement the decree. Although the design of vehicles sold in Indonesia have conformed Euro 2 standards, some components have not complied with the standards. A lobby to the Ministry of Environment resulted in the postponement of the decree to 2010. In fact, the decree has not been fully implemented until today.

In addition, oil companies such as Pertamina, Petronas and Shell only supply gasoline with high aromatic and olefin content and automotive diesel with high sulfur content. The quality of fuel in Indonesia made the automotive industry hesitate to invest in the advance emission control technology. Standard equipments such as catalytic converter has not installed yet to all of in-used vehicle even the ULG has been supplied to the Greater Jakarta (2001), and nationa-wide (2006). Also Diesel particulate filter (DPF) has not installed in to all in-used vehicles due to high sulfur content in diesel. Thus, vehicles do not fully comply with Euro 2 criteria.

Compared to other countries in ASEAN, Indonesia is lagging behind others. For example, Thailand's automotive industry adopted Euro 1 standards in 1996, Euro 2 in 2001 and Euro 4 in 2004. Malaysia's automotive industry adopted Euro 1 in 1997 and Euro 2 in 2000. Vietnam and Laos' automotive industry adopted Euro 1 in 1998 and 2000 respectively. Thus the opportunity for Indonesian automotive industry to tap into the Southeast Asian market is small.

However, it is important to note that although automotive industry in the above countries adopted Euro 1 and Euro 2 standards before Indonesia, it does not mean that their fuel quality improvement go hand in hand with the emission standards.

From the economic point of view, the unclear policy has resulted in lower competitive edge of auto manufacturers in Indonesia. The hesitation to invest in advanced emission technology has reduced domestic vehicles' market share because of increased imported 'more environmentally friendly' vehicles into the country. In order to have complete implementation of Euro 2 emission standards in Indonesia, the automotive industry is expected to coordinate with their principals in the country of origin i.e. Japan in the adoption of advance emission technology. In addition, the GOI has to ensure the availability of fuels that comply with Euro 2 emission standards nationwide.

The full implementation of Euro 2 emission standards both on vehicle technology and fuel quality will ensure a reduction of air pollutions and increase of automotive industry's competitiveness in the Southeast Asian market.

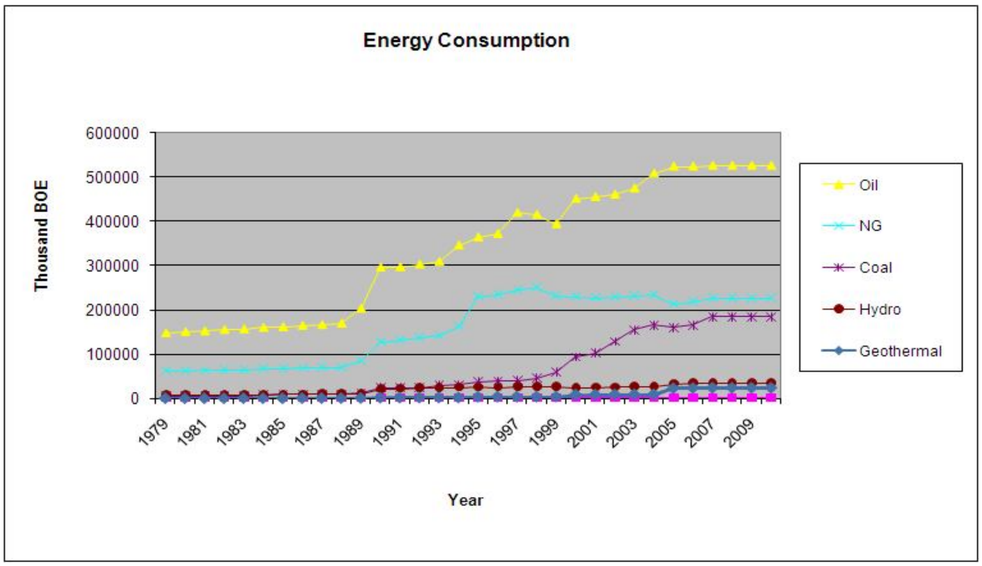
6.1. Total Energy Consumption

a. Energy Mix Final

The energy mix in 2005 showed that oil usage accounted for 55% followed by gas (22%), coal (17%), water (3.8%) and geothermal (2%).

Realizing the need to secure energy and mitigate climate change at the same time, the GOI through Presidential Regulation No. 5/2006 pertaining to National Energy Policy reduced the dependence on oil to 20% while increasing usage of coal (33%), gas (30%) and renewable (17%). Renewable consists of geothermal, nuclear and biofuels in 2025.

Figure 6: Energy Consumption



b. Energy Consumption by Source

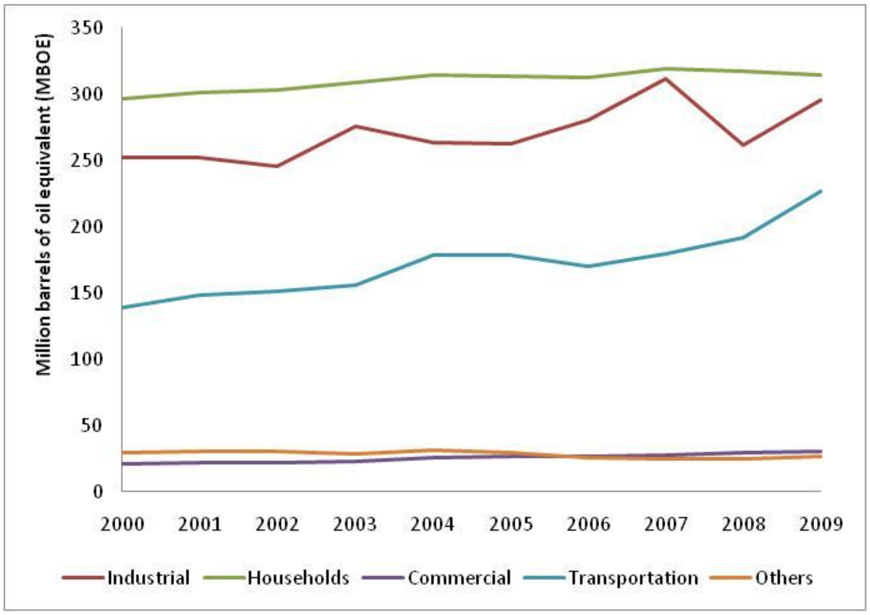
In the period of 1979-2007, there was an increasing consumption in the consumption of oil, coal, hydro and geothermal in the industrial, transportation and household sectors. However, except for gas and coal, energy consumption fell in 1997/98. Gas consumption fell in 2000/01 while coal consumption was constant. This trend showed the existence of monetary crisis in Indonesia in those years.

c. Energy Consumption by Sector

Following population trend, consumption of energy in Indonesia tends to increase as well. In the period of 2000-09, average energy consumption (including biomass usage) in the household sector accounted for 38.6% followed by the industrial sector (33.52%), transportation sector (21.26%) and the commercial and other sectors (6.62%).

Figure 7 shows that final energy consumption in the transportation sector, although not accounted for the largest, it increased at compound annual growth rate (CAGR) of 6.98% in the period of 2000-09. The trend is expected to continue given the increase of vehicles population in the country.

Figure 7: Final Energy Consumption by Sectors in Indonesia, 2000-09



d. Refined Petroleum Product Consumption by Sectors (1997-2007)

Since 2000, refined petroleum product consumption in the industrial, transportation, households and commercial sectors has been fluctuated and reached the peak in 2004. Indonesia imports almost 40% of its petroleum product to meet domestic demand that increases on annual basis. This situation is expected to continue if there is no change in the capacity of domestic refineries and consumer behavior.

6.2. Diesel & Gasoline Supply

6.2.1. Gasoline Supply

Referring to data during the period of 1989 – 2007, gasoline supply was increased, however, there was a sharp reduction in 2005/06 mainly because of increase in fuel price on Oct. 1, 2005.

Domestic refineries produce up to 62% of gasoline demand and the rest is imported. In 2009, total gasoline produced by domestic refineries reached 11.77 million liters, a total of 3.4% from total capacity of refineries.

Dependency on imported gasoline has started in 1995. It increased on annual basis as shown in figure X. Imported gasoline is a combination of high octane mogas component (HOMC) RON 92 and RON 95 which is then blended with Naphta into RON 88 gasoline.

In addition, bioethanol (ethanol) has been added to gasoline pool by introducing ethanol blended gasoline E5 (5 vol% ethanol blended with gasoline) for both RON 92 and RON 95 gasoline grades. However, ethanol blended gasoline is mainly available in Jakarta and Malang at the moment due to ethanol availability and pricing issues. Even today, ethanol procentage in the gasoline is not more than 1%.

6.2.2. Diesel Supply

Diesel fuel supply fluctuated with a decreasing trend, following the demand pattern which is also fluctuating over the years with a decreasing trend. Sharp reduction of supply occurred in 1998 which was due to economic crisis starting from 1997. The sharp decrease also occurred in the year of 2006, after the increase of auto diesel fuel price which was up to 104.76% on 1 October 2005. The total demand for the year of 2007, for instance, was 10,445,490,94 KL.

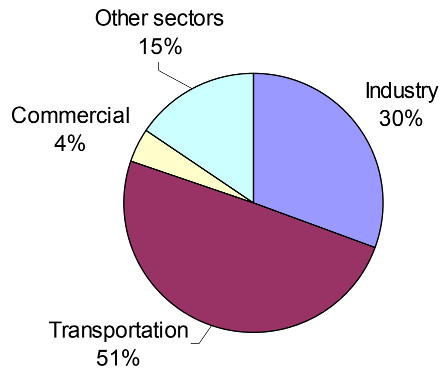


Figure 8: Diesel Supply

Similar with gasoline, biodiesel blend is available in some parts of the country in the form of B1 (1 vol% of biodiesel blended with diesel). Domestic refineries have the maximum total capacity of 87 million barrels of diesel per year, and import volume is approximately 75 million barrels per year[4].

Referring to data on the average demand for ADO during the period of 2000 – 2010, it showed that ADO demand is still dominated by the fuel demand in transportation sector (please refer to diagram).

6.3. Fuel Price Development

Fuel Pump Price

On the basis of graph above, from time to time there was an increasing trend for the fuel retail price, both for gasoline and for auto diesel fuel. The highest increase occurred on 1 October 2005 which was by 100%. The 2005 price increase was triggerred by the sharp rise of crude oil price exceeeding the crude oil prices stipulated by Government.

Today, the price of regular gasoline is Rp 4,500 per liter, similar price with regular auto diesel fuel price. Since 24 March 2008 the price has increased to Rp 6,000 or equivalent to 66.66 cents US Dollar for reguler gasoline, and Rp 5,500 or equivalent to 61 cents US Dollar per liter for regulair diesel fuel. These prices are higher than those in Vietnam (67 cents US Dollar for gasoline and 53 cents US Dollar for auto diesel fuel), but cheaper than those in China and India. Prices of gasoline in China and India are 69 and 101 cents US Dollar per liter, respectively, as the diesel fuel prices are 61 and 75 cents US Dollar per liter, respectively.

Fuel subsidy: structure, development

Concept of price setting for fuel (BBM) in Indonesia generally consists of three methods, namely Border Price, Production Costs (HPP), and Government's Price. Pricing by Border Price method refers to the determination of price at ex Singapore's refinery. Price setting is assumed applicable at competitive price. By such assumption, the price of fuel (BBM) from Singapore refinery is already close to efficient price. Benchmark Price of ex Singapore's refinery uses Posted Price published regularly. This Price is also then added by other cost components such as

[4] KPBB, Investigative Report, 2007.

transportation, taxes, subsidy and others. All make up to the selling price in Indonesia. Meanwhile, Costs of Goods Sold or HPP is the calculation value of the average production costs of fuel (BBM). Production Costs or HPP is calculated by substracting income from sales of fuel (BBM) in the country after less all costs and then divided by the volume of fuel (BBM). The costs are grouped in the costs for the procurement of crude oil and production as well as operating costs. The cost structure for fuel (BBM) in Indonesia shall be as follows:

Total Cost = Cost of Crude oil purchase (83.4%) + processing cost (6%) + sea transportation cost (5.8%) + distribution cost (3%) + other cost (1.8%).

This Cost Structure is rather different than those implemented in other countries, such as the United States of America (please refer to diagram of Fuel Cost Structure), which is not only eliminating the subsidy but also imposing taxes.

6.4. Fuel quality

Specifications for gasoline & diesel

Table. 9. Fuel Specification

Fuel Specification

Ref: Dir. Gen. of Oil and Gas, Decree No: 3674K/24/DJM/2006 for Gasoline Fuel; No: 3675K/24/DJM/2006 for Diesel Fuel

OIL COMPANY	Gasoline Branded	Fuel Spec. Type base on 3674K/2006			
		88 LG	88 ULG	91 ULG	95 ULG
PERTAMINA	Premium (Leaded)	Phased- out in Jun.06			
	Premium (Unleaded)		●		
	Bio Premium (E5)		●		
	Pertamax			●	
	Bio Pertamax (E5)			●	
	Pertamax Plus				●
SHELL	Super 92			●	
	Super Extra 95				●
PETRONAS	Prima 92			●	
	Primax PX2				●
GULF	Petrol 92			●	
	Petrol Super 95				●

OIL COMPANY	Diesel Branded Name	Fuel Spec. Type base on 3675K/2006	
		CN 48 (S<3500ppm)	CN 51 (S<5000ppm)
PERTAMINA	Regular Solar	●	
	Bio Solar (B5)	●	
	Pertamina Dex		● (S<500ppm)
SHELL	Shell Solar		●
GULF	D-xtra		●

The fact shows that the fuel specifications in Indonesia as provided in Decree of Director General of Oil and Gas No 3674K/24/DJM/2006 and No 3675K/24/DJM/2006, have yet to provide the restriction and regulations regarding the importance of more firm standards that meet the regulations in order to produce cleaner fuel as it becomes the prerequisite for the requirement of low emission vehicle. In simple way, it can be mentioned that Director General of Oil and Gas still accepts the possibility for the sale and marketing of leaded gasoline, even though Pertamina has been able to eradicate leaded gasoline production and marketing in the national scale. In addition, Director General of Oil and Gas makes a very loose restrictions regarding the sulphur content contained in auto diesel fuel, namely 3500 ppm. Not to mention, if we look into further details on the fuel component such as the content of aromatic, destilation, RON, Cetane Number, etc., the actual conditions are still far from the expectation to obtain a clear limit that will lead into the production of more quality fuel which can meet the requirements for the application of low emission vehicle.

Fuel quality monitoring at distribution & pump station

With respect to gasoline quality, prerequisite to apply low emission vehicle has been fulfilled since nationally, unleaded gasoline can be supplied throughout the country since 1 July 2006. In this context, it is a very good sign for auto-industry to develop low emission vehicle which is, for instance, referring to Standards Euro 2.

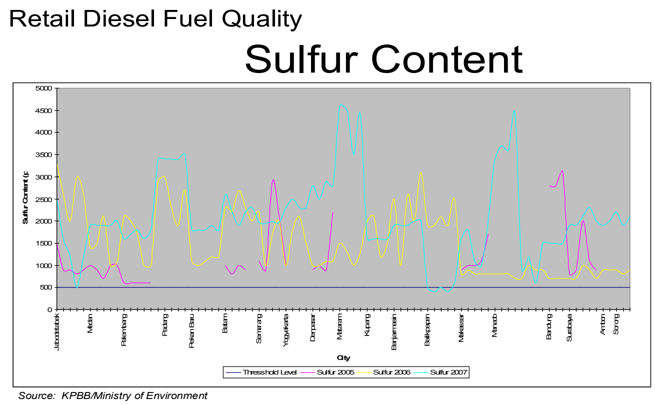


Figure 9: Sulfur Content

Different case occurs to quality auto diesel fuel, where very high content of sulphur is still found, which is 1751 ppm in average nationally with the lowest range of 400 ppm and the highest range of 4,600 ppm. Similar to other detail specifications which are intended to minimize the emission such as cetane number, distilation and aromatic content; they have yet to show the level that meets requirements for the application of low emission vehicle with auto diesel fuel.

Comparison with other countries (China, India, Vietnam, Singapore)

Related to the status of quality fuel, we are far left behind China, India, Vietnam and Singapore. These four countries at least do have fuel that meets the requirements of Standards Euro 2 (together with the details for every component in its specifications), and moreover, Singapore has met the requirements of Standards Euro 4.

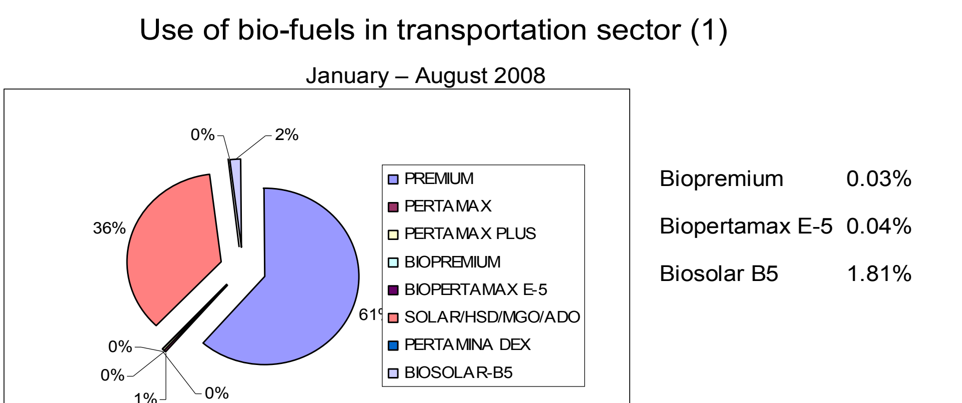
Compliance status of current fuel quality in Indonesia with Euro standards

For gasoline, even though nationally already supplied in form of unleaded gasoline, it still requires quality upgrading so that it will perfectly meet the requirements of Standards Euro 2. These requirements include among others RON 91, minimizing the content of aromatic and olefin. The current quality of the gasoline has met the requirements of Euro 2, but it has not been able to make vehicle engine of Standards Euro 2 work effectively in order to reduce emission as per the design.

Meanwhile, for auto diesel fuel, it is clear that there are many parameters that have not met requirements of Euro 2 Standards, in terms of both the main parameter i.e. sulphur content and cetane number and other parameters (distilation, aromatic content, and others).

Bio-fuel

Figure 10: Bio-fuels use in transportation sector



	PREMIUM	PERTAMAX	PERTAMAX PLUS	BIOPREMIUM	BIOPERTAMAX E-5	SOLAR/HSD/MGO/ADO	PERTAMINA DEX	BIOSOLAR-B5
Sales	12,984,783.090	135,336.923	53,114.000	6,008.000	9,321.717	7,712,403.002	432.122	385,864.000
Share (%)	61%	0.64%	0.25%	0.03%	0.04%	36.23%	0.00%	1.81%

Source: Pertamina, 2008

We are aware that since the issue of Presidential Instruction No 1/2006 regarding the Utilization of Bio Fuel, the situation was so conducive in a bid to develop bio fuel that the policy, regulation, political will as well as technical support such as specifications of the fuel, Bio-fuel SNI, technical assisstance and credit scheme were developed and very well opened.

However the market is still unable to absorb the products so that bio-fuel does not grow as it was expected. There are technical and non technical factors making the market failed to absorb this bio-fuel program, which is including hesitation of certain auto-industry fragments / parts that are still unwilling to adopt bio-fuel as the opportunity to develop their vehicles since harmonization with the technology development of the vehicles is still required, and on the other side, the policy on subsidy for fuel (BBM) makes bio-fuel (which is not subsidized) unable to compete fairly in the fuel market.

Table. 10. Domestic Refinery Capacity

Domestic refinery capacity

REFINERY	GASOLINE Volume MKL/D (TEL content gram/L)			DIESEL Volume MKL/D (Sulfur Content ppm)	
	Subsidy	Non subsidy			
	PREMIUM ULG	PERTAMAX ULG	PERTAMAX PLUS ULG	Subsidy	Non subsidy
1. P. BRANDAN	—	—	—	—	—
2. DUMAI	3.79 (0.013 g/L)	—	—	0.05 (500 ppm)	—
3. SUNGAI MUSI	3.38 (0.013 g/L)	0.03 (0.001 g/L)	—	0.13 (1500 ppm)	—
4. BALONGAN	7.32 (0.001 g/L)		0.20 (0.001 g/L)	—	0.74 (300 ppm)
5. CILACAP	10.02 (0.013 g/L)	—	—	2.16 (2500 ppm)	—
6. BALIKPAPAN	5.54 (0.013 g/L)	0.01 (0.001 g/L)	—	0.26 (1500 ppm)	—
7. KASIM					
TOTAL (MKL/D)	30.05	0.05	0.20	2.60	0.74

As it has been described before, policy on fuel diversification by introducing Bio-Premium E-10 and Bio-Pertamax, which at the market scale, make them as gasoline with E-5 composition, and even lately, this composition has continue to decrease so the product available today in the market is E-2,5. Likewise, the Bio-Auto diesel fuel which was introduced as the B-10 composition for the existing market scale with composition B-5, was transformed into B-2,5 by the end of 2007 and now it is only B-1. Today, it is difficult to find out the bio-fuel in the market (gas station).

6.5. Fuel Supply

a. Domestic Refinery Capacity

Currently, domestic refinery has the total capacity of unleaded gasoline production at 30.30 ML/D (million liters per day) and auto diesel fuel at 3.34 ML/D (million liters per day). On the basis of the installed capacity, it can be seen that it is actually unable to meet the domestic demand for gasoline and auto diesel fuel, and therefore policy on fuel import was then sought.

b. Sulfur Content.

Sulphur contents in auto diesel fuel prodiced domestically are varied. The highest sulphur content is found in auto diesel fuel which is produced at Cilacap Refinery, which is 3500 ppm in average, and meanwhile, the lowest sulphur content is auto diesel fuel which is produced at Balongan Refinery, 300 ppm in average. Dumai Refinery also has low content which is 500 ppm in average and Plaju Refinery is 900 ppm in average. In the meantime, Kasim and Balikpapan Refinery produce auto diesel fuel with the sulphur content of 1000 ppm in average.

Table. 11. Diesel Fuel Sulfur Content

Diesel Fuel Sulfur Content

Refinery

	REFINERY	SULFUR CONTENT (ppm)			SUPPLY TO BACK LOADING TRANSIT TERMINALS
		Avg	Min	Max	
1.	DUMAI	500	500	500	PEKANBARU, MEDAN, ACEH, BATAM, PADANG , PONTIANAK, JAMBI AND LAMPUNG
2.	PLAJU	900	600	1500	PALEMBANG, BANGKA BELITUNG, LAMPUNG AND JAKARTA.
3.	BALONGAN	300	200	350	JAKARTA, BANDUNG, SEMARANG AND SURABAYA
4.	CILACAP	3500	2500	4500	BANDUNG, YOGYA, SOLO, SURABAYA AND BALI.
5.	BALIKPAPAN	1000	1000	1000	SAMARINDA, BANJARMASIN, PALANGKARAYA, SURABAYA,SEMARANG, UJUNG PANDANG AND MENADO.
6.	KASIM	1000	1000	1000	AMBON AND PAPUA.

Imported

	FLOATING TRANSIT TERMINALS	SULFUR CONTENT (ppm)			SUPPLY TO BACK LOADING TRANSIT TERMINALS
		Avr	Min	Max	
1.	TELUK-SEMANGKA LAMPUNG	2500	3500	5000	PADANG, LAMPUNG, JAKARTA, SEMARANG AND SURABAYA.
2.	KALBUT SITUBONDO	2500	3500	5000	JAKARTA, SEMARANG, SURABAYA AND BALI.

Since production capacity of domestic refinery is so limited, auto diesel fuel shall be imported, whereas in average the sulphur content of the import auto diesel fuel is 3500 ppm. The fact is that there are no specifications for auto diesel fuel with sulphur content of 3500 ppm at the international market, and instead the auto diesel fuel has the sulphur content of 500 ppm, 2500 ppm, and 5000 ppm. The imported auto diesel fuel with the sulphur content around 3500 ppm in average occurs due to the blending of auto diesel fuel and the sulphur content of 2500 ppm and 5000 ppm at the transporting tanker. Meanwhile, on the basis of price considerations, Pertamina is not in the position to import auto diesel fuel with the maximum sulphur content of 500 ppm.

As a result of blending of auto diesel fuel produced by domestic refinery and such imported auto diesel fuel, then it is found that at the public filling station (SPBU) for auto diesel fuel with sulphur content ranging between 400 ppm (lowest) and 4600 ppm (highest).

c. Alternative Fuel

i. Gas

Fuel gas consumption in Indonesia is divided into 2 categories, LNG (liquid natural gas)-based fuel gas and LPG-based fuel gas. The source of LPG (liquid petroleum gas) itself is divided into 2, which are the separation of LNG products and (mainly) the side product of crude oil refinery.

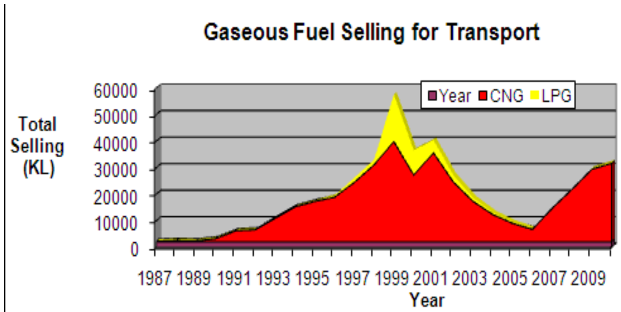


Figure 11: Gaseous Fuel Selling for Transport

Natural gas

The history of fuel gas consumption as fuel for motor vehicle has been taking place for long time. For example, in Italy, fuel gas (BBG) has been used as fuel for vehicles since the 1920s. Beside Italy, fuel gas (BBG) has also been utilized as fuel for vehicles in several other countries. Data on the total number of fuel gas (BBG) vehicles in several countries according to European Natural Gas Vehicle Association and International Association for Natural Gas Vehicle are as follows:

Although the history of fuel gas (BBG) consumption and utilization for motor vehicle has been taing place for quite some time, the growth of the total number of fuel gas vehicles is not as fast as the growth of the total number of fuel oil vehicles. Until today, the total number of fuel gas vehicles in the world is predicted to only 1.7 million units. Such figure is so small compared to the total number of gasoline vehicles and diesel fuel vehicles which are predicted to be 99% of the total population of the vehicles all over the world.

In Indonesia, fuel gas (BBG) was determined by the government as fuel for motor vehicles in the month of June 1986, in order to support energy diversification and conservation program as well as environmental program, known as Blue Sky Program. In the month of April 1989, fuel gas (BBG) commercial marketing began in Jakarta at the price of Rp. 190 lsp. Price of fuel gas (BBG) was later increased gradually up to Rp. 450 per lsp in the year of 1998, and later Rp 850, then to Rp 2,562 and lastly is Rp 31,100.

In the year of 1998, Jakarta was predicted to have 3000 units of fuel gas taxis and 110 units of fuel gas buses of State Bus Transportation Company, Perum PPD DKI. In addition to fuel gas (BBG) taxis and city buses, Jakarta has also operated around 40 units of fuel gas mikrolet (public mini van). In Surabaya, there are around 1000 units of fuel gas taxis belonging to taxi company Zebra and several fuel gas mikrolets (public mini vans) of KOPATAS.

Until today 28 units of Fuel Gas Filling Stations (SPBG) have been built, consisting of 21 units belonging to Pertamina and 7 units owned privately. Of the 21 units of Pertamina's Fuel Gas Filling Station (SPBG), only 11 units are now operating as, from the 7 units of privately owned Fuel Gas Filling Station (SPBG), 6 units are operating. The total capacity of

28 units of Fuel Gas Filling Station (SPBG) above is 403,020 lsp per day at the consumption level of only 18% of the total capacity.

LPG

In addition to fuel gas (BBG) or CNG, since the year of 1995, LPG has also been utilized as fuel for motor vehicle in Indonesia. Until now, 18 units of Liquid Petroleum Gas Filling Station (SPB LPG) have been developed by private sector. Of the 18 units of Liquid Petroleum Gas Filling Station (SPB LPG), only 4 units are now operating in Jabotabek.

ii. Gas Demand Projection for transportation sector

At present, in the regions of DKI Jakarta, it is predicted that there are around 300 units of fuel gas (BBG) taxis and 391 units of fuel gas (BBG) buses that are still being operated. In 2011, DKI Jakarta plans to add 10.000 units of gas fueled mikrolet (small van) public transport vehicles and as well as 500 units of gas fueled buses. Therefore, in 2011, it is predicted that DKI Jakarta areas will operate around 10,300 passenger vehicles and 891 units of gas fueled buses for the total demand of fuel gas (BBG). For large vehicles, they are designated to use CNG as smaller vehicles are recommended using LPG. Nonetheless, the current technology development has made it possible for LPG-fueled large vehicles to operate.

Outside DKI Jakarta areas, Pertamina alos planned to operate several units of Fuel Gas Filling Station (SPBG), which were not operated yet. These Fuel Gas Filling Station (SPBG) are existing in Cirebon, Cikampek, Surabaya, Medan, Palembang, and Bogor.

iii. The Current Status of Gaseous Fuel Utilization for Transportation Sector

Utilization and consumption of fuel gas for transportation started in the year of 1987 and it has become more intensive after the launching of Blue Sky Program Campaign in the year of 1996. If in the year of 1987, the total consumption of fuel gas for transportation was up to 204 KLSP (Gasoline- Equivalent Kiloliter), then 3 years after the launching of of Blue Sky Program Campaign, the fuel gas consumption reached its peak at 55,637 KLSP, consisting of 2 types of gas, namely CNG and LPG. However, the total consumption then gradually decreased in line with the recklessness of policy makers to maintain incentive policy for the users and retailers of fuel gas, which include among others: (1) price of fuel gas at the maximum level of 55% gasoline price, (2) continuity of credit scheme for the installation of conversion kit, (3) periodical up-grade of the fueling technology along with the increase of Fuel Gas Filling Stations (SPBG), (4) to improve fuel gas quality (particularly with regard to the water content), (5) the absence of facilities and personnel who are able to perform regular I/M, (6) continuity of supply (volume) not meeting the minimum requirements (2 bars) until June 2008. Due to the above conditions, then fuel gas utilization and consumption for transportation has now been reducing to around 4,854 KLSP or Premimum-Equivalent Kiloliters (2007). Then, utilization gaseous fuel for BRT-Trans Jakarta, total consumption increases to be 29,986 KLSP.

7. Policy Analysis

The increased of green house gas emission has spurred the increased concern of global climate change. One of the most important green house gases, CO_2, grew at 1.8% annually between 1990 and 2007. The growth rate between 2000 and 2007 is even higher, reaching an average of 3.07%. Despite high income countries has significant share of CO_2 emission and high ratio of CO_2 emission per capita, the growth of CO_2 emission for other economies are higher (Table 12 and 13).

Table 12: Selected Statistics on CO2 Emission by Economies
(metric tons)

	Average Growth of Total CO2 Emission			Average CO2 Emission Per Capita			Average Growth of CO2 Emission Per Capita		
	1990-2000	2000-2007	1990-2007	1990-2000	2000-2007	1990-2007	1990-2000	2000-2007	1990-2007
Indonesia	7.05%	6.76%	6.83%	1.15	1.49	1.30	4.79%	5.38%	4.93%
World	0.95%	3.07%	1.80%	4.13	4.33	4.22	-0.49%	1.83%	0.50%
High income	1.08%	1.02%	0.90%	12.20	12.49	12.31	0.52%	0.35%	0.29%
Middle income	0.72%	5.26%	2.61%	2.50	2.82	2.64	-0.56%	4.03%	1.47%
Upper middle income	-1.52%	2.49%	0.07%	5.11	4.91	5.04	-2.52%	1.52%	-0.81%
Lower middle income	2.71%	6.94%	4.54%	1.78	2.26	1.99	1.31%	5.62%	3.28%
Low income	-3.70%	2.62%	-1.28%	0.51	0.28	0.42	-6.56%	0.37%	-3.74%

Source: www.worldbank.org, processed.

Table 13: Contribution of World CO2 Emission by Economies

	1990-2000	2000-2007	1990-2007
Indonesia	0.9%	1.2%	1.0%
High income	52.9%	48.5%	51.2%
Middle income	43.1%	46.8%	44.5%
Upper middle income	19.0%	17.0%	18.2%
Lower middle income	24.1%	29.8%	26.3%
Low income	1.3%	0.8%	1.1%

Source: www.worldbank.org, processed.

The average CO2 emission per capita in Indonesia is still significantly lower than world and high income average. However, we can see that the growth rate of per capita CO2 emission is significantly higher for between 1990 and 2007.

There are several factors affecting high growth rate of CO2 emission in Indonesia. Inefficient energy use is one of the factors that contribute to a significant share of CO2 emission. One indicator that can be used to measure energy efficiency is the ratio of GDP to energy use, which is calculated by dividing the GDP of an economy (PPP method) with the amount of energy use (kg oil equivalent). High ratio indicates high efficiency of an economy as more GDP is created using one kg of oil equivalent of energy. Table 14 depicts the ratio of GDP to energy use for selected Asian countries. Singapore and Japan has the most efficient energy use in term of GDP created, where both countries have ratio over 7. On the contrary, Indonesia has the least efficient energy use among those countries, with ratio around 4.

Table 14: Ratio of GDP to Energy Use
(Constant 2005 PPP $ per kg of oil equivalent)

	2005	2006	2007
Indonesia	4	4.1	4.1
Malaysia	4.6	4.8	4.7
Singapore	7	7.8	8.5
Philippines	6.3	6.7	7.1
Thailand	4.6	4.7	4.7
South Korea	5.2	5.4	5.5
Japan	7.5	7.6	7.9

Source: www.worldbank.org

7.1. What causes inefficient energy use?

This is a big question to answer, as a lot of factors have to be accounted for. To name a few; inefficient public transportation system, energy pricing policy and fuel quality contribute to inefficient energy use in Indonesia.

Transportation

As transportation contributes to a significant share of energy use, most people would point to inefficient transportation system as one culprit. Without looking at the detail data, this presumption is likely to be true. Japan and Singapore are two countries with excellent transportation system, and rely more on public transportation. On the contrary, Indonesia has poor transportation system, especially in the urban area.

Economically speaking, people would choose public transportation system if the cost of using private transportation is significantly higher. There are various costs of using certain mode of transportation, some of which are measurable economically (such as private cost and time spent), while others are not (such as level of stressed caused by traffic jam).

The above notion would lead us to the energy pricing policy that caused over consumption of fossil based fuel. Most fossil-based fuels in Indonesia are still heavily subsidized by the central government. Lower price implies that the cost of using private transportation mode is cheaper (*ceteris paribus*), hence, increased overall energy consumption.

How does it fit to the data in Asian countries? Table 4 indicates that Indonesia has the second lowest gasoline price among 7 selected Asian countries. Combined with unreliable public transportation system, this would give more incentive to use private transportation mode. On the contrary, Japan and Singapore have the most expensive gasoline, which causes more public transportation use. Following this logic, it is not surprising that these two countries have high efficiency in energy use in creating GDP, which is shown in table 15.

Table 15: Pump Price of Most Widely Sold Grade Gasoline
(US $ per liter)

	2000		2002		2004		2006		2008	
	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
China	0.4	0.45	0.42	0.37	0.48	0.43	0.69	0.61	0.99	1.01
India	0.6	0.39	0.66	0.41	0.87	0.62	1.01	0.75	1.09	0.7
Indonesia	0.17	0.06	0.27	0.19	0.27	0.18	0.57	0.44	0.6	0.46
Japan	1.06	0.76	0.91	0.66	1.26	0.95	1.09	0.9	1.74	1.54
Korea, Rep.	0.92	0.66	1.09	0.64	1.35	0.95	1.65	1.33		
Malaysia	0.28	0.16	0.35	0.19	0.37	0.22	0.53	0.4	0.53	0.53
Philippines	0.37	0.28	0.35	0.27	0.52	0.34	0.76	0.67	0.91	0.81
Singapore	0.84	0.38	0.85	0.38	0.89	0.55	0.92	0.63	1.07	0.9
Thailand	0.39	0.35	0.36	0.32	0.54	0.37	0.7	0.65	0.87	0.64
Vietnam	0.38	0.27	0.34	0.27	0.48	0.32	0.67	0.53	0.8	0.77

Source: www.worldbank.org

7.2. The Impact of Inefficient Energy Use and Poor Fuel Quality:

Theoretically, poor fuel quality leads to higher pollutant level given the same quantity of fuel consumed. Adding insult to injury, inefficient energy use causes the amount of fuel consumed for a given travel distance increased, which results in higher concentration of pollutant particles. The following table 5 indicates that the above notion is likely to be true. We can see that there is a positive correlation between PM 10 level with inefficient energy use and fuel price.

Table 16: Level of PM 10 at Country Level in Selected Asian Countries
(Microgram per cubic meter)

	2000	2001	2002	2003	2004	2005	2006
China	84.56	79.36	78.38	79.48	78.93	75.24	73.01
India	93.35	88.58	86.02	80.14	74.86	68.24	64.92
Indonesia	119.21	116.82	111.17	101.74	101.02	94.77	82.88
Japan	33.47	33.37	33.53	32.10	31.02	30.95	29.64
Korea, Rep.	46.87	45.50	44.75	41.39	39.88	36.66	34.72
Malaysia	26.74	28.59	28.02	27.65	26.52	24.42	22.89
Philippines	47.83	41.81	34.14	30.72	30.18	26.16	22.83
Singapore	43.70	43.58	48.84	47.28	44.72	40.54	40.87
Thailand	79.00	79.96	77.83	78.30	80.29	77.93	70.90
Vietnam	70.01	68.99	66.70	65.58	65.45	60.80	55.32

Source: www.worldbank.org

We conducted econometric estimation to empirically test whether or not inefficient energy use and low fuel price play a role in increasing PM10 level of a country. The results are presented in table 17 and 18. All the six regressions we conducted using pooled least square, random effect and fixed effect technique confirmed the hypothesis, both in level and double log specification. Both of the tables indicate that fuel price is statistically significant in affecting PM10 level of a country. The double log specification in table 7 shows that **1% increase in fuel price would lead to 0.31-0.35% decrease of PM10 level.**

Table 17: Regression Result of Country Level of PM10 Determinant
(Level Specification)

	PM10		
	Pooled	**Random Effect**	**Fixed Effect**
GDP to Energy Use	0.384	-0.43	-0.472
	(0.46)	(0.88)	(0.89)
Fuel Price	-38.776	-24.819	-22.169
	(7.36)***	(8.64)***	(7.19)***
Constant	81.09	73.643	71.342
	(14.41)***	(16.64)***	(18.89)***
Observations	244	244	244
R-squared	0.2		0.32
Number of OBS		123	123
Absolute value of t statistics in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%			

Table 18: Regression Result of Country Level of PM10 Determinant
(Double Log Specification)

	LOG (PM10)		
	Pooled	**Random Effect**	**Fixed Effect**
Log (GDP to Energy Use)	-0.057	-0.035	-0.034
	(0.67)	(1.20)	(1.13)
Log (Fuel Price)	-0.312	-0.347	-0.351
	(5.21)***	(11.84)***	(11.10)***
Constant	3.661	3.615	3.611
	(24.14)***	(47.65)***	(71.01)***
Observations	244	244	244
R-squared	0.13		0.52
Number of OBS		123	123
Absolute value of t statistics in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%			

7.3. Demand for Vehicle

An important part in calculating the impact of a certain regulatory regime—such as the impact of current fuel standard—is the calculating the base for analysis. For this study, as the air quality is affected by technology (both in vehicle and fuel) and the amount of fuel consumed, we need to estimate the projected number of vehicle and national fuel consumption should there is no change in policy.

That would give us the baseline for the analysis, which reflects the business-as-usual scenario. Once we have the forecast of the determinant factors, the estimated air quality would be obtained, and consequently the economic and non economic cost of the current regulatory regime.

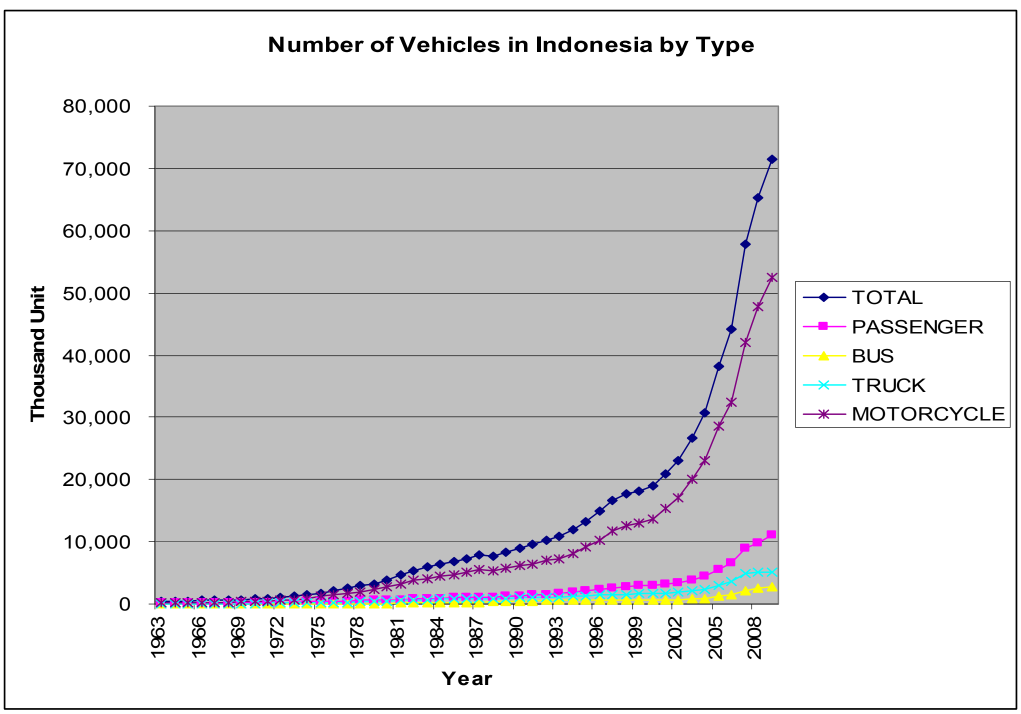


Figure 12: Number of Vehicles in Indonesia by Type

The following section discusses about the existing and forecast number for vehicles. Figure 12 depicts the total number of vehicle by types. We can see that the motorcycle contributes significantly to the total number of vehicle, and there is a steep increase in the last decade. For car, bus and truck category, MPV with displacement of less 1.5l contribute the largest share of vehicle production in Indonesia between 2003 and 2007 (Figure 13). We may suspect that the increased share for small MPV is due to consumer preference towards more fuel efficient vehicle. Figure 13 also confirms that the demand for vehicle depends on the fuel price, indicated by two significant decreases in production, which took place after mid 2005 to beginning of 2006, and after mid 2008 and beginning of 2009. That significant decrease follows the fuel price increase in the same year.

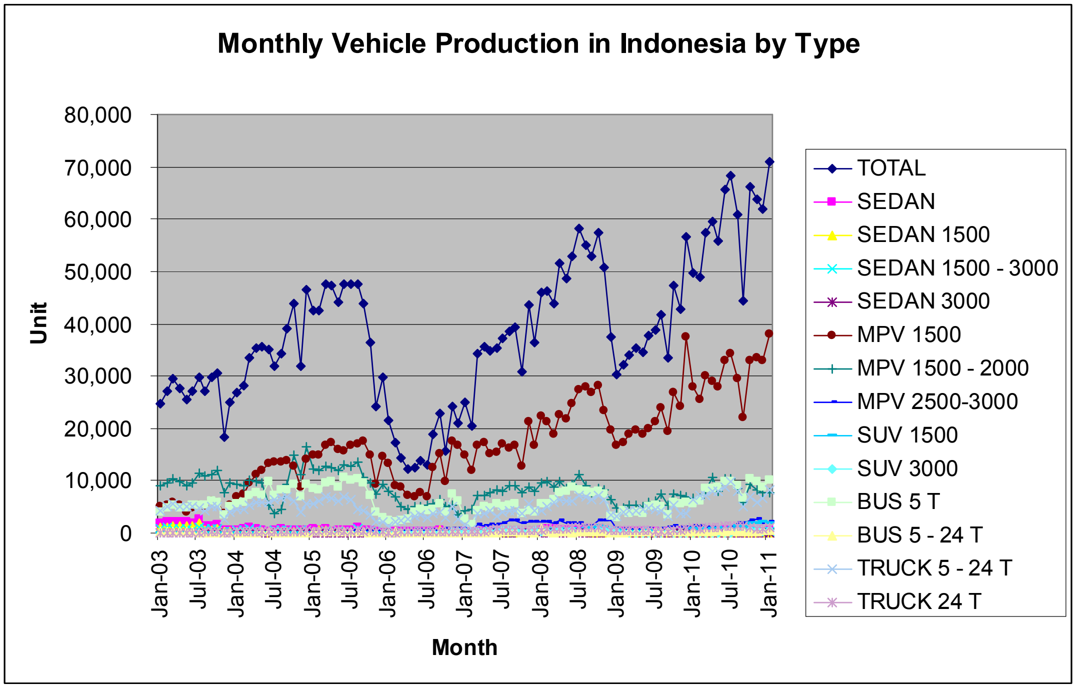


Figure 13: Monthly Vehicle Production in Indonesia by Type

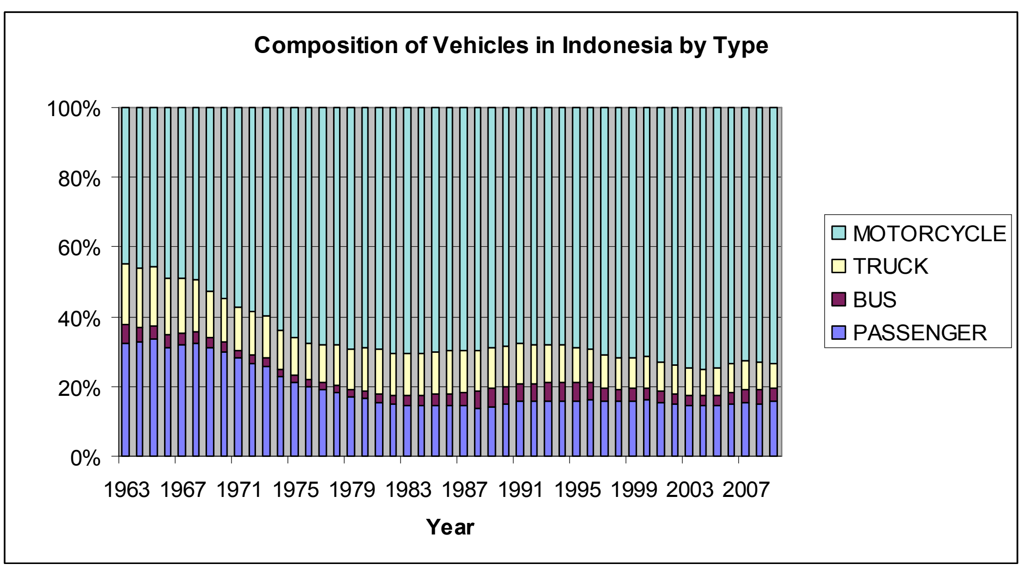


Figure 14: Composition of Vehicle Production by Type

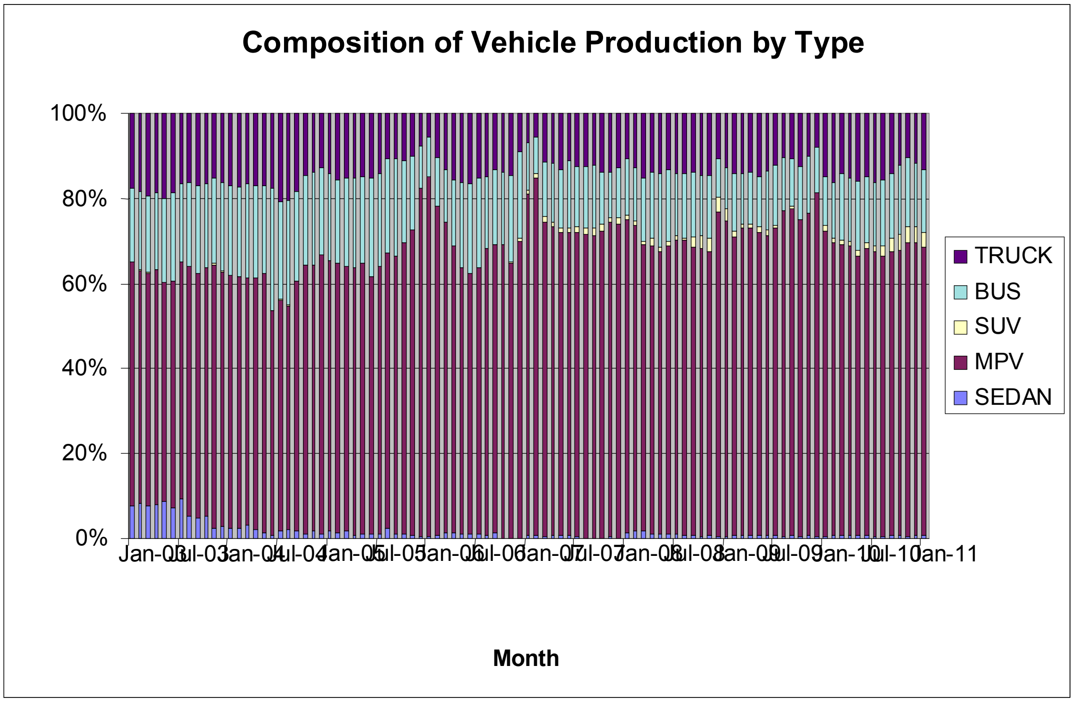


Figure 15: Composition of Vehicle Production by Type

In order to forecast the number of vehicles, the first step we need to do is conducting time series regression for each type of vehicle. The reliability of our forecast depends heavily on the regression result. We came up with the same specification for each type, and each result has high accuracy level, which is reflected by high Adjusted R squared. Table 19-22 contain the regression results for each type of vehicle, which indicate that the average annual growth for motorcycle, passenger car, bus and truck sales is 10.6%, 9.7%, 11.6% and 8.9%. Based on these estimation results, we estimate number of vehicle in up to 2015, as presented in table 23.

Please note that this forecast is solely based on the trend of vehicle sales, without taking into account the road infrastructure capacity. Theoretically, the demand for vehicle should follow an S-shaped curve, indicating that when the number of vehicle approaching the maximum capacity of road, the growth of demand will be much lower. However, we can only conduct regression with such assumption if we have full knowledge on the capacity of road infrastructure.

Table 19: Regression Result for Motor Cycle

Dependent Variable: LOG(MOTOR)
Method: Least Squares
Sample(adjusted): 1965 2009
Included observations: 45 after adjusting endpoints
Convergence achieved after 4 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.82861	0.584421	21.95096	0.0000
@TREND	0.105969	0.014693	7.212112	0.0000
AR(1)	1.383440	0.139874	9.890630	0.0000
AR(2)	-0.435318	0.138367	-3.146116	0.0031
R-squared	0.998517	Mean dependent var		15.22238
Adjusted R-squared	0.998408	S.D. dependent var		1.518059
S.E. of regression	0.060567	Akaike info criterion		-2.685461
Sum squared resid	0.150401	Schwarz criterion		-2.524868
Log likelihood	64.42287	F-statistic		9200.227
Durbin-Watson stat	2.260594	Prob(F-statistic)		0.000000
Inverted AR Roots	.90	.48		

Table 20: Regression Result for Passenger Car

Dependent Variable: LOG(PASSENGER)
Method: Least Squares
Sample(adjusted): 1965 2009
Included observations: 45 after adjusting endpoints
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.56786	0.393703	29.38216	0.0000
@TREND	0.097357	0.012306	7.911028	0.0000
AR(1)	1.312568	0.146098	8.984155	0.0000
AR(2)	-0.399556	0.169814	-2.352902	0.0235
R-squared	0.998339	Mean dependent var		13.91794
Adjusted R-squared	0.998218	S.D. dependent var		1.176345
S.E. of regression	0.049662	Akaike info criterion		-3.082468
Sum squared resid	0.101119	Schwarz criterion		-2.921875
Log likelihood	73.35552	F-statistic		8215.446
Durbin-Watson stat	2.212258	Prob(F-statistic)		0.000000
Inverted AR Roots	.83	.48		

Table 21: Regression Result for Bus

Dependent Variable: LOG(BUS)
Method: Least Squares
Sample(adjusted): 1965 2009
Included observations: 45 after adjusting endpoints
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.418802	0.454544	20.72143	0.0000
@TREND	0.116291	0.013891	8.371575	0.0000
AR(1)	1.456196	0.123707	11.77130	0.0000
AR(2)	-0.525799	0.119375	-4.404580	0.0001
R-squared	0.997496	Mean dependent var		12.21004
Adjusted R-squared	0.997313	S.D. dependent var		1.566870
S.E. of regression	0.081228	Akaike info criterion		-2.098432
Sum squared resid	0.270516	Schwarz criterion		-1.937840
Log likelihood	51.21472	F-statistic		5443.770
Durbin-Watson stat	2.399441	Prob(F-statistic)		0.000000
Inverted AR Roots	.79	.66		

Table 22: Regression Result for Truck

Dependent Variable: LOG(TRUCK)
Method: Least Squares
Sample(adjusted): 1965 2009
Included observations: 45 after adjusting endpoints
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.25097	0.292888	38.41385	0.0000
@TREND	0.089763	0.009448	9.500564	0.0000
AR(1)	1.536148	0.127094	12.08667	0.0000
AR(2)	-0.610574	0.127531	-4.787645	0.0000
R-squared	0.997693	Mean dependent var		13.40982
Adjusted R-squared	0.997524	S.D. dependent var		1.224339
S.E. of regression	0.060917	Akaike info criterion		-2.673928
Sum squared resid	0.152145	Schwarz criterion		-2.513335
Log likelihood	64.16337	F-statistic		5910.947
Durbin-Watson stat	2.242718	Prob(F-statistic)		0.000000
Inverted AR Roots	.77 -.14i	.77+.14i		

Table 23: Number of Vehicle by Type, Actual Vs Forecast
(Thousand unit)

	Motorcycle		Passenger Car		Bus		Truck	
Year	**Actual**	**Forecast**	**Actual**	**Forecast**	**Actual**	**Forecast**	**Actual**	**Forecast**
2000	13.563	14.238	3.039	3.180	0.666	0.702	1.707	1.733
2001	15.275	14.892	3.189	3.354	0.685	0.732	1.777	1.850
2002	17.002	17.359	3.403	3.536	0.714	0.755	1.865	1.925
2003	19.976	19.221	3.885	3.809	0.798	0.797	2.047	2.037
2004	23.056	23.056	4.464	4.454	0.933	0.924	2.316	2.296
2005	28.556	26.353	5.494	5.112	1.185	1.104	2.921	2.639
2006	32.523	33.471	6.615	6.405	1.511	1.451	3.542	3.520
2007	41.955	36.706	8.865	7.586	2.103	1.839	4.846	4.135
2008	47.684	49.608	9.860	10.431	2.583	2.640	5.147	5.990
2009	52.433	53.295	11.127	10.761	2.730	3.017	5.187	5.462
2010		57.800		12.190		2.959		5.364
2011		63.813		13.204		3.258		5.660
2012		70.524		14.260		3.623		6.061
2013		78.001		15.408		4.052		6.560
2014		86.322		16.682		4.547		7.152
2015		95.578		18.104		5.112		7.835

7.4. Demand for Fuel

In estimating the demand for fuel by types, we also conduct an econometric regression. However, we use two sources of data, namely CEIC database and data from Pertamina (National Oil Company). The CEIC database shows the sales of oil by types and uses from 1990 January to 2008 December, with some missing observations in the middle. Thus, we cannot estimate using solely data from CEIC. To enable estimating the fuel up to 2015, we use also the data supplied by Pertamina, which cover the sales of fuel for Diesel Oil and Gasoline.

For gasoline, the data is not much different between CEIC and Pertamina (despite CEIC database come from Pertamina). However, for Diesel Oil, the figure is significant between the two sources. Thus, for reliability consideration, for diesel oil demand estimation we use only the data from Pertamina.

The estimation results are depicted in the following tables. We can see that monthly gasoline consumption grow by 0.52% or equivalent to 6.2% annually. The power of regression is reliable as 97% of the variation on the gasoline consumption is captured by the model, and covariance proportion for the forecasting purpose is 96.9%. For diesel oil, the figure is similar, where monthly consumption grows on average 0.57% or equivalent to 6.89% annually. The power of the regression is still reliable despite smaller number of observations used (The Adjusted R square of the model is 85.2% and covariance proportion is 91.8%).

Based on following model, we estimate that under business as usual scenario, the monthly gasoline consumption will reach 2.5 million kilo liters by 2015. This is a 0.378 million kilo liter (17%) higher than the maximum consumption in 2010 (the available data from Pertamina). For diesel oil, the consumption in 2015 is estimated to reach 1.6 million kilo liter, an increase of 0.418 million kilo liter than the maximum consumption in 2010 (34%).

As air pollution is a linear function of fuel consumption, thus we can estimate the level of pollution in the future using business as usual scenario. This means that should there is no significant change in the policies affecting private and public transportation use, the fuel consumption will be approximately 17% and 34%% higher that the current gasoline and diesel oil consumption respectively. The effect on air pollution will be similar in linear fashion.

Table 24 : Gasoline Demand Estimation

Dependent Variable: LOG(GASOLINEP)
Method: Least Squares
Sample(adjusted): 1990:03 2010:12
Included observations: 250 after adjusting endpoints
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	13.17562	0.020516	642.2146	0.0000
@TREND	0.005235	0.000139	37.67588	0.0000
AR(1)	0.428378	0.062126	6.895320	0.0000
AR(2)	0.198006	0.061707	3.208818	0.0015
R-squared	0.977234	Mean dependent var		13.83644
Adjusted R-squared	0.976956	S.D. dependent var		0.388667
S.E. of regression	0.059000	Akaike info criterion		-2.806673
Sum squared resid	0.856339	Schwarz criterion		-2.750330
Log likelihood	354.8342	F-statistic		3519.833
Durbin-Watson stat	2.011245	Prob(F-statistic)		0.000000
Inverted AR Roots	.71	-.28		

Table 25 : Diesel Oil Demand Estimation

Dependent Variable: LOG(DIESELP)
Method: Least Squares
Sample(adjusted): 2006:03 2010:12
Included observations: 58 after adjusting endpoints
Convergence achieved after 4 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.57153	0.267069	47.07229	0.0000
@TREND	0.005743	0.001179	4.872255	0.0000
AR(1)	0.425692	0.118031	3.606627	0.0007
AR(2)	0.161435	0.112792	1.431260	0.1581
R-squared	0.860367	Mean dependent var		13.83918
Adjusted R-squared	0.852610	S.D. dependent var		0.139710
S.E. of regression	0.053637	Akaike info criterion		-2.946699
Sum squared resid	0.155352	Schwarz criterion		-2.804599
Log likelihood	89.45426	F-statistic		110.9095
Durbin-Watson stat	2.148744	Prob(F-statistic)		0.000000
Inverted AR Roots	.67	-.24		

Figure 16: Forecasting Statistics: Gasoline Consumption

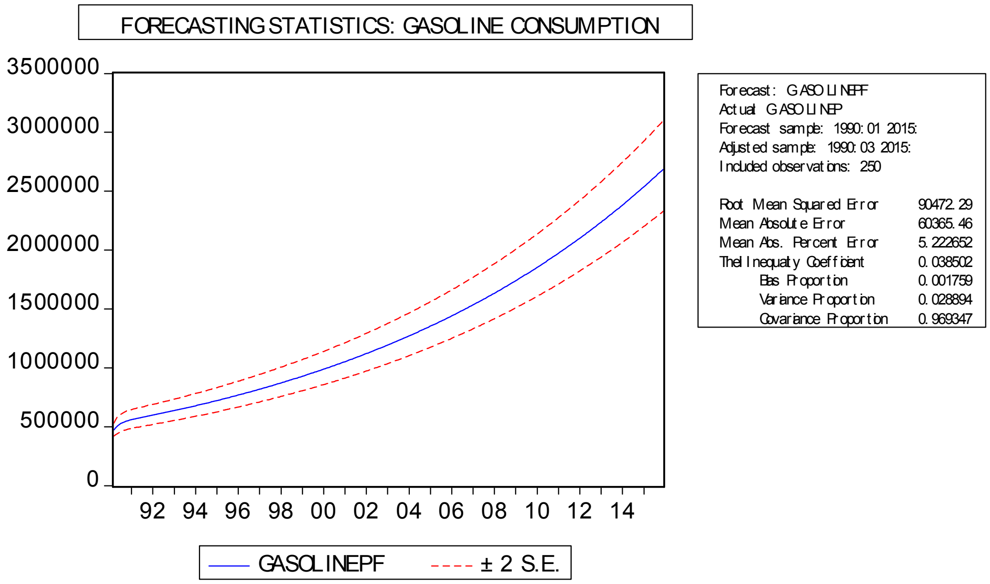


Figure 17: Forecasting Statistics: Diesel Oil

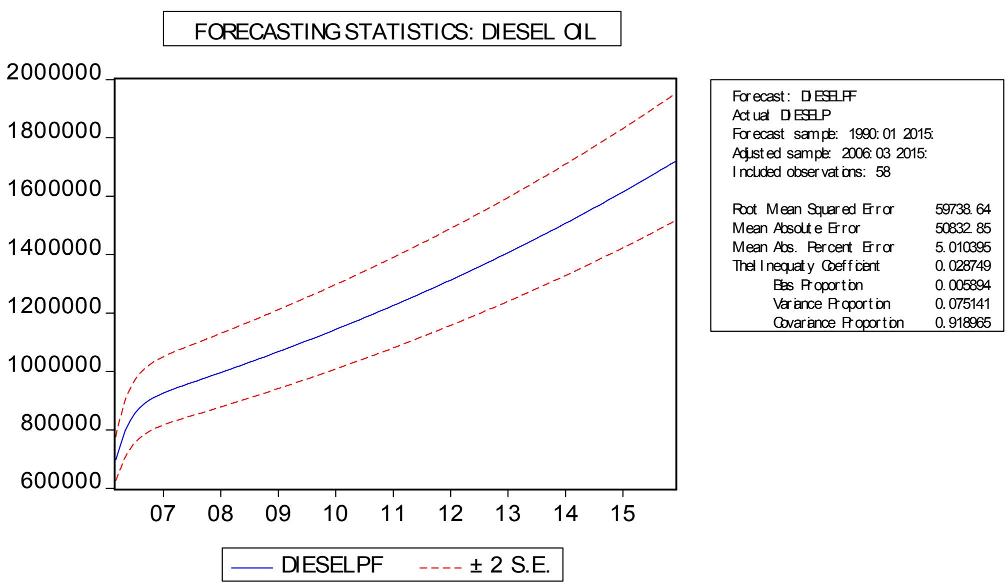


Table 26: Indonesia Gasoline Consumption: Actual Vs Predicted

TIME	ACTUAL	PREDICTED	TIME	ACTUAL	PREDICTED	TIME	ACTUAL	PREDICTED	TIME	ACTUAL	PREDICTED
2008:01	1,595,324	1,633,698	2010:01	1,786,199	1,852,403	2012:01		2,100,386	2014:01		2,381,567
2008:02	1,474,911	1,642,273	2010:02	1,827,396	1,862,126	2012:02		2,111,410	2014:02		2,394,067
2008:03	1,611,715	1,650,893	2010:03	1,931,117	1,871,899	2012:03		2,122,492	2014:03		2,406,632
2008:04	1,637,186	1,659,558	2010:04	1,996,188	1,881,724	2012:04		2,133,632	2014:04		2,419,264
2008:05	1,727,674	1,668,268	2010:05	2,027,459	1,891,601	2012:05		2,144,831	2014:05		2,431,962
2008:06	1,573,065	1,677,024	2010:06	1,965,778	1,901,529	2012:06		2,156,088	2014:06		2,444,726
2008:07	1,804,930	1,685,826	2010:07	2,141,848	1,911,509	2012:07		2,167,405	2014:07		2,457,558
2008:08	1,748,430	1,694,674	2010:08	2,150,954	1,921,542	2012:08		2,178,781	2014:08		2,470,456
2008:09	1,764,794	1,703,569	2010:09	2,157,039	1,931,628	2012:09		2,190,216	2014:09		2,483,423
2008:10	1,773,685	1,712,510	2010:10	2,113,173	1,941,766	2012:10		2,201,712	2014:10		2,496,457
2008:11	1,760,880	1,721,499	2010:11	2,014,528	1,951,958	2012:11		2,213,268	2014:11		2,509,560
2008:12	1,770,876	1,730,534	2010:12	1,850,967	1,962,203	2012:12		2,224,885	2014:12		2,522,732
2009:01	1,634,587	1,739,617	2011:01		1,972,501	2013:01		2,236,562	2015:01		2,535,973
2009:02	1,517,433	1,748,748	2011:02		1,982,854	2013:02		2,248,301	2015:02		2,549,283
2009:03	1,552,114	1,757,926	2011:03		1,993,262	2013:03		2,260,101	2015:03		2,562,663
2009:04	1,641,082	1,767,153	2011:04		2,003,723	2013:04		2,271,964	2015:04		2,576,114

2009:05	1,695,777	1,776,428	2011:05		2,014,240	2013:05		2,283,889	2015:05		2,589,635
2009:06	1,947,476	1,785,752	2011:06		2,024,812	2013:06		2,295,876	2015:06		2,603,227
2009:07	1,888,782	1,795,125	2011:07		2,035,440	2013:07		2,307,926	2015:07		2,616,890
2009:08	2,057,636	1,804,547	2011:08		2,046,123	2013:08		2,320,039	2015:08		2,630,625
2009:09	2,071,783	1,814,018	2011:09		2,056,862	2013:09		2,332,216	2015:09		2,644,433
2009:10	2,065,975	1,823,539	2011:10		2,067,658	2013:10		2,344,457	2015:10		2,658,312
2009:11	2,023,147	1,833,110	2011:11		2,078,510	2013:11		2,356,763	2015:11		2,672,265
2009:12	1,913,856	1,842,731	2011:12		2,089,420	2013:12		2,369,132	2015:12		2,686,290

Table 27: Indonesia Diesel Oil Consumption: Actual Vs Predicted

TIME	ACTUAL	PREDICTED	TIME	ACTUAL	PREDICTED	TIME	ACTUAL	PREDICTED	TIME	ACTUAL	PREDICTED
2008:01	977,096	996,481	2010:01	1,203,788	1,143,782	2012:01		1,312,813	2014:01		1,506,824
2008:02	887,607	1,002,231	2010:02	1,203,895	1,150,370	2012:02		1,320,374	2014:02		1,515,503
2008:03	972,530	1,008,011	2010:03	1,185,600	1,156,995	2012:03		1,327,979	2014:03		1,524,231
2008:04	1,024,602	1,013,822	2010:04	1,214,284	1,163,659	2012:04		1,335,628	2014:04		1,533,010
2008:05	1,091,978	1,019,664	2010:05	1,179,891	1,170,361	2012:05		1,343,320	2014:05		1,541,840
2008:06	979,370	1,025,539	2010:06	1,159,535	1,177,102	2012:06		1,351,057	2014:06		1,550,720
2008:07	1,109,120	1,031,448	2010:07	1,141,430	1,183,881	2012:07		1,358,838	2014:07		1,559,651
2008:08	1,056,396	1,037,389	2010:08	1,138,696	1,190,700	2012:08		1,366,665	2014:08		1,568,634
2008:09	1,093,116	1,043,365	2010:09	1,135,987	1,197,558	2012:09		1,374,536	2014:09		1,577,669
2008:10	1,098,623	1,049,375	2010:10	1,133,080	1,204,455	2012:10		1,382,453	2014:10		1,586,755
2008:11	1,090,692	1,055,419	2010:11	1,130,761	1,211,392	2012:11		1,390,415	2014:11		1,595,894
2008:12	1,096,883	1,061,498	2010:12	1,129,524	1,218,369	2012:12		1,398,423	2014:12		1,605,086
2009:01	986,790	1,067,612	2011:01		1,225,386	2013:01		1,406,477	2015:01		1,614,330
2009:02	1,107,949	1,073,761	2011:02		1,232,444	2013:02		1,414,578	2015:02		1,623,628
2009:03	1,051,906	1,079,945	2011:03		1,239,542	2013:03		1,422,725	2015:03		1,632,980
2009:04			2011:04			2013:04			2015:04		

	1,152,970	1,086,165			1,246,681			1,430,919			1,642,385
2009:05	1,140,260	1,092,421	2011:05		1,253,862	2013:05		1,439,161	2015:05		1,651,844
2009:06	1,197,693	1,098,713	2011:06		1,261,083	2013:06		1,447,450	2015:06		1,661,358
2009:07	1,209,953	1,105,041	2011:07		1,268,347	2013:07		1,455,786	2015:07		1,670,927
2009:08	1,209,622	1,111,405	2011:08		1,275,652	2013:08		1,464,171	2015:08		1,680,550
2009:09	1,122,099	1,117,806	2011:09		1,282,999	2013:09		1,472,604	2015:09		1,690,229
2009:10	1,219,284	1,124,244	2011:10		1,290,388	2013:10		1,481,085	2015:10		1,699,964
2009:11	1,196,670	1,130,720	2011:11		1,297,820	2013:11		1,489,616	2015:11		1,709,755
2009:12	1,182,941	1,137,232	2011:12		1,305,295	2013:12		1,498,195	2015:12		1,719,603

Figure 18: Number of Motor Cyle in Indonesia

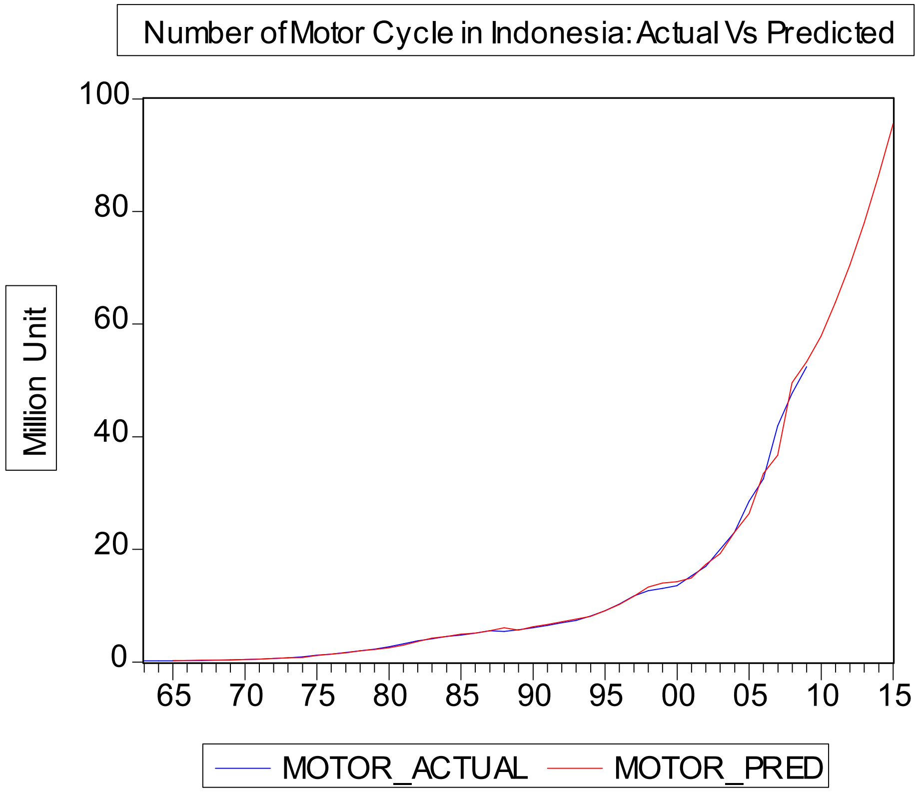


Figure 19: Number of Passengers Car in Indonesia

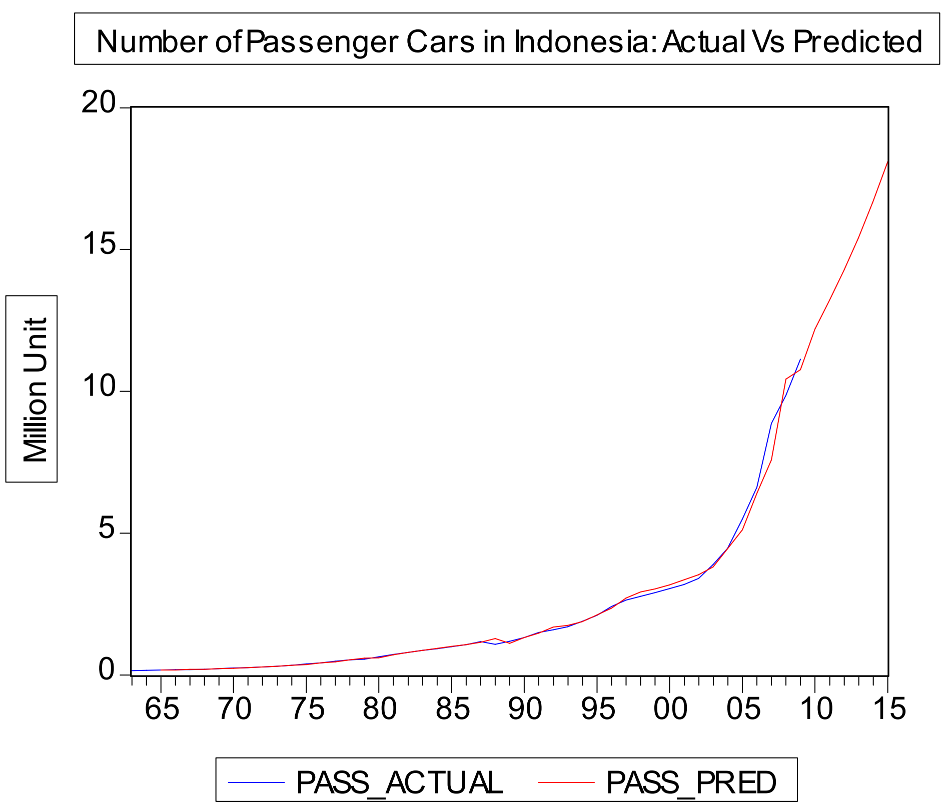


Figure 20: Number of Buses in Indonesia

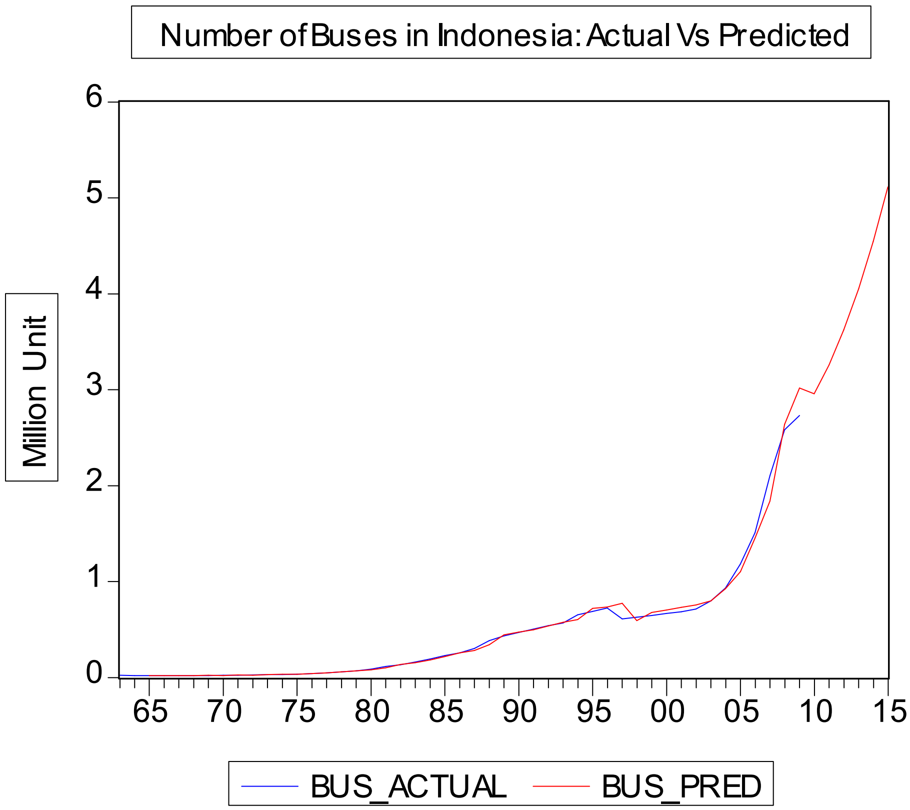
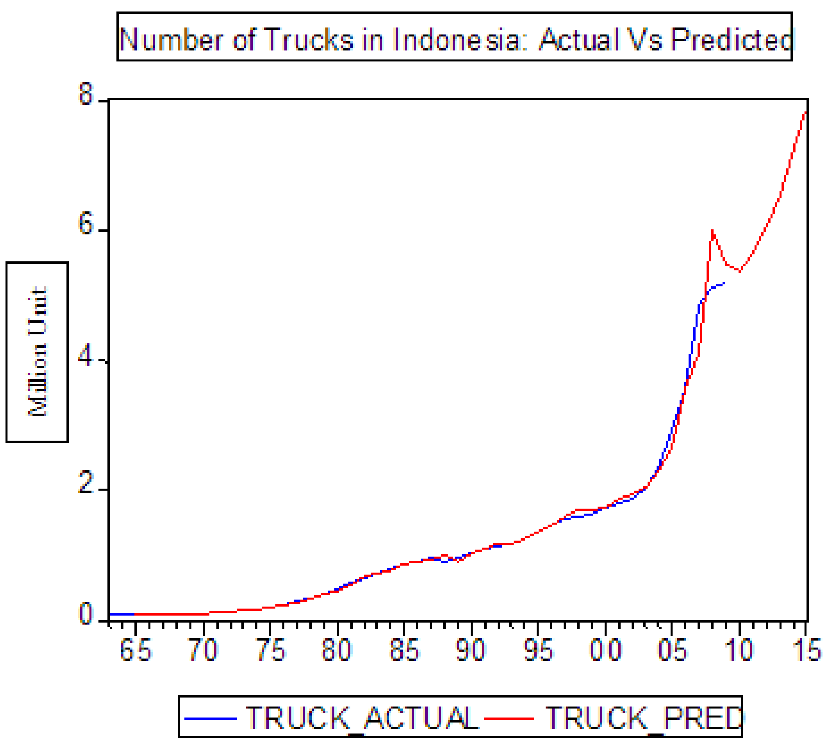


Figure 21: Number of Trucks in Indonesia



7.5. Economic Impact of Envestment in Fuel Refineries

Another important aspect in improving fuel quality is upgrading fuel refinery technology. Investment needed to upgrade refinery technology will be very expensive. In cost benefit analysis, we must also take into account the effect of investment in refinery sector on **ALL** sectors in the economy. Failure to do so will lead to a conclusion that upgrading refinery plant to produce better fuel quality will be economically infeasible.

One must note that increased investment in fuel refinery will also have other effect. For instance, the demand for sectors producing output used refinery plant – i.e., steel industry-- will increase. To produce more output, steel industry will also need more input from other sectors. At the end, all sectors are affected. If we sum up all the increased output in each sector, we will get that for each dollar of investment, output of the economy will increase more than one dollar. This is called as backward linkage effect/multiplier.

Similarly, increased output in refinery sector implies that more fuel is available with better quality. Theoretically, output in other sectors that use fuel as their input will increase. Summing up the increased output in all sectors caused by increase fuel refinery output will give us forward linkage. This is called as forward linkage effect/multiplier.

This backward and forward linkage multiplier must be taken into account to better capture the benefit of investment in a particular sector. However, for refinery sector in an open economy, backward linkage is more appropriate measure for the effect of investment. In an open economy, fuel shortage will be fulfilled by import. The story will be different if the economy does not have the capacity to import, or does not have the source of the fuel of the desired quality.

The backward and forward linkage effect can be calculated using Input Output approach. The detail calculation is as follow. Let, X is an n x 1 matrix of total output, I is an n x n identity matrix, F is an n x 1 final demand matrix, and A is an n x n technology that represents the use of input to produce one unit of X. The output of sector X will be distributed by the amount of AX as input for other sectors as much, and for final consumption by the amount of F. The matrix notation is described in equation (1).

$$AX + F = X \quad \ldots\ldots \quad (1)$$

Rearranging equation (1) will give us the following equation.

$$X - AX = F \quad \ldots\ldots \quad (2)$$

$$(I - A)X = F \quad \ldots\ldots \quad (3)$$

$$X = (I - A)^{-1} F \quad \ldots\ldots \quad (4)$$

As investment is a part of final demand, the effect of one unit increase in investment can be calculated by taking the first derivative of equation (4). This will give us $(I - A)^{-1}$, which is called as Leontief Matrix. Summing up all columns in a given row values in Leontief Matrix will give us Forward Multiplier, while summing up all rows in a given column will give us Backward Multiplier.

The backward and forward multiplier can be calculated for output, income, and employment created. The calculation method comprised of three approaches. Firstly, Type I Multiplier, where we include business direct and indirect spending. Secondly, Type II Multiplier which consists of Type I multiplier plus household spending. Thirdly, Type III Multiplier, which is a modified Type II using different income group. For this study, Type I and Type II Multipliers are more relevant.

Analysis on the impact of investment in fuel refinery can only be conducted using Input Output with 175 sectors. The most recent table from Central Bureau of Statistic (BPS) for 175 sectors is 2005. There is a recent Input Output Table published by BPS in 2008 for 66 sectors. Unfortunately, oil refinery and natural gas refinery are combined in Input Output table of 66 sectors. Thus, despite 5 years lag, it is better to use 175 sectors for accuracy consideration.

The calculation of multiplier effect for each sector in the economy is depicted in table 13. Oil refinery sector is coded in sector 104. From our calculation, the backward multiplier is only 1.08 using type I method. This means that each dollar invested will cause economy to produce $ 1.08 as demand for other sectors will also increase. If we take into account the increased spending by household experiencing increased income due to increased demand, the economy will increase by $ 7.02.

The forward multiplier is much higher than backward multiplier as output of refinery sector as fuel product is a necessity in almost any activity. However, as mentioned previously, in the case of open economy and no constraint on fuel import, forward linkage becomes less relevant

7.6. Baseline Data of Fuel Economy

This session describes baseline data of fuel efficiency covering only 99 vehicles of 234. In this baseline, because of data availability fuel economy is expressed in terms of fuel consumption per travel distance (FC) and rate of carbon dioxide (CO2) per unit of distance (i.e. gram CO2 per km). That is, the amount of fuel used per unit distance, liters per 100 kilometer (L/100 km). To put it another way, the less fuel consumed to travel in 100 km, the more efficient the vehicle is and the lower CO2 emission. The other way to indicate fuel efficiency is mile per gallon (MPG) of fuel used.

Out of 99 vehicles, 51 or 51.5% is vehicles with "medium" engine capacity i.e. 2000 cc – 5000 cc, 34 or 34.3% is small engine (less than 2000 cc), and 14 or 14.2 is large engine (larger than 5000 cc). The data shows that average fuel consumption is about 12.94 ranging from 2.31 (min) to 44.23 (max). According to engine capacity, vehicles with engine less than 2000 cc and 2000 cc to 5000 cc consume 9.1 and 12.7 liter fuel per 100 km respectively. Meanwhile, vehicles with engine greater than 5000 cc use two time (23.2 L/100km) than that of the former. The fuel consumption significantly varies for >5000 cc type as indicated by large standard deviation. Table 28 illustrates descriptive statistic of fuel consumption by engine size in more detail.

Table 28: Fuel consumption by engine size

Engine size (cc)	Descriptive statistic				
	Mean	Median	Minimum	Maximum	st.deviation
<2000	9.1	8.9	6.0	12.3	1.8
2000-5000	12.7	12.4	6.8	24.0	3.1
>5000	23.2	23.5	2.3	44.2	14.3

Source: Author's calculation

In terms of types of fuel used whether vehicles use gasoline or diesel, it is found that gasoline engines spend much more fuel (19.7 L/100km) and more vary in consumption compared to vehicles using diesel (12.0 L/100km). See table 29 for more detail information. This result is in line with the nature of combustion process and overall engine concept stating that a diesel engine is more efficient than petrol engines hence consumes less fuel, other things held equal. It is indicated, however, that there is a weak relationship between fuel consumption/100km and type of fuel used. A coefficient correlation to be 0.35 would describe that fuel consumption and type of fuel are weaky related.

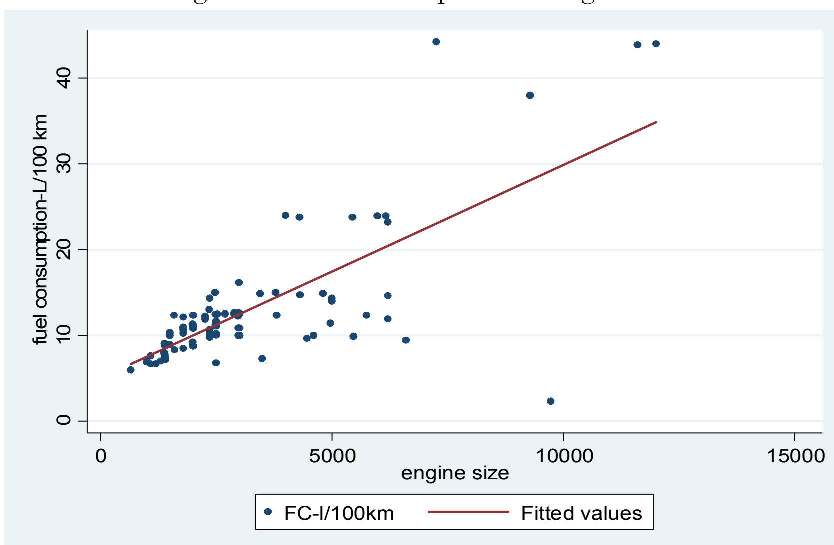
Table 29: Fuel consumption by type of fuel used

Fuel type	Descriptive statistic				
	Mean	Median	Minimum	Maximum	st.deviation
Diesel	12.0	11.1	2.3	44.0	5.4
Petrol	19.7	15.0	6.8	44.2	13.8

Source: Author's calculation

The scatter diagram in figure 22 shows graphically the correlation between fuel consumption and engine size. It is indicated by the diagram that the larger engine capacity tends to consume more fuel and much fuel it needs to travel a certain distance. This looks not plausible since larger engines will generally use more fuel, other things being equal. The relationship between fuel consumption and engine size measured by correlation coefficient indicates both variables have strong correlation. The correlation coefficient is 0.73 out of 1 describing strong positive correlation.

Figure 22: Fuel consumption and engine size



Source: Author's plot

In addition to engine size and fuel type, it is found that fuel consumption is not strongly correlated with types of vehicle. That is, the correlation coefficient between fuel consumption and type of vehicle is roughly 0.53 indicating moderate positive correlation. Further, passenger car and cargo vehicle spend relatively the same liter of fuel while bus consumes more. Other vehicles include tractor head which is known of having large engine size consumes more fuel compared to the other type as figured in table 30 (it approximately use of 41.96 L/100km). The data also shows that Bus more varies in fuel consumption indicated by large standard deviation. It should be noted, however, the variation may probably because data insufficiency. As noted previously, the fuel consumption data includes only 42% of 234 observed vehicles.

Table 30: Fuel consumption by type of vehicle

Type of vehicle	Descriptive statistic				
	Mean	Median	Minimum	Maximum	st.deviation
Passenger	11.82	11.23	5.97	23.98	4.05
Bus	16.20	10.44	9.6	44.23	13.77
Cargo	10.80	14.98	2.31	14.98	5.93
Others	41.96	43.89	38	44	3.43

Source: Author's calculation

CO_2 Emission

Fuel efficiency directly affects emissions causing pollution by the amount of fuel used. Some countries have paid more attention to reduce gas emission by introducing mandatory CO_2 emission standards from cars.

This baseline includes 98 vehicle data. Preliminary figure suggest that average CO_2 emission is approximately 278.02 g/km (table 31) which is much higher, for instance, compared to CO2 car's emission in UK (67.4 in 2010). However, more series data is necessary to understand its trend more clearly. Furthermore, it is found that large engine vehicles (>5000) produce CO_2 emission two times of small and medium engine vehicles. There is also large variation in CO2 emission for large engine rather than other engine types.

Table 31: CO2 emission by engine size

Engine size (cc)	Descriptive statistic				
	Mean	Median	Minimum	Maximum	st.deviation
<2000	211.2	207.1	155.9	267.8	34.8
2000-5000	264.3	256.4	164.0	357.0	36.0
>5000	485.3	371.6	222.8	879.0	242.5
Total	278.0	252.9	155.9	879.0	129.5

Source: Author's calculation

The relation between CO2 emission and engine size can be examined by using correlation test. The correlation coefficient is about 0.85 indicating that there is strong relation between two variables (see **figure 23**). The data also indicates that petrol engine produce more emission than gasoline engine. The average CO2 emission for diesel and petrol are roughly 264.41 g/km and 375.54 g/km respectively. It implies that petrol engine produce more emission. This baseline result, similar with engine concept stating that while producing more efficient combustion it generates less emission. In practice, we can tabulate between fuel type and engine size and CO2 emission. The result indicates that for the same medium engine size (i.e. 2000 cc to 5000 cc), diesel engine also produce less CO2 emission rather than petrol engine, but this neither apply for low engine (<2000 cc) nor high engine size (>5000 cc). In particular, CO2 emissions are 243.6 g/km for diesel and 268.8 g/km for petrol.

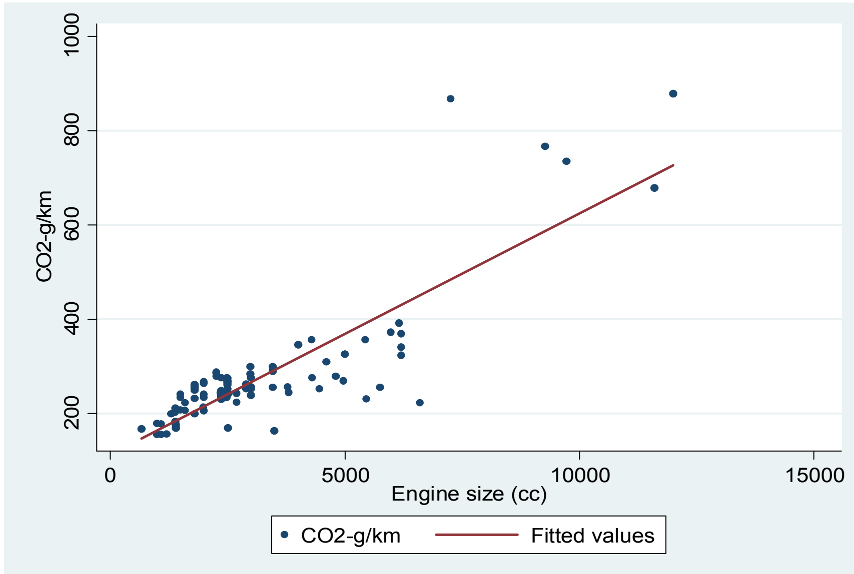
In addition, standard deviation for petrol engine two times higher representing that it has more dispersed emission data. See table 32 provides more detail information.

Table 32: CO2 emission by fuel type

Fuel type	Descriptive statistic				
	Mean	Median	Minimum	Maximum	st.deviation
Diesel	264.41	252.5	155.87	879	99.67
Petrol	375.54	259.3	170.29	867.9	243.51

Source: Author's calculation

Figure 23: CO2 emission and engine size



Source: Author's plot

Further, it is not surprising that fuel consumption positively correlates with CO2 emission. A correlation coefficient of 0.62 expressing that there is a relatively strong correlation between two variables observed. It implies that large vehicle causes more CO2 emission. Based on the baseline data, the lowest amount of CO2 emission among vehicle types is the passenger car (251.82 g/km). It is also found that the variation in fuel consumption is small for the passenger vehicle, but not for other types. See table 33 for more detail information.

Table 33: CO2 emission by vehicle type

Type of vehicle	Descriptive statistic				
	Mean	Median	Minimum	Maximum	st.deviation
Passenger	251.82	252.5	155.87	392.2	52.87
Bus	359.58	259.26	248.49	867.9	249.16
Cargo	322.04	235	170.29	734.9	232.49
Others	774.97	767	678.9	879	100.29

Source: Author's calculation

8. Cost and Benefit Analysis on Fuel Economy Policy in Indonesia: A Policy Analysis

A policy evaluation is needed by government when they want to issue a regulation, particularly if thatproposed policy will affect market prices, import duties, taxes, subsidies or other charges imposed on production and distribution process .Costs-benefits analysis as well as Cost-effectiveness analysis are needed by policy makers to evaluate policies about their policy effects on economic efficiency, contribution to the alleviation of poverty, and support for good governance.This study will identify policy options that are expected to give effect to the reduction of emissions and ultimately provide economic benefits for Indonesia. Cost benefit and cost-effectiveness analysis will be used to evaluate several policy options and provide recommendations the most appropriate policy options.

Many studieshave shownthat emissionsfrom motor vehicleshavea very significant impactto the quality oflife ofthe people, especiallyin urban areas. Ahighlevel pollutant may be harmfulto public health andcan be ultimately reducepeople's productivity in work andalso potentially required additioncost of livingfor health maintenance. Thereforeefforts toreduceemissionsfrom motor vehiclesproduce air pollutionis very important action to give impact onpublic healthand the environment.In addition, withthe high price ofinternational crude oilandthe same time the declining of oilreservesof Indonesia, theneed fora reduction infuel consumption ofthe vehiclemust begin todoby thingking to makean efforts in developingalternative fuels. Fortunately, there effort to reducevehicle emissionswill indirectly affect to theneed offuel subsidywhich is quiteburden fornational budget.

8.1. Regulatory and Policy Assesments

a. Oil and Gas Policy

Law no. 22 of 2001 on oil and gas regulate oil and gas operations in Indonesia, both upstream and downstream. According to this law, the implementation of oil and gas operation must be able to balance and guarantee the effectiveness of not only the implementation and control of exploration activities in the upstream sector, but also the effectiveness of the implementation and control of the business of processing, transportation, storage, and trade in the downstream sector. By law, oil and gas activities in the upstream and downstream competition organized through the a reasonable, fair, and transparent mechanism to ensure the efficiency and effectiveness of the availability of petroleum and natural gas, both as a source of energy and a raw material for domestic needs. This regulation is to support and develop the national capacity to better compete in the national, regional and international levels and contributes to the national income and the national economy.

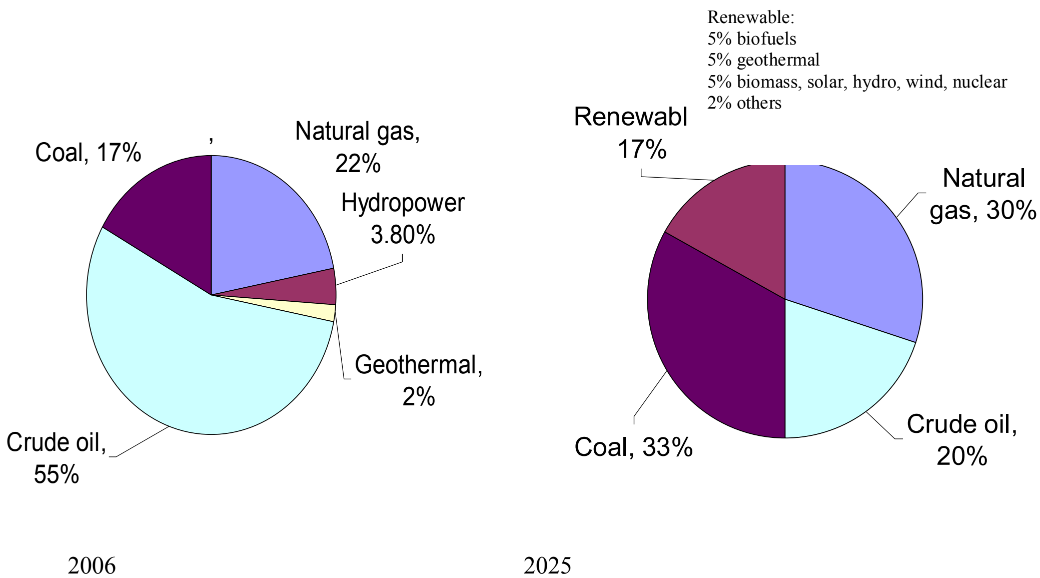
Law No. 22 of 2001 which set out in Government Regulation (PP) No. 71 of 2005 on the system of a certain type of fuel distribution has opened the downstream oil and gas industry for new players, in addition to Pertamina for a domestic single player. Implications of Law No. 22 of 2001 and Government Regulation No. 71 of 2005 was simultaneously changed the role of PT. Pertamina as the only player in the downstream sector. This policy does provide greater choice for consumers and will push the quality improvement of and also have to makeproduction efficiency in downstream sector since there is a competition on non subsidy oil and gas prices. Fuel market in the industrial sector is a real example of how competition in the downstream of oil and gas markets, particularly fuel. Since 2005 government actually have taken policy to apply fuel subsidy removal in the industry. Finally, the law impliedto encourage PT. Pertamina to immediately restructure its processing plant and refinary infrastructure to match the needs of standar emissions and also compete with its competitors.

b. National Energy Policy and Energy Mix

National Energy Policy(KEN) bythe Minister of Energyand Mineral ResourcesNo. 0983K/16/MEM/2004included theNational Energy Management Blueprint(BP-PEN) 2005-2025policiesas is stipulated in thePresidential Regulation. 5 Year2006 onNational Energy Policy(KEN). Based onthis decree, KENhasgoals and objectives. KENaimsto provide guideline foreffortsin order to realizethe nationalsecurity ofenergy supply. There are problems encounteredin securingthe nation's energysupplyisthe comprehensiveness ofthe long-termnational energy policybothexisting conditionsand its forecastsonenergy trendsinthe future,both in terms ofsupply and demandof domesticand international.

Two main goals of KENaremaintaining nationalenergy elasticitylessthan one and achievingnational energy mix. Energy elasticityisthe ratiobetween the growth rateof energyconsumptiontoeconomic growth. National energy mixis the target oftherole of theoptimalmix ofanyenergy source used. In 2025, theoptimalenergy consumptionofeachenergy sourcethatwill consistof (1)crude oilto lessthan 20percent, (2)natural gas to more than 30 percent, (3)coal to more than 33 percent, (4)biofuels(biofuels) to more than 5 percent, (5)geothermal to more than 5 percent, (6) new energy and other renewable energies in particular biomass, nuclear, and hydropower, solar, and wind power to more than5 percent, and (7)of liquefied coal to more than 2 percent. With the target of energy mix, the supply system, fuel used and energy policy related to the fuel would have to be mutually supportive.

Figure 24. Final energy mix in 2006 and planned energy mix for 2025



Source: MoEMR (2007) and Presidential Decree No. 5/2006

In order to achieve the target of KEN, Government of Indonesia has also set targets for reduction in fuel consumption by conducting some policy action. There some policies have been implemented as follows:

- In the electricity sector, currently PLN is encouraged to use coal and gas. So that, PLN's power plantsare recently built and designed for dual typeof energy, gas or coal.

- In the household sector, since 2007governmente implemented programs Zero Kerosene. The target was no kerosene subsidy by 2012 for cooking and therefore kerosene will be sold in the market according to economic value. The implications of this target can be observed through government policies for gradually subsidies removal. As a substitute for kerosene, 3 Kg packaged LPG pogram gradually released through energy conservation.Although the program is not yet fully implemented nationwide, but this policy is considered effective in reducing the dependence on fossil fuels. Therefore, we see that its implementation requires the development of LPG infrastructure and the involvement of both national and local governments. In addition, the program requires better coordination among government institutions in the region as well as local retailers to ensure an avalaible supply of LPG in the region according to the priority.

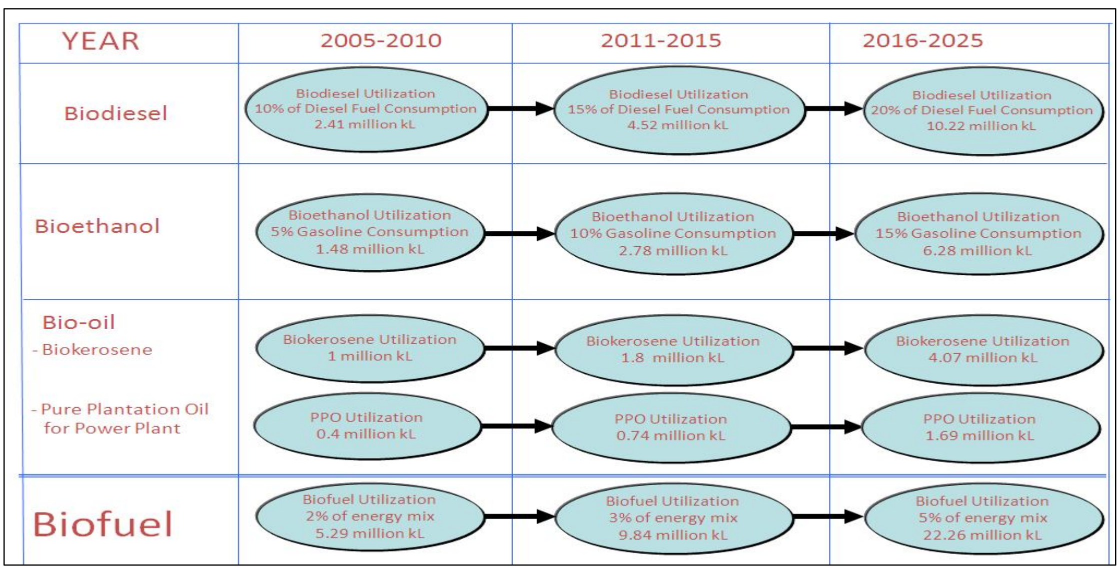
- Another policy is a package of policies related to taxation and levies. The package is a parking tax, motor vehicle fuel tax, motor vehicle tax revision, electronic road pricing (ERP), and other charges. Fuel taxes that have been imposed so far is only the fuel industry and Specia fuel (BBK) such as Pertamax, Pertamax plus, Pertamina dex, and biopertamax, in the form of value added tax of 10 percent.

- The government is encouraging the use of gas fuel (CNG) for motor vehicles. The use of fuel for motor vehicles has long been applied in Italy, the United States, Canada, New Zealand, Argentina, Malaysia, Brazil, Thailand and Russia. But in Indonesia the use of gas fuel for motor vehicles is still very limited. However, the rising of fuel prices in global market may affect the future trend of the use of gas fuel to continue to rise.

- In addition to CNG, Indonesia has developed a Special Fuel (BBK). With the BBK, which is more environmentally friendly than conventional fuel, the cleaner energy technology will also have a high demand. The government's policy has not set prices BBK and leave it to the market as an incentive to industry, not only for the existing players in the oil and gas market, but also the new players to further develop a more environmentally friendly fuel.BBK have been produced by Indonesia to date include several products PT. Pertamina known as pertamax bio, bio diesel, Pertamina dex, plus Pertamax and Pertamax.

- There is also fuel product of BBKthat is part of the strategy of energy diversification in order to conserve energy or better known as biofuels. Figure 25. road map shows the development of biofuels in Indonesia.Biofuel products that will be developed in the country is biodiesel, bioethanol, and PPO (Pure Plant Oil). PPO produced from Jatropha oil is purified without due process of esterification so that production costs are relatively cheaper than biodiesel.In 2007, a large manufacturer in the biodiesel industry in Indonesia has a total production capacity of approximately 620,000 tons per year. Biodiesel producers are PT Eterindo Wahanatama (120,000 tons / year-MultipleFeed), PT Sumi Asih (100,000 tons / year of raw material-RBD Stearin), PT Indo BBN (50,000 ton.tahun-Multiple Feeds), and Wilmar Bioenergy (350,000 tonnes / year of raw material CPO), while small industries and medium enterprises with a total biodiesel production capacity of approximately 30,000 tons per year of which is PT Ganesha Energy, Alternative Energy PT Indonesia, and several state-owned plantations (PTPN).

Figure 25. Biofuel Development Roadmap



Sources: Presidential Decree No.5/2006

c. Emission Standards, Fuel Efficiency and Vehicle Technology Adoption

Suhadi et. All (2010) provided very comprehensive review on the issues related to emission standards, fuel efficiency and vehicle techonology adoption. Minister of Environment DecreeNo.141/2003stipulates that allnew vehicles soldinIndonesiamust beginin accordance tothe Euro 2 standardin a process sinceJanuary 1, 2005. This regulationsis effectiveto impose by January 1, 2007after effectively eliminated leaded gasoline throughout Indonesia. The implementation of

Euro2 requires gasoline to befreeof lead containing additives. The 2 Euro emission standards have not been comprehensively implemented in Indonesia. However, new diesel vehicles sold in Indonesia are not always comply to Euro 2 standard due to shortage of diesel fuel sold in gas stations in the cities in Indonesia which are comply to Euro 2 Standard.

Furthermore, the adoption of fuel efficiency technology will help to reduce energy consumption and CO2 emissions. It also can reduce air pollution from vehicles by reducing emissions per kilometer traveled. However, fuel economy and lower emissions of sulfur and nitrogen oxides or particles do not always go hand in hand. The authorities and manufacturers in Europe and Japan have entered a voluntary agreement to improve their fuel economy. The agreement seeks to accomplish CO2 emissions average about 140 g / km by 2008 for new passenger vehicles. With heavy investment in technology, Japan is currently the top runners in achieving the target of 125 g / km CO2 for passenger cars by 2015, while Europe is still relatively slow going.

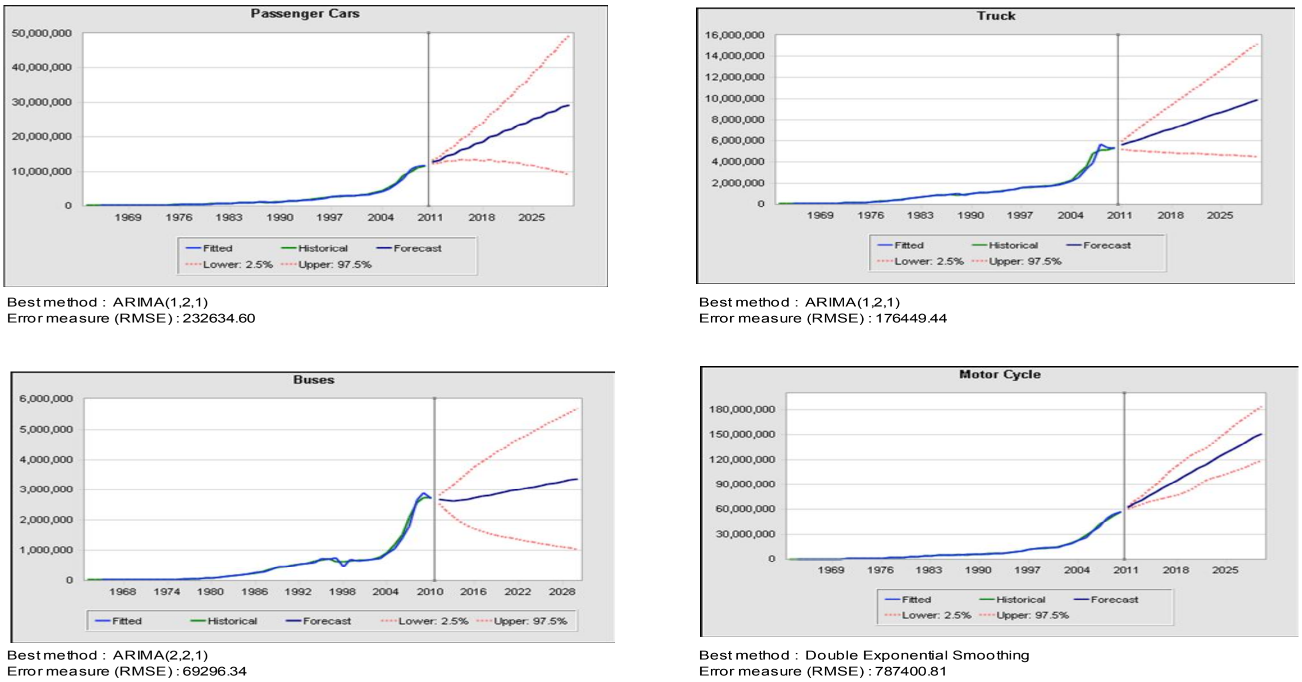
Hybrid vehicles is generally a key technology to achieve higher fuel efficiency up to three to four times more efficient than conventionally fueled vehicles. To support the adoption of hybrids in Indonesia, there should be attractive incentives for the automotive industry to do investment in such technology.. However, since this type of car is considered as a luxury vehicle, which ensures high taxation, the major barrier to the purchase of this imported hybrids in Indonesia is very higher and so that it can not be sold in Indonesia at competitive prices. In the meantime, if the incentives given to the purchase of imported hybrids to improve their competitiveness compared to conventionally fueled vehicles, it will not only harm the Indonesian automotive industry, but also loses tax. Such solutions are not effective because the cost of providing tax breaks for hybrid imports outweighed the benefits of fuel savings and CO2 emission reductions.Therefore, to support the implementation of the hybrid in Indonesia, there should be incentives for the domestic auto industry to invest in the production of vehicles with low fuel intensity, either hybrid or other technology such as electric vehicle. If fiscal incentives will be introduced for low-emission vehicles and fuel-efficient, they should not be classified as hybrid vehicles, gas-or oil-fired, but according to the quantity of CO2 emissions.

Government has also encouraged the use of CNG for tranportation sector. Although CNG has not met its full potential as an alternative to gasoline and diesel fuel, the price is right and the security measures to improve its competitiveness. CNG is an inherently clean fuel in terms of air pollutants such as particulate matter, the most important air pollutants from a health perspective. However, there some burden for CNG adoption related to very low controlled price that unattractive to be CNG-filling station operator. Another issues is safety concern as there have been a number of incidents, in some cases resulting in death, involving CNG vehicles and in particular storage cylinder.

8.2. Refinary Infrastructure Need Assesment for year 2030

Transportation sector is known asthe mostrapidly increasingsource ofgreenhouse gas (GHG) emissions, growing fasterthanGDPinsome developing countries. To forecast vehicle numbers up to 2030, we apply econometric time series model as depicted in the figure 26.

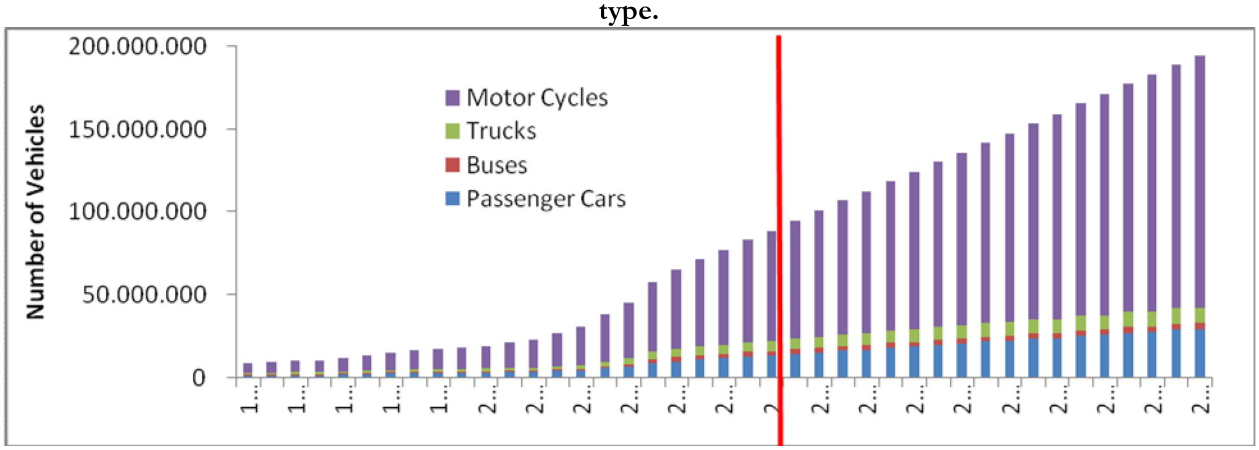
Figure 26. Forecasting of Vehicle number up to 2030



Source: Author estimation (2012)

Vehiclegrowthhas been dominatedbymotorcycles about 70% of total vehicle numbers,whichhas increased4 timesfrom2000 to 2010, an average growthof32 percentannually. Fortunately, this phenomenal growthin thenumber ofmotorcyclesis not parallel to consumptiongrowth of liquid fuelsand CO2 emissionsproduced by sincemotorcyclesconsumeless fuelperkilometerthanpassengercarsandheavy vehicles.

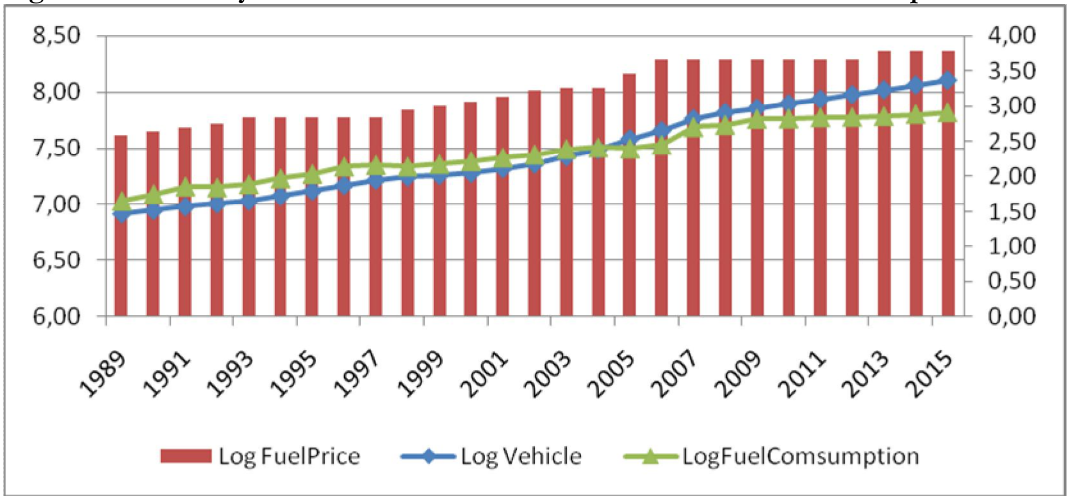
Figure 27. Vehicle growth and its share by type.



Source: CIEC and Author estimation (2012)

From thegrowth data1990-2010vehicles, provingthat the growth offuel consumptioninthe transportation sectorelasticto growthandchanges invehiclefuel prices. An interesting fact isthateverytime there isan increasein fuel priceswouldlead tolower growth inthe vehicleand will ultimately reducefuel consumption, as happenedin 1998and 2002and 2005. Elasticitychanges infuel priceshigher than thegrowthelastitasvehicles, this meansthat thefuel priceadjustmentwill positively impactthe growth rate ofvehiclesettingsin addition to reducingfuel subsidies.

Figure 28. Elasticity of Fuel Price and Vehicle Numbers on Fuel Consumption



Source : CIEC, Pertamina and Author Estimation

Refineries in Indonesia did not have the capacity to produce fuel with less sulfur yet, however Pertamina claimed it refinerieshave comply to thresholdset bythe DirectorateGeneral ofOilandGas in producingdiesel with sulfur levels. According to Fuels Pertamina improvement plan, Pertamina already has plans to increase production of fuel which comply to Euro 2 (and higher) emission standards. By establishing a new refinery with required investment as much IDR 4.3 billion, andhave a capacity of 300 MBCD to produce an additional 4.7 million kL of petrol and diesel 2.3 million kL per year between 2008 and 2010, Pertamina will ability to produce fuel with sulfur level not exceeding 500 ppm. However, this plan depends on the commitment of the government approval to commit in following Euro emission standards.

Table 32. Pertamina's fuel improvement plan and Capital Investement Need

Year Fuel Standards	2008-2010 Euro-2	2011-2015 Euro-3	2016-2020 Euro-3	2021-2025 Euro-4
Gasoline	produced by all refineries	produced by Cilacap & Kasim	produced by all refineries	produced by all refineries
Diesel	produced by Dumai & Balongan	produced by all refineries		
Investment required	New additional refinery w/ capacity: 300 MBCD - Gasoline: 4,716,000 kL - Diesel: 2,354,000 kL	Additional desulphurization unit	Additional benzene splitter unit, desulphurization unit, selective hydrogen unit	Additional Selective hydrogen unit, desulphurization unit
Refinery Improvement: - Modification - Additional unit - Construct new refinery Additional puring unit	Construction of isomerization unit: - Cilacap: 34.61 MBCD - Balikpapan: 25.50 MBCD New refinery: - Plaju: 13.32 MBCD Additional hydrogen selective unit for Plaju and Balongan	Additional desulphurization unit for: Dumai, Cilacap, Balikpapan, Plaju & Balongan	Additional desulphurization unit for: Dumai, Balongan	Additional Selective hydrogen unit for: Cilacap, Balikpapan
Estimated Capital Investment*	Rp 4,313 Billion	Rp 1,725 Billion	Rp 1,785 Billion	Rp 4,200 Billion

* Capital Cost for refinery improvement is calculated based on study by Coffey Geosciences Pyy Ltd, 2003

Source : Pertamina (2008)

Table 33. Cost Comparison of Capital Investment and Import Clean Diesel

Year **Fuel Standards**	**2008-2010** **Euro-2**	**2011-2015** **Euro-3**	**2016-2020** **Euro-3**	**2021-2025** **Euro-4**
Domestic Production (KL)	57,307,712	89,948,102	92,302,102	92,302,102
Imported	11,556,236	6,156,592	18,737,079	37,909,864
Demand	68,863,948	96,104,694	111,039,181	130,211,966
Additional Cost Simulation from Current				
Estimated Capital Investment (IDR Billion)	4,313	1,725	1,785	4,200
Import Clean Diesel(IDR Billion)	2,339	1,246	3,792	7,672

Source : Pertamina, MoMR and Author'sEstimation (2012)

8.3. Policy Type and Policy Option

The policy types are to be assessed in this paper as depicted in Table 34. There are ninetypes of offered solutions to reduce air pollution and CO emissions are identified and initially assessed for their costs and effectiveness in reducing vehicle emissions and the associated benefits. The policy types are:

Table 34. Policies Type.

Scenario	Policy Option	Objective	Cost	Benefit	Outcome
1	Diesel Quality Improvement	to meet Euro 3 fuel requirement (max sulphur content of 350 ppm) by 2015 and to meet Euro 4 fuel requirement (max sulphur content of 50 ppm) by 2020	New Refineries Modification Additional Unit Catalytic Converter	health impact reduced	% of PM Reduction % of SO2 Reduction % of NO2 Reduction % of CO2 Reduction
2	Introduction of fuel efficiency standard	to reduce fuel consumption and subsidy (applicable to diesel & gasoline vehicles)	Vehicle Tax incentive (Technology Improvement)	health impact reduced reduction of fuel consumption & subsidy	% of PM Reduction % of SO2 Reduction % of NO2 Reduction % of CO2 Reduction
3	Use Natural gas for Transportation	to reduce liquid fuel dependency & subsidy by increasing supply	Adjust gas selling price (currently it is low) Tax-neutral incentive for gas retrofit equipment	health impact reduced reduction of fuel consumption & subsidy	% of PM Reduction % of SO2 Reduction % of NO2 Reduction % of CO2 Reduction
4	Catalytic converter retrofit	to reduce criteria air pollutants from gasoline vehicles	tax-neutral incentive for catalytic converter kits	health impact reduced reduction of fuel consumption & subsidy	% of PM Reduction % of SO2 Reduction % of NO2 Reduction % of CO2 Reduction
5	Scrapped of old vehicles	to reduce emissions of old vehicles in vehicle intensive provinces	increase tax progressively for old vehicles (> 10 years), Compensation	health impact reduced reduction of fuel consumption & subsidy	% of PM Reduction % of SO2 Reduction % of NO2 Reduction % of CO2 Reduction
6	Introduction of hybrids	to reduce fuel consumption & subsidy	Tax-neutral incentives for hybrid cars	health impact reduced reduction of fuel consumption & subsidy	% of PM Reduction % of SO2 Reduction % of NO2 Reduction % of CO2 Reduction
7	Use Biofuel	to reduce fuel consumption and subsidy (applicable to diesel & gasoline vehicles)	Tax-neutral incentives for biofuel cars	health impact reduced reduction of fuel consumption & subsidy	% of PM Reduction % of SO2 Reduction % of NO2 Reduction % of CO2 Reduction
8	Public Transport/Mobility Management	to reduce fuel consumption and subsidy (applicable to diesel & gasoline vehicles)	Investment on Bus Rapid Transit, Busway, Commuter line, and MRT	health impact reduced reduction of fuel consumption & subsidy, Shifting to Public Transport	% of PM Reduction % of SO2 Reduction % of NO2 Reduction % of CO2 Reduction
9	Leap frog-Diesel Quality Improvement	to meet Euro 3 fuel requirement (max sulphur content of 350 ppm) by 2013 and to meet Euro 4 fuel requirement (max sulphur content of 50 ppm) by 2016	New Refineries Modification Additional Unit Catalytic Converter	health impact reduced	% of PM Reduction % of SO2 Reduction % of NO2 Reduction % of CO2 Reduction

8.4. Economic Analysis

8.4.1. Methodology

CBA is a systematic quantitative method of assessing the desirability of goverment projects or policies when it is vital to take a long view of future effects and a broad view of possible side-effects, therefore cost-benefit analysis to compare the costs and benefits of public goods projects and decide if goverment should be undertaken. While, CEA is a widely used alternative to CBA, especially in areas like health & defence policy when the analysts unwilling or unable to monetize the most vital policy impact and also may recognize that a particular effectiveness measure does not capture all of the social benefits (SB). (Boardman,2006).

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 methodology to calculate reductions in vehicle emissions and associated public health risks and to estimate monetary values of the benefits and costs of implementing the options was adopted from Geosciences (2003) given the situation that a full cost-benefit analysis was not feasible due to unavailability of comprehensive data and related studies in Indonesia. In the analysis, it was assumed that the costs of a measure or all other measures put together are defined as all costs associated with the implementation of the measure(s), which include government costs and manufacturer compliance costs.

The benefits are defined as reduced public health risks associated with reductions of CO, HC, PM10 and NOx emissions, fuel production and fuel subsidy saving related to fuel consumption reduction caused by technology improvement and emission standard compliance. In the other side, the cost is consisted of capital and operating costs of refinery and technology application. To value of alternative policies, CBA provide a social net benefit as total social benefits deducted by total costs, while CEA makes programs with identical types of outcomes comparable by showing which program yields the greatest outcome per dollar spent but it does not indicate whether a particular policy has positive net benefits overall, ie the cost of reduction each tiype of emission.

From those type of policies are expalined in Table 35, we can then formulate policy options that may be in form of individual policy type or its combinations. By assuming the euro 2 emission standars has been implemented and now under going to adoption of euro 3 and euro 4, we then formulate the policy options in Table 35. The table also includes some parameters and its source where were taken. The information are about emission factor, converter cost and impact of certain policy to emission reduction.

Table 35. Policies Formula.

Policy Option	Title	Description	Parameter and Its Source
1	Emission Standard	Implement Euro 2 at 2005, Euro 3 at 2015, and Euro 4 at 2020	Table Appendix 3. Adopted Emission Factors (g/km) at 80,000 km, source : Coffe (2005)
2	Fuel Efficiency +Option 1	Enhance fuel Efficiency 10 % by 2009	
3	CNG +Option 1	Convert to Gas for Passenger Cars and Bus, at least 1 % at 2009, 2 % at 2011, and at 5 % at 2021	Assume Cost for Gas Coverter = $100 , Gas Fuel CO NO HC PM Reduction 0.89 0.53 0 0.85 Sources Evaluating the Emission Reduction Benefits of WMATA Natural Gas Buses, www.eere.energy.gov
4	Catalytic Coverter+Option 1	Use Catalytic Converter to Diesel vehicles (25 % of Passenger Car, Bus, and Truck)	Cost for Catalyc Coverter = $100 , Gas Fuel CO NO HC PM Reduction 0.0 0.15 0 0.5 Sources: Michael P.Walsh (May,2006)
5	Scapped + Option 1	Scrapped the 50 % vehicles that more than 20 years old from 2009	
6	Hybrid Technology + Option 1	Use Hybrid technology for Passenger cars and Bus, at least 0.05% at 2009, 0.1 % at 2011,0.5 % at 2016, and 1 % at 2021	Cost for Catalyc Coverter = $10,000 Assume fuel efficiency increases about 4.1 times than non hybrid technology.
7	Biofuel + Option 1	Convert to Biofuel for Passenger Cars and Bus, at least 1 % at 2009, 2 % at 2011, and at 5 % at 2021	Cost for processing biofuel = IDR 4,584/Liter is taken from Hadi et.al,(2010),http://psp3.ipb.ac.id/jurnal/index.php/artikel/article/view/23 Gas Fuel CO NO HC PM Reduction 0.47 -0.22 0.46 0.55 Sources: Xue, J., Tony, E.G and Alan C.H (2011)
8	Public Transport + Option 1	Result passenger car and motor cycle shift to public transport at least 5% and 1% at 2011, 10% and 5 % at 2014, 20% and 10% at 2018 and 40% and 20% at 2025	Invest on bus rapid transit and busway (2005-2015), commuter line (2010-2020), and MRT (2015-2025). Cost for Investment is provided in table 9. We have limitation to consider operating and maintanance cost as well as expected reveneue from tariff.
9	Leapfrog Emission Standard + Option 1	Implement Euro 2 at 2005, Euro 3 at 2013, and Euro 4 at 2016	Implement Euro 2 at 2005, Euro 3 at 2013, and Euro 4 at 2016

Source : Author, compiled from many sources.

Concerning on option 7 (the use of biofuel), we set target at least 5% of passenger car and bus will use biofuel as transportation fuel by 2020. This number is almost similar to USA data for about 4.8% in 2008 (Anderson, 2012). However, the percentage of biofuel vehicle in Europe is about two times of this number up to 10,9% in Germany and 5,6% in Sweden (Anderson, 2012). Furthermore, the impact of biofuel on emission is still debatable, but study by Xue,.et al(2011) summarized the implication of biofuel on emission and showed that it reduces emission of CO (47,4%), HC (45,6%) and PM(55,5%). However, biofuel in oppositely increase of emission of NO about 22,1% (Table 36).

Table 36. Impact of biofuel on emission (%)

Gas Fuel	CO	NO	HC	PM
n Increase	7 0.106	45 0.625	3 0.053	7 0.096
n Similar	2 0.03	4 0.058	3 0.053	2 0.027
n Decrease	57 0.844	20 0.29	51 0.895	64 0.877
Impact	**0.47426**	**-0.22093**	**0.45645**	**0.5551**

Source : Calculated from Xue, J., Tony, E.G and Alan C.H (2011)

For option 8 (Public transportation), we calculate infrastructure cost for public transportation by adopting the cost provided by Weisbrod (2009). To make reliable, we do adjustment the total cost needed per km by purchasing power parity provided by World Economic Outlook of IMF, April 2012. Additionally, we also assumed additional cost related to public transport improvement to buy some busses which is approximately IDR 500 million per bus.

Table 37. Cost per KM for Fixed Guideway Infrastructure

Cost per Mile (Weibord, 2009)	Dollars Permile	IDR per KM	Length of	Total Cost	Total Cost Adj PPP	Construction			Annual Inv
	(Million)	(Billion)	Line (KM)	(IDR Billion/KM)	(IDR Billion/KM)	start	end	year	(IDR Billion)
BRT : Bus Rapid Transport	10.3	157	100	15,747	2.70	2004	2015	11	0.246
BW : Busway	80.5	1,231	50	61,537	10.57	2004	2015	11	0.961
CR : Commuter Line	115.3	1,763	40	70,512	12.11	2010	2020	10	1.211
HR : Heavy Rail Transit	384.8	5,883	10	58,831	10.10	2015	2025	10	1.010
LR : Light Rail Transit	105.9	1,619	10	16,191	2.78	2015	2025	10	0.278

Note : Implied PPP conversion rate between Indonesia and US is 5,822 : 1 (Expressed in national currency per current international dollar), Based on World Economic Outlook, IMF, April 2012

Source : Adopted from Weisbrod (2009), calculated by Author.

To calculate costs and benefit, we need a basis data of the prediction vehicles number until 2030. Then, the comsumption of fuel is estimated by multiplying number of vehicles to travelled distance and fuel efficiency per type of vehicles.

As noted in previous section, adopting new emission standards would involve some costs to improve vehicle technology and fuel quality. The incremental cost for achieving Euro4 per vehicle provided by MVEC while capital and operating cost for refinery improvement followed the information from Australian Refinery (Coffey Geosciences, 2003).

On the benefit side, many researches have shown that there are strong relationship between air pollutant and human health. According to Coffey Geosciences, there are some incremental costs involved in order to change from Euro 3 to euro 4 or directly from Euro2 to Euro 4 with new technology. For instance, a small car would require an additional cost as much IDR 2,4 million to improve from Euro3 to Euro 4 while it may increase become IDR 4,8 million with new technology (See Table Appendix 1).

While to estimate the capital and operating costs for refinery improvement, this study employed Pertamina Plan of refinery improvement to achieve fuel standards until 2005. The costs are calculated based on Australian refinery cost as shown in the study by Coffey Geosciences. For example, to improve to Euro2, is would require at least IDR 566 Billion for octane enhancement and 863 for 35% aromatic per refinery, and it costs about IDR 90 per liter of fuel processing (See Table Appendix 2).

On the benefit side, many researches have shown that there are strong relationship between air pollutant and human health. The estimation of health cost avoided per tonne of pollutant was taken from Valuation of Health Impact provided by Beer (2002) in Coffee Geosciences (2003), The reduction of health costs is based on the estimation of emission factor in gram per kilometer that is adopted from previous work by NSW EPA, US EPA and Coffee Geosciences.

The estimation of health benefit is started by knowing how much vehicle kilometer travelled. From this data, the amount of emission would be calculated based on emission factor for each type of vehicle and emission standard (See Table Appendix 3). For instance, the passenger car – petrol that no compliance to Euro2 is estimated would produce 2.1 gram of CO, 0.62 gram of NOx, 0.26 gram of HC, and 0.028 gram of PM per kilometer.

The reduction cost of health as benefit is calculated from amount of emission reduction and multiplied to valuation health impact of pollutants provided by Beer in Coffey 2005 (see Table 39). The production cost and fuel subsidy saving are simply calculated by multiplying amount of fuel consumption reduction to production cost of a liter fuel in each standards and a series of fuel subsidy per liter (from 2009, it is assumed about IDR 400 per liter, while at 2006 is IDR 1,694, 2007 is IDR 672, and 2008 is IDR 466 per liter).

Table 39. Valuation of Health Impacts of Pollutants (IDR/Tonne)

1 AUD=IDR 7,500				
Ozone Included	CO	NOx	HC	PM
Upper Bound	9	72,500	900	221,100
Best Estimate	3	19,331	870	147,429
Lower Bound	2	11,700	280	108,300

Sources, Beer (2002), in Coffey,2005

8.5. Economic Benefit and Effectiveness Analysis

Table 40 below explains the comparison of cost and benefit analysis of economic gain and fuel subsidy of 9 options that have been set. As the base of comparison, we set option 1 or the only improvement of fuel quality to meet Euro fuel standards as a basis. By following emission standar alone, it will affect to reducing sulfur levels to below 500 ppm, the benefits are: substantial reduction in health costs and productivity losses which are estimated at more than IDR 38,963 net present value (NPV) over a period of 2005-2030. This option also provides a NPV in fuel savings of IDR 71,395 billion between 2009-2030.

The cost benefit analysis indicated scrapped of old vehicele or the 5th option would ultimately promised to result the highest net benefit as much as net present value (NPV) IDR1,563,678billion or annual average of IDR 260,793 billion during 2005-2030. That policy also offered of potentially fuel saving at the 2009-2030 period as amount of NPV IDR 1,098,827billion. Although this policy option give the largest economic gain, but this option has a weakness of politically impelementation because mostly older vehicles owned by lower-income people, so the issue of justice and the distribution of wealth will be a challenge. Besides that, this policy also require huge compensation or incentive schemes for people who already have a vehicle older than 20 years and be willing to be compensated. However, because this policy will certainly directly affect fuel consumption, the goverments should have good strategy in convincing people to get into this policy.

As an alternative, the 2rd optionis the second largest option which provide net benefit and potential fuel saving. The introduction of fuel efficiency standards result the NPV of net benefit from reduced health costs and impact on CO_2 emissions are estimated about IDR 803.6 trillion over the next 26 years. Additionally, the NPV of net benefit from fuel subsidy savings is IDR 469.5 trillion over 22 years, equaling IDR 74.6 trillion per annum. We consider this policy as the one which is visible to be implemented by government with the scheme of tax incentives for new fuel-efficient or low CO_2-emission vehicles produced by automobile industry.

Interestingly, the option to provide public transportation is the third largets to provide economic gain. This policy is expected to result the NPV of net benefit from reduced health costs and impact on CO_2 emissions are estimated about IDR 599.9 trillion over the next 26 years and the NPV of net benefit from fuel subsidy savings is IDR 388.1 trillion over 22 years. Although this policy really depend upon the behavior and social attitude of people in the country, but the result contend how important public transportation not only to increase quality of life by reducing pollution but also to hugely reduce fuel consumption.

The policies of the use of CNG for transportation, the introduction of hybrid technology, and the use of biofuel for transportation result similar figures. However, the use of CNG for transportation is the largest economic gain among this three and the use of biofuel for transportation is the largest policy of this three to have fuel saving.

The leapfrog policy to speed up the implementation of Euro 4 from 2020 (option 1) to 2016 (option 9) will result net economic gain as much as IDR 8.7 trillion and save fuel consumption as much as IDR 13.3 trillion. From this finding, government's effort to faster implementing Euro 4 by 2014 will get worth result.

Table 40. Cost and Benefit Analysis of 9 options (2005-2030)

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9
Cost									
Refinery Production	467,416	428,932	431,091	467,416	338,794	464,669	458,053	421,638	466,745
Technology Utilization	493,312	664,566	15,863	643,108	784,586	30,911	342,032	117,541	493,312
Total Cost	960,728	1,093,497	446,954	1,110,523	1,123,380	495,580	800,086	539,179	960,057
Benefit									
Health Improvement	1,656,264	2,646,587	1,532,923	2,012,137	2,854,542	1,667,728	1,667,729	1,649,883	1,648,305
Production Saving	27,712	157,826	52,277	27,712	448,393	36,237	57,138	169,923	31,387
Subsidy Saving	286,392	1,640,422	539,615	286,392	4,601,071	373,975	589,473	1,746,763	324,084
Total Benefit	1,970,368	4,444,835	2,124,816	2,326,241	7,904,005	2,077,940	2,314,340	3,566,569	2,003,776
FY 2005-2030									
Net Benefit	1,009,640	3,351,338	1,677,862	1,215,717	6,780,625	1,582,360	1,514,255	3,027,390	1,043,719
NPV; SDR 8 %	38,963	803,680	310,516	374,486	1,563,678	290,778	275,887	599,926	47,736
Net Benefit Average	38,832	128,898	64,533	46,758	260,793	60,860	58,241	116,438	40,143
FY 2009-2030									
Fuel Saving	286,392	1,640,422	539,615	286,392	4,601,071	373,975	589,473	1,746,763	324,084
NPV; SDR 8 %	71,395	469,465	127,900	71,395	1,098,827	91,202	144,873	388,089	84,727
Net Benefit Average	13,018	74,565	24,528	13,018	209,140	16,999	26,794	79,398	14,731

Source : Author Calculation (2012)

According to the table 40, we can see a consistent directions between net economic benefit matter or fuel saving concern except between the use of CNG and the use of Biofuel. However, we can conlude that among those policies, the option 2 to standardize fuel efficiency will give best benefit, then the improvement of public transport is become second best option. Furthermore, we can elaborate and carefully compare between the use of CNG for transportation, the introduction of hybrid technology, and the use of biofuel for transportation. All each of this has drawback such as; the use of CNG required high cost for converter and availability of gas supply. The introduction hybrid technology make hybrid car prices in Indonesia are still very expensive and it is estimated odds USD 100 million compared to ordinary vehicles. The use of biofuel has some weaknesses because this policy is still unsubsidized and make biofuels are expensive. Furthermore, the issue on food security may affect to develop land farming to plant biofuel feedstocks.

Concerning of cost effectiveness of 9 options, we find that the use of CNG is the most effectiveness. The introduction of hybrid technology and the provison of public transportation are the second and the third best of effectiveness. From table 40 and table 41, we conclude that the the provison of public transportation is the best option by considering the net economic gain, fuel saving and the least cost to reduce emission per million ton.

Table 41. Cost of Effectiveness of 9 options (2005-2030)

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9
Cost (IDR Billion)	960,728	1,093,497	446,954	1,110,523	1,123,380	495,580	800,086	539,179	960,057
Emission Reduction (Million ton)									
CO	9,142	12,869	9,231	9,142	13,565	9,156	9,190	12,488	11,519
NOx	6,269	11,548	6,524	7,596	13,621	6,327	6,204	6,799	7,903
HC	2,178	3,057	2,178	3,244	3,244	2,438	2,196	2,697	2,741
PM	663	768	671	776	776	664	668	684	858
Cost Effectiveness (IDR Billion per million ton)									
CO	105	85	48	121	83	54	87	43	83
Nox	153	95	69	146	82	78	129	79	121
HC	441	358	205	342	346	203	364	200	350
PM	1,449	1,424	667	1,431	1,447	746	1,198	788	1,120

Source : Author Calculation (2012)

Table 42 shows the budget impact to implement the policy of Eurot2to Euro 4 during period 2005 to 2030. The cost to implement Euro 4 at 2020 need cost of IDR 498.3Trillion or IDR 21.6 Trillion annually, while IDR 449.1 billion or IDR 19.5 Trillion annually is required to push faster implementing Euro4 at 2016.By speeding-up to implement Euro 4 at 2016, it would potentially save budget of refinery cost about IDR 49.2 Billion or IDR 2.13 Billionannually.

Given net economic gain difference between them as much as IDR 8.7 Trillion (as explained in Table 40) and also the additional potential saving of refeinery cost, thus the policy to faster the implementation of Euro 4 emission standard by 2016 should be strongly taken to save national budget. However, this strategy needs major regulationof the introduction of new standards through a variety of policy options will require new technologies for vehiclesas well as oil refining technologies that meet the new standards towards Euro 4 are needed to process fuel in accordance to standard requirement.By this policy, the benefits of increased air quality imply health care cost savings, the potential for cost reduction of subsidies for fuel and the potential reduction in production costs are expected to be in placed.

Table 42. Budget Impact of Policy from Euro 2 to Euro 3 and Euro 4 (IDR Billion)

Road Map	Policy	Budget Impact Expenditure (Euro 4 at 2020)	Budget Impact Expenditure (Euro 4 at 2016)	Different
Period				
2005-2007	Euro2	148,338	155,463	-7,125
2008-2015	Euro3	178,005	172,665	5,340
2016-2030	Euro4	320,281	276,457	43,824
Cumulative				
2005-2007	Euro2	148,338	155,463	-7,125
2008-2015	Euro3	326,343	328,128	-1,785
2016-2030	Euro4	646,624	604,586	42,039
Incremental				
Euro2-Euro3	8 Years	178,005	172,665	5,340
Euro3-Euro 4	15 Years	320,281	276,457	43,824
Euro2-Euro4	23 Years	498,286	449,123	49,164
Annual				
Euro2-Euro3	Euro2	22,251	21,583	668
Euro3-Euro 4	Euro3	21,352	18,430	2,922
Euro2-Euro4	Euro4	21,665	19,527	2,138

Source : Author Calculation (2012)

Finally, the CBA modeling conclude the best option would be depend on our concern or policy target, whether to have economic profit and to save fuel subsidy or to focus on effectiveness of emission reduction. In the period 2005-2030 is estimated that the average annual economic profit is between IDR38.8 trillion to IDR260.8 trillion. While the average subsidy could be saved per year is estimated at between IDR13.0 billion to IDR209.1 billion in the period 2009-2030 (see Table 43).

By using a social discount rate of 8%, it is estimated that the net economic benefits over 26 years (2005-2030) ranged from IDR38.9billion to IDR1.56 Trillion and the total subsidy savings over 22 years (2009-2030) will achieve the range of IDR71.4 billion and IDR1,1 trillion.

In addition to use traditional cost-benefit analysis, this study also calculate the cost effectiveness required to reduce the emissions of each type of pollutants such as CO, NOx, HC and PM per million tonne. The analysis showed that the cost-effectiveness of each policy is ranged between IDR 43-121 billion to reduce pollutants CO per million tonne, IDR 69-153 billion to reduce the pollutant NOx per million tonnes, IDR 203-441 billion to reduce pollutants HC per million tonne and IDR 667-1.449 billion to reduce PM per million ton.

Table 43. Summary of Policy Impact

Summary of Policy Impact	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9
Cost-Benefit Analysis (IDR billion)									
Net Benefit Average (2005-2030)	38,832	128,898	64,533	46,758	260,793	60,860	58,241	116,438	40,143
NPV of Net Benefit (2005-2030)	38,963	803,680	310,516	374,486	1,563,678	290,778	275,887	599,926	47,736
Fuel Subsidy Saving Average(2009-2030)	13,018	74,565	24,528	13,018	209,140	16,999	26,794	79,398	14,731
NPV of Fuel Subsidy Saving (2009-2030)	71,395	469,465	127,900	71,395	1,098,827	91,202	144,873	388,089	84,727
Cost-Effectiveness Analysis (IDR billion/Million Ton)									
CO Emisssion Reduction	105	85	48	121	83	54	87	43	83
NOxEmisssion Reduction	153	95	69	146	82	78	129	79	121
HC Emisssion Reduction	441	358	205	342	346	203	364	200	350
PM Emisssion Reduction	1,449	1,424	667	1,431	1,447	746	1,198	788	1,120

Source : Author Calculation (2012)

8.6. Sensivity Analysis

Given that each policy option is always dealing with risk and uncertainty, hence in this study was also carried out risk analysis and sensitivity of each policy. Risks arising affected by changes such as the level of assumptions used social discount rate, rate of subsidy per liter, power every kind of vehicle mileage per year, vehicle efficiency per liter of each type of vehicle as well as the assumption of health cost savings per gram of any kind of vehicle emissions.

By considering the coefficient of variation of each policy option on the value of the Net Present Value (NPV) of the economic benefits, weshows that the second and third policy have the lowest risk level, meaning that policy will provide a more stable economic advantage than others in term of expected net economic benefits. But if the sole focus is to make savings subsidy, the second policy option has also the smallest degree of risk and it supports the privious finding that this policy also has the greatest potential net economi gain and subsidy savings.

To complete risk analysis, sensitivity analysis of the economic benefits of each policy on a variety of input variables needed to provide information for policy makers in determining what is a variable factor and carrying capacity of the policy will be taken. Ranking results of the variable based on the sensitivity analysis shows Social discount rate is the main factor that affect every policy option except option 5 and option 8. While the cost factor of the health effects of NOx emissions is the next factor affecting economic gain.

Sensitivity testing of major variables demonstrated that net present value of the net benefit of options was sensitive to estimate used. The most sensitive variables are social discount rate and vehicle kilo travelled. However, the price gap that government given away as subsidized to Public Service Obligation (PSO) fuel was not sensitive enough to influence the change of net economic benefit and amount fuel subsidy saving.

Based on table 44, the five major factors to consider is the SDR, health cost savings of NOx emissions, Vehicle Kilo Travelled Bus, healthcare cost savings of PM emissions, and Kilo Travelled Vehicle Truck. This shows that the emissions of NOx and PM are the main pollutants that are harmful to health and the ability of the fuel efficiency of trucks and buses are also a major contributing factor to the emissions compared to other vehicle types.

Table 44. Risk Analysis of Net Economic Benefit

	Risk Analysis Results of NPV-Net Economic Benefit for Alternative Scenario								
	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**	**Option 8**	**Option 9**
Determinate Case	**38,963**	**803,680**	**310,516**	**195,786**	**1,563,678**	**290,778**	**275,887**	**599,926**	**47,736**
Risk Analysis									
Range	393,746	1,185,192	502,187	514,866	5,429,440	483,528	501,400	3,460,711	403,397
Mean	40,579	807,573	313,527	197,516	1,639,232	293,410	278,556	665,778	49,566
Median	35,799	796,429	308,241	192,562	1,604,230	288,319	273,009	637,537	44,730
Standard Deviation	48,322	148,395	62,128	62,354	657,712	60,866	61,071	414,484	49,564
Coeff. of Variability	1.1908	0.1838	0.1982	0.3157	0.4012	0.2074	0.2192	0.6226	1.0000

Source : Author Calculation (2012)

Table 45. Risk Analysis of Fuel Subsidy

	Risk Analysis Results of NPV-Fuel Subsidy for Alternative Scenario								
	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**	**Option 8**	**Option 9**
Determinate Case	**97,132**	**638,702**	**197,099**	**97,132**	**1,494,942**	**124,079**	**197,099**	**527,991**	**115,270**
Risk Analysis									
Range	119,390	719,183	260,303	119,390	3,568,094	163,383	260,303	3,296,473	139,463
Mean	97,659	638,247	198,622	97,659	1,564,335	125,038	198,622	592,941	116,018
Median	96,604	632,638	196,366	96,604	1,530,467	123,582	196,366	565,033	114,860
Standard Deviation	14,763	88,624	31,445	14,763	460,824	19,670	31,445	413,889	17,362
Coeff. of Variability	0.1512	0.1389	0.1583	0.1512	0.2946	0.1573	0.1583	0.6980	0.1497

Source : Author Calculation (2012)

Table 46. Sensitivity Ranking of Input variables.

	Sensitivity Rank of NPV to Input Variable								
	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**	**Option 8**	**Option 9**
SDR (Social Discount Rate, %)	1	1	1	1	2	1	1	7	1
Fuel Subsidy (Rp/Liter)	14	14	14	14	14	14	14	14	13
Fuel-Bus (Km/L)	7	10	10	8	5	9	10	4	8
Fuel-Motor Cycle (Km/L)	11	11	12	12	8	11	12	6	11
Fuel-Passenger Car (Km/L)	10	7	7	10	3	12	7	1	10
Fuel-Truck (Km/L)	8	9	8	9	4	8	9	3	9
Health-CO Red (Rp/Ton)	15	15	15	15	15	15	15	15	14
Health-HC Red (Rp/Ton)	13	13	13	13	13	13	13	13	12
Health-NOx Red (Rp/Ton)	2	2	2	2	9	2	2	10	2
Health-PM Red (Rp/Ton)	3	5	3	3	11	3	3	11	3
Refinery Capital Cost (Rp Billion)	12	12	11	11	12	10	11	12	15
Subsidy/Liter (Rp/Lt)	4	3	4	4	6	4	4	8	4
VKT- Bus (KM/Year)	5	4	5	5	1	5	5	2	5
VKT-Motor Cycle (KM/Year)	6	8	9	7	7	7	8	5	6
VKT-Passenger Car (KM/Year)	9	6	6	6	10	6	6	9	7

Source : Author Calculation (2012)

8.7. Stakehoder Impacts

The impact of any policy or regulations will affect the behavior of consumers, the auto industry, refineryindustry and government. For example, to meet the requirements at each stage of the implementation of emission standards, the refining industry which in this case is Pertamina must make investments to improve the technology and capacity refinery to produce fuel with sulfur content in accordance with the provisions of standardization.

In this simulation, the need for investment into the production line with Euro 4 done gradually by Pertamina according to the work plan of the years 2008-2025.The increase in the cost of investment and production quality improvement will certainly have an impact on fuel price increases will be felt by consumers. However, this negative impact will actually be compensated by an increase in the quality of public health resulting in lower healthcare costs.For the government, any alternative policy would provide the fuel subsidy reduction in the need for more efficient use of the fuel well as improving the quality of fuel or the use of vehicle technology.

For the automotive industry, the impact will be more rely on the scheme of government tax incentives, the increased of costs related to production technologies toward efficient vehicles and environmentally friendly which will increase the price of the vehicle. LPEM studies (2004), suggests that the impact of price changes on demand for cars (price elasticity) by segment have different influences. The study concluded that the class pick ups, trucks and buses are widely used for commercial ventures, the most elastic demand that every 10% price increase, demand will decrease 23.7%. Elastic demand for cars that were then shown the class versatile 4x2, Sedan Sedan Small and medium. Most auto demand is price-inelastic is versatile and Sedan Lux 4x4. Thus the government should also set up various incentive schemes in the choice of policy to maintain the purchasing power since the transport sector has forward and backward linkages are very strong with other economic sectors.

The cost of adopting stronger emission standard would be initially borne by vehicle manufacturers and oil refinery proucers in upgrading technology, plant and equipment. Some cost for sure would be passed on to the consumer by way of higher fuel and vehicle price although no information how much share of price change would be transferred to consumers.

Therefore, consumers of motor vehicles would be affected by change of price of new vehicles as a consequence in meeting with the emission standard that requires the development and introduction better technologies. The change of price would influence purchase decision and consumer behavior. LPEM (2005) found that the most elastic demand occurs in the pick ups, trucks and buses class, which is mostly for commercial uses. Every 10% price rise will result in 23.7% decline in demand. The next less elastic demand occurs in the all purposes 4x2, Small Sedans and Medium Sedans classes while the least elastic car demand is in the All purpose 4x4 and Luxurious Sedans classes.

The benefit form avoided health costs would flow to those with pre-existing health condittions, the public health system and families through lower level of sickness and less restricted activity days to be more productive.

8.8. Conclusion and Recommendation

- Base on the costs-benefits and effectiveness analysis, the scrapped old vehicle policy has the largest of net economic benefit and potential subsidy saving, however its not viable policy in near future due to equality issue and required an expensive cost to compensate it.
- The second policy options to introduce fuel efficiency standard is the most rational choice and best option as it result the greatest net economic gain and fuel saving. However this option is not the most cost-effectiveness to reduce emission.
- The next best option is to provide public transportation. Although this policy largely depend on people behavior but this research shows the result as the third greatest of net economic gain and fuel saving. Furthermore, this policy is among the best of cost-effectiveness to reduce emission.
- The policy is the most cost of effectiveness means it provide estimated smallest cost needs to lower emission per million tonne. The use of CNG for transportation and the introduction of hybrid technology are among the lowest cost to reduce emission. However both of them have some darwbacks related to avalaibility of gas supply and expensive cost of gas converter and hybrid technology.
- The different of net economic benefit to faster implementation of Euro 4 at 2016 compare to implement Euro 4 at 2020 is large and imply the higher benefits of increased air quality imply health care cost savings, the lower cost of subsidies and the larger potential reduction in production costs. Therefore, government may consider this exercise in designing roadmap of standard emission in Indonesia.
- The second option of introduction of fuel efficiency standards demonstrate a relatively small degree of risk in terms of economic benefits and savings subsidies. Its sensitivity is relatively stable output with respect to social discount rate, health cost savings, and vehicle kilo travelled. Its relatively easier to implement than the politically and fiscal policy than others.

9. Institutionalization Arrangement

The issue of air pollution resulted from the transportation sector (i.e. mobile sources pollution) is related to and affects the economic, social and cultural aspects of the society. Therefore, the factors underlying the differences in the perspectives of the government, the communities as well as the business world toward the efforts to control air pollution always include the three aspects stated above. Thus, the paradigm of the solution must be built based on the interests of these three aspects.

The objective of the current environmental management stipulated in the legislation is still general and broad in nature. Therefore, it is necessary to develop more specific policies to manage the environmental-related issues, particularly in the management of air pollution. The current air management policy needs to be reviewed and amended in order to be stipulated as a new policy that meets the expectations and improvement anticipated by the society.

The increasing cases of air pollution in urban areas caused by transportation activities – both in terms of quality and quantity – indicate a number of interrelated weaknesses related to the management of air pollution and the law enforcement of which. These weaknesses include: (a) the laws and policies in the sector of air pollution control that still contain many weaknesses in terms of concept and implementation; (b) the sectoral policies which negate the problem of air pollution, especially those resulted from motor vehicle gas emissions; (c) there is lack of human resources, both in terms of quality and quantity, in the air pollution control sector; and (d) there is lack of awareness as well as appropriate manners of the people in the use of motor vehicles.

The numerous aspects affecting air quality, particularly those aspects originating from motor vehicle activities, require the commitment of the entire stakeholders which should be realized through the synergy of a program and the implementation of it. The coordination between stakeholders in the government and other institutions that are mandated by the legislation constitutes an effort to reduce the sectoral ego and create a comprehensive and holistic program.

When we avoid the dichotomy between the interests of the economic, environmental and social aspects, the air quality management must be built upon two principles, namely the balance principle and the precautionary principle. Economic growth – in this case the growth of motor vehicle production – is recognized as the main source of urban air pollution problems. Therefore, the economic growth should be balanced with the stipulation of laws and regulations as well as fiscal provisions that may conform to the importance of air quality management. As such, in the process of stipulating the air pollution control policies, the economic instrument is an important issue that must be considered.

9.1. Policy Aspect

The Blue Sky program, established by the Government since 1996, has placed a policy framework that includes strategies of air pollution control for both the mobile-sourced and the stationary-sourced air pollution. For the mobile sources of air pollution, for example, the Government through the relevant Ministry has issued certain standards and requirements for the application of vehicle technology, the fuel quality improvement, the use of fuel gas and the introduction to more environmentally friendly alternative energy, as well as the development of monitoring systems.

The emergence of the idea of the local governments (provincial government) to issue the provisions or regulations on the management of air pollution is generally based on: (1) the worsening air quality in several provinces (cities or districts). Thus, a provision or a regulation is one of the tools/instruments of law implementation and law enforcement which is used to realize a better air quality. (2) The laws and regulations relating to air pollution in both open and closed spaces are still sectoral in nature. This affects the flexibility as well as the capacity of the relevant personnel under such laws and regulations. In order to address the air pollution issues resulted from motor vehicle gas emissions, it should be bear in mind that the aspects of motor vehicle technology, fuel type, engine condition, manner of driving as well as traffic conditions are interrelated.

The institutional aspects are more dominated by the inter-sectoral coordination and governmental administrative issues. Meanwhile, the legal aspects explore more of the legal issues underlying the pattern as well as the order of the institutional relationship issues. Both these aspects will affect the funding/budget of the implementation of air pollution control policies. As it is commonly known, the funding/budget aspect is one of the key instruments in the success of making and implementing a policy.

9.2. Legislation Aspect

There are numerous aspects and various regulations governing the air pollution of motor vehicles, yet the level of law enforcement as well as the level of compliance is still relatively low. This indicates that the institutional issues, particularly the coordination, the human resources and the budget have never been addressed with a comprehensive and holistic system.

Following are several laws and regulations relating to the issue of motor vehicle air pollution:

Table 47. Regulations Related to Air Quality in Indonesia

Legal Instruments	Concerning	Relevancy With Air Quality
1. General Regulations		
Law Number 32 of 2009	Environmental Protection and Management	• The control of environmental pollution and/or damage includes; prevention; mitigation, and recovery. • In the context of air pollution from mobile sources, the instruments for the prevention of environmental pollution and/or damage consists of **KLHS (Strategic Environmental Assessment)** to ensure that the principle of sustainable development has become a foundation and has been integrated into a development of an area and/or policies, plans, and/or program.
Law Number 22 of 2009	Traffic and Public Transportation	It should be mandatory for every motor vehicle to meet the requirements of the gas emission threshold and the noise threshold as an effort to preserve the environment.
Law Number 30 of 2007	Energy	Each energy management activity must prioritize the use of environmentally friendly technologies and meet the requirements stipulated by the legislations in the environmental field.
Law Number 32 of 2004	Local Government	• Each local government is required to preserve the environment. • The compulsory affairs that shall be authorized by local governments include environmental control.
Law Number 22 of 2001	Oil and Gas	• The Government shall prioritize the use of natural gas for domestic needs and is responsible for providing strategic petroleum reserves to support the supply of domestic fuel oil, which shall be further stipulated by a Government Regulation. • Fuel oil and certain processed products marketed locally to meet the domestic needs should meet the quality standards set by the Government.
2. Specific Regulation		
Government Regulation Number 41 of 1999	Air Pollution Control	Air pollution control shall include the following activities: 1. Inventory of local air quality 2. Stipulation of ambient air quality standards and emission quality standards 3. Determination of the air quality in a region 4. Monitoring of air quality

			5. Oversight of regulatory compliance 6. Community participation 7. Policies on clean and environmentally friendly fuels 8. Stipulation of policies
	Government Regulation Number 42 of 1993	Motor vehicles inspection on the road	1. Inspection of the administrative requirements of both drivers and motor vehicles. 2. Inspection of the technical requirements of motor vehicles (including the emission test).
	Presidential Regulation Number 5 of 2006	National Energy Policy	• The realization of optimal mix energy (primary) in 2025, namely each type of energy should have a contributing role to the national energy consumption. • The target of the use of biofuels is more than 5%.
	Minister of Transportation Decision Number KM 71 of 1993	Periodic Motor Vehicle Inspection	• DLLAJ as the party responsible for the emission test is required to undertake the efforts to preserve the environment. • It is restricted to buses, freight cars, trailers, semi-trailers, special vehicles and public transport vehicles.
	Minister of the Environment Regulation Number 07 of 2009	Noise Threshold for New Type Motor Vehicle	The scope of this regulation includes the noise threshold for new type motor vehicle, the noise type test methods, and the procedures for reporting noise type test methods.
	Minister of the Environment Regulation Number 04 of 2009	Gas Emission Threshold for New Type Motor Vehicle	The scope of this regulation covers the gas emission threshold for new type motor vehicle, the gas emission type test methods, and the procedures for reporting gas emission type test methods.
	Minister of the Environment Regulation 05 of 2006	Gas Emission Threshold for Older Models Motor Vehicle	The scope of this regulation includes the gas emissions threshold, the test methods, the test procedures, the evaluation, and the reporting procedures.
	Minister of the Environment Decision Number Kep-13/MENLH/3/1995	The quality standards of stationary-sourced emission	• Dominant and critical parameters • Fuel quality • Raw materials quality • Technology
	Minister of the Environment Decision Number Kep-48/MENLH/11/1996	The standards of the level of statuary-sourced noise	• Human comfort aspect • Infrastructure safety aspect • Building sustainability aspect
	Minister of the Environment Decision Number Kep-49/MENLH/11/1996	The standards of the level of stationary-sourced vibration	• Human comfort aspect • Infrastructure safety aspect • Building sustainability aspect
	Minister of the Environment Decision Number Kep-50/MENLH/11/1996	The standards of the level of stationary-sourced odor	• Human comfort aspect • Infrastructure safety aspect • Building sustainability aspect
	Minister of the Environment	Air pollutant standard index	The impacts of the level of air quality on

	Decision Number Kep-45/MENLH/…/1997		health, humans, animals, plants, buildings as well as aesthetic value.
	Minister of the Environment Decision Number Kep-15/MENLH/11/1996	Blue Sky Program	1. Develop a national policy on air pollution control. 2. Increase the capacity of local governments on air pollution control. 3. Improve the mechanism for the supervision and control as well as the prevention and recovery of air quality.
	Directorate General of Oil and Gas Decision Number 3674 K/24/DJM/2006	Standards and quality specifications of gasoline fuel marketed domestically	• Lead and non-lead 88 octane gasoline. • Only non-lead 91 octane gasoline. • Only non lead 95 octane gasoline.
	Directorate General of Oil and Gas Decision Number 3675 K/24/DJM/2006	Standards and quality specifications of diesel marketed domestically	• Diesel oil with 48 cetan and maximum of 3500 ppm sulfur. • Diesel oil with 51 cetan and maximum of 500 ppm sulfur.
	Directorate General of Oil and Gas Decision Number 247 K/10/DJM.T/2011	Specifications of CNG fuel gas for transportation marketed domestically	Parameter of C1 component of 77% volume at minimum.
	Directorate General of Oil and Gas Decision Number 2527.K/24/DJM/2007	Standards and quality specifications of LPG fuel gas for motor vehicle marketed domestically	LPG with 98 RON or 88 MON.
	Minister of Energy and Mineral Resources Regulation Number 19 of 2010	Natural gas utilization for fuel gas used for transportation	• The utilization of natural gas for fuel gas that can be used for transportation may be in the forms of compressed natural gas (CNG) or Liquefied Gas Vehicle. • The utilization of natural gas for fuel gas used for transportation referred to in paragraph (1) shall be prioritized for cities or districts having the sources of natural gas. • The transmission/ distribution channel of natural gas or cities/districts having a high growth rate of vehicles or a high level of gas emissions.
	Minister of Energy and Mineral Resources Decision Number 2932 K/12/MEM/2010	The selling price of the fuel gas used for transportation in Jakarta	The fuel gas selling price used for transportation in Jakarta, including Bogor, Bekasi, Tangerang and Depok is IDR 3,100.00 (three thousand and one hundred rupiah) for every 1 (one) Liter Equivalent to Premium (LSP) including taxes.
4. Local Regulations			
	Local Regulation of DKI Jakarta Province Number 2 of 2005	Air Pollution Control	The actions to handle mobile-sourced air pollution include the monitoring of compliance to the gas emission threshold, the inspection of motor vehicle gas emission, the maintenance of motor vehicle gas emission, the monitoring of ambient quality on the road, the inspection of motor vehicle gas emission on the road, and the provision of environmentally friendly fuel.
	Regulation of the Governor	The use of fuel gas for public	The motor vehicles required to use fuel

	of DKI Jakarta Province Number 141 of 2007	transportation and local government operational vehicles	gas under this regulation shall include: 1. Local government operational vehicles; 2. Public transportation vehicles.
	Decision of the Governor of DKI Jakarta Province Number 1236 of 1990	Implementing Guidelines for the Quality Standards of Motor Vehicle Gas Emission within the area of DKI Jakarta	The obligation for any motor vehicle to meet the gas emission standards.
	Decree of the Governor of DKI Jakarta Province Number 95 of 2000	Emission Inspection System and Passenger Cars Maintenance System	The obligation for the inspection and maintenance of private passenger cars as a requirement for the payment of vehicle tax.

9.3. Alternative Policies

The increasing cases of air pollution in big cities in Indonesia clearly indicate a number of interrelated weaknesses related to the management of air pollution and the law enforcement of which. These weaknesses include: (a) the laws and policies in the field of air pollution control that still contain numerous weaknesses in terms of concept and implementation, (b) the sectoral policies which negate the problem of air pollution, especially those resulted from motor vehicle gas emissions, (c) there is lack of human resources, both in terms of quality and quantity, in the air pollution control sector, and (d) there is lack of public awareness of the environmental rights – this condition is highly related to the civil and political rights of the people.

The numerous factors affecting air quality, particularly those factors stemming from the activities of motor vehicles, require the commitment of the entire stakeholders which should be realized through the synergy of a program and the implementation of it. The coordination between stakeholders in the government and other institutions that are mandated by the legislation constitutes an effort to reduce the sectoral ego and create a comprehensive and holistic program.

Local Regulation Number 2 of 2005 on Air Pollution Control ("PPU Regulation") is an example of the issue described above. In the process of preparing the implementation, BPLHD as the agency responsible for air pollution control has only limited socialization budget as well as limited preparation of the operating instruments for this PPU Regulation. As a unit of DKI local government administration, the limitation of BPLHD is a manifestation of a thorough executive position and understanding of the body of the DKI Jakarta Local Government. For example, the issue of air pollution resulted from motor vehicle gas emission requires the synergy and coordination between the relevant sectors, while at the same time, the mandatory use of gas on public transportation and government operational vehicles also require a coordination with the central government institutions.

In order to improve the current situation, it is necessary to stipulate a number of policies, among others:

A. Legislation policy

Various regulations on environmental protection have already been issued. As an effort to control air pollution, the Government has issued the Government Regulation Number 41 of 1999 on Control of Air Pollution as a follow up of Law Number 23 of 1999 on Environmental Management which was subsequently amended by Law Number 32 of 2009 concerning Environmental Management and Protection.

Particularly in the transportation sector, an action to suppress the air pollution has actually been included in Law Number 22 of 2009 concerning Road Traffic and Road Transportation as well as

Government Regulation Number 44 of 1993 on Vehicles and Drivers. The said Government Regulation stipulates an obligation to conduct a periodic test for passenger car motor vehicles which also includes the gas emission test. Given the different local situations and needs in responding to the environmental conditions, it is evident that the roles of the central and local governments are considerably imperative in overcoming the problems in each region based on the identification of the existing air problems. Thus, it is necessary to encourage local governments as a first line enforcement of air pollution control in each of the region.

However, it should be noted that it is not simple to encourage the local legislation, and a comprehensive consideration on policies is highly required. The local legislation should not only be translated to merely encourage the presence of regulation at the local level but also the law implementation as well as the law enforcement.

For example, the issuance of the Local Regulation of DKI Jakarta Province Number 2 of 2005 on Air Pollution Control is one of the instruments used to respond to the problem of air pollution in Jakarta based on the current local conditions. However, the presence of the Local Regulation has not yet been followed by the concrete and strategic follow-up actions. The issuance of the Local Regulation Number 2 of 2005 leads to numerous consequences that should be dealt with in a consistent manner, particularly the efforts to harmonize various local regulations related to the aspects of air pollution, such as transportation, local spatial structure as well as green open-space.

Therefore, it should be highlighted that the effort to stipulate legislations must be balanced with the stipulation of policies that can implement as well as enforce such legislations, such as: (1) implementing regulations (governor regulations, decree, etc.); (2) strong and harmonious institutional agencies; (3) good quality as well as quantity of human resources; and (4) infrastructures. As an example, up to date, the Local Regulation of DKI Jakarta Province Number 2 of 2005 has only one implementing regulation following its issuance, namely the Regulation of the Governor of DKI Jakarta Number 75 of 2005 on the Prohibition of Smoking.

B. Supervision and coordination amongst the government agencies

In order to ensure the compliance toward the current legislations, the implementation as well as the supervision of the legislations is required. The supervision issue highly requires the competence of the relevant agencies to supervise business activities giving rise to pollution, as well the consistency and continuity of the supervision, including regular monitoring of the air quality conditions. The results of the regular monitoring and supervision should be informed to the public to encourage the awareness of the air pollution control.

As a breakthrough, the Government should develop a mechanism that allows the public to participate in monitoring the compliance toward the current legislations. This is considering that up do date the efforts to supervise the compliance are still hindered by the limited human resources, both in terms of quantity and quality. On this basis, the mechanism for complaints regarding air pollution control should also be considered in order to improve the supervision of the compliance to the legislations.

In terms of coordination, inter-sectoral coordination needs to be done both vertically (central-local) and horizontally (between agencies). Vertically (central-local), the authority to carry out the air pollution control is still hindered by many obstacles. Administratively, the local government has the opportunity to use the authority in the field of air pollution control in a comprehensive manner based on the characteristics of the local problem. Thus, there should be a clear division of the central authority and the local authority on air pollution control. Furthermore, the position of the central government in promoting national air control policies should also be clarified. The horizontal coordination (between agencies) should also be encouraged to improve the current policies which are "sectoral bias" where there is no conformity between the air control policies and other policies.

C. Law enforcement

By far, the law enforcement is the weakest aspect of the air pollution control. There has not been any consistent law enforcement which has deterrent effect over nearly all of the violations on air pollution. Generally, there are several factors giving rise to the law enforcement issues, namely: (1) the expertise of the lawyers, the public, the police officers, the environmental management agencies, the prosecutors, and the courts are very poor; (2) there is lack of coordination and shared understanding among the law enforcement agencies; (3) there is no systematic and long-term planning in the law enforcement; and (4) there is lack of integrity of law enforcement officers that may affect the law enforcement process itself.

The responsibilities of the central and the local governments in the law enforcement sector should be clarified. In processing the cases of air pollution, the authority of the local government as well as that of the central government should be made clear. Thus, a coordination which places the local government as the first line enforcement should be implemented. This is a strategy to encourage the local governments in controlling the air pollution.

D. Improving the public participation

The efforts to encourage the air pollution control will fail in the absence of public participation. Public participation is a form of public awareness on the importance of air pollution control. With such public awareness, the compliance toward the legislations on air pollution control will run effectively. Public participation is also a form of society control which may help to ensure that the action points taken to control air pollution have been run accordingly.

In policy making, the government as a decision maker should encourage pro-public-patterned policies by considering the aspirations of the people and address the issues related to the public interest. For example, in the transportation policy, the increasing number of users of private vehicles (e.g. motorcycles and cars) is indirectly caused by the government's lack of response to the problems of public transportation. The issue of public transportation which has never been addressed accordingly causes many people to turn to private vehicles and ultimately leads to a worsening traffic jam and wasted fuel. This will eventually increase air pollution in the city.

The management of public complaints and dispute resolutions related to air pollution also need to be considered in the context of air pollution control. A well-managed and transparent management of complaints and dispute resolutions will lead to better public participation and constitutes a good feedback for the government policies that have been implemented.

In order to encourage public participation, the information related to the planning, decision making and implementation of public policy should be made accessible for the public. So far, the issue of the access to the information remains a significant constraint in the process of policy-making, and as such, the public has not been actively participated yet to the extend of public control level.

E. **Global Partnership Development**

The issue of air pollution is a global issue that has implication with international responsibility. The principle of sharing the burden of responsibilities should be encouraged internationally in efforts to control air pollution. This principle has been adopted in 1992 Rio de Janeiro Summit on Sustainable Development reaffirmed in the World Summit Sustainable Development (WSSD) in Johannesburg 2002. Global partnership development based on the fact that environmental problems cannot only be approached on a national level, but on an international level especially since there are industrial countries that have the technology as well as being the world's largest energy consumers that have contributed to air pollution problems.

Global partnership development at least should be encouraged to address the funding issues related to air pollution control programs especially for developing countries. These funding issues should be resolved fairly so in a long term it will not cause environmental impact on developing countries.

9.4. Towards the Euro 4 Standards in Indonesia

Indonesia's current condition is in EURO II which for diesel fuel passenger car contains 1.0 gr/km CO pollutant, 0.70 gr/km HC.Nox, and 0.08 gr/km particulate. Gasoline fuel passenger car contains 2.2 gr/km CO pollutant and 0.5 gr/km Hc.Nox. As for diesel fuel light commercial vehicle contains 1.0 - 1.5 gr/km CO pollutant, 0.7 – 1.2 gr/km Hc.Nox, and 0.08 – 0.17 gr/km particulate. Gasoline fuel light commercial vehicle contains 2.2 – 4.0 gr/km CO pollutant, 0.65 – 0.8 gr/km Hc.Nox, and zero particulate.

Table 48. European Union's Standards on Exhaust Emission for Passenger Car (gr/km)

Level (Euro)	Year	CO	HC	$HC.NO_x$	NO_x	PM
Diesel						
Euro I	1992	2.72	-	0.97	-	0.14
Euro II-IDI	1996	1.0	-	0.70	-	0.08
Euro II-DI	1996 - 99	1.0	-	0.0	-	0.10
Euro III	2000	0.64	-	0.56	0.50	0.05
Euro IV	2005	0.50	-	0.30	0.25	0.025
Gasoline						
Euro II	1996	2.2	-	0.50	-	-
Euro III	2000	2.3	0.2	-	0.15	-
Euro IV	2005	1.0	0.1	-	0.08	-
(-) not regulated; IDI indirect injection; ID direct injection						

Source: Cononse 1997

Table 49. European Union's Standards on Exhaust Emission for Light Commercial Vehicle (gr/km)

Class	Level (Euro)	Year	CO	HC	$HC.NO_x$	NO_x	PM
Diesel							
1	I	1994	2.40	-	0.97	-	0.14
	II-IDI	1998	1.0	-	0.70	-	0.80
	II-DIa	1998	1.0	-	0.90	-	0.1
	III	2000	0.64	-	0.56	0.50	0.05
	IV	2005	0.50	-	0.30	0.25	0.025
2	I	1994	5.17	-	1.4	-	0.19
	II-IDI	1998	1.25	-	1.0	-	0.12
	II-DIa	1998	1.25	-	1.3	-	0.14
	III	2002	0.80	-	0.72	0.65	0.07
	IV	2006	0.63	-	0.39	0.33	0.04
3	I	1994	6.9	-	1.7	-	0.25
	II-IDI	1998	1.5	-	1.2	-	0.17
	II-DIa	1998	1.5	-	1.6	-	0.2
	III	2002	0.95	-	0.86	0.78	0.1
	IV	2006	0.74	-	0.46	0.39	0.06
Gasoline							
1	I	1994	2.72	-	0.97	-	-
	II	1998	2.2	-	0.5	-	-
	III	2000	2.3	0.2	-	0.15	-
	IV	2005	1.0	0.1	-	0.08	-
2	I	1994	5.17	-	1.4	-	-
	II	1998	4.0	-	0.65	-	-
	III	2002	4.17	0.25	-	0.18	-
	IV	2006	1.81	0.13	-	0.10	-
3	I	1994	6.9	-	1.7	-	-
	II	1998	5.0	-	0.8	-	-
	III	2002	5.22	0.29	-	0.21	-
	IV	2006	2.27	0.16	-	0.11	-

(IDI) indirect injection; (ID) direct injection; (-) not regulated
Note: Euro I and II, 1st class (<1250 kg), 2nd class (1250-1700 kg), 3rd class (>1700 kg). Euro III and IV, 1st class (<1305 kg), 2nd class (1305-1760 kg), and 3rd class (>1760 kg).
Source: Dieselard Undatel

Euro 4 Standard Application Opportunities in Indonesia *Box*

The enforcement of Euro 2 standards for new vehicles in 2005 was initially doubtful considering the fuel availability, especially diesel fuel that was found containing HC of more than 500 ppm. However, in line with the commitment of all stakeholders and the opening of private sector's role in the provision of fuel, supplying quality fuel tend to be not a problem anymore in a few cities and provinces in Indonesia.

In accordance with the issue and problem of quality fuel availability, the National Government has begun to put this issue on a bigger level, which is supporting the movement of efficiency - saving - and development of alternative energy as its response and role in environmental and climate change issues. For instance, national energy policy (Perpres No.5 Tahun 2006), the provision and utilization of bio diesel fuel (biodiesel) as alternative fuel (Inpres No. 1 Tahun 2006), and energy savings (Inpres No. 10 Tahun 2005). All of those policies are essentially an attention toward the issue of fuel crisis and to provide opportunities on the development of alternative energy.

In its development, the implementation of those policies has been translated through a program plan to restrict the use of subsidized fuel for private vehicles. Long before, the Ministry of Transportation also facilitated the implementation support through providing fuel for 3.400 public-transportation vehicles in Jakarta and Surabaya. Other policies regarding the issue are the development of biodiesel production; and the diversification and conservation of other energy policy.

From the perspective of air pollution issues and problems that comes from motor vehicles, the quality and the use of environmentally-friendly fuel greatly affected the air quality, considering that transportation sector is the biggest consumer of fuel. Therefore, in order to reduce air pollution from this sector, the idea to apply Euro 4 standards on vehicles is being raised. This proposal is very understandable when people are faced by choices of quality fuel through the supply of gasoline and diesel provide by many oil companies, including Pertamina by selling gasoline called Pertamax and Super Pertamax, also Pertadex for diesel which the specifications has met Euro 4 standards quality.[5]

Mr. Ridwan Tamin, the Deputy Assistant on Vehicle Emission in the Ministry of Environment, stated that the plan towards the implementation of Euro 3 and 4 should be integrated with the fuel quality and the vehicle technology, regional harmonization.[6] This means that the needs of vehicle technology would follow the fuel availability and quality to meet the customer satisfaction. Based on a research, several car manufacturers in Indonesia have expressed their readiness and prepared strategies if their automotive industry policy is required to use the Euro 4 standards.

As the institution responsible for setting emission standard, the Ministry of Environment is required to come up with a new policy which is based on the reason above, as well as other operational technical support such as the use of testing method refers to ECE standards. Coordination with the Ministry of Transportation is a critical step, since it is the party responsible for the roadworthy test.

The emergence of this idea should be supported through socialization step to other Ministries, such as the Ministry of Industry, the Ministry of Energy and Mineral Resources, the Ministry of Transportation, and the Ministry of Finance. The inclusion of Indonesia into Euro 4 standard has become opportunity to create market in countries that have set the Euro 3 and 4 standards in its automotive industry markets. As a note, Indonesia has been able to produce 7.3 million unit of two-wheeled vehicles per year (the average local content is approximately 90-95%). It means for this case, Indonesia is nearly not depending on overseas production.

Other opportunities, the implementation of Euro 4 standards has become a promotion tool to promote environmentally-friendly vehicles through market mechanism and as the incentive for automotive industry to produce environmentally-friendly vehicles (*Ridwan D. Tamim*). In the free market era, automotive industry plans should be synergized with technology development, the ability of producers, the ability and the needs of consumers, the work safety and health, also the environmental management.

[5] In Europe, the implementation of Euro 4 standards was started in 2005.
[6] Ridwan D. Tamin. Deputy Assistant on Vehicle Emission, the Ministry of Environment. Round table Discussion: Overview on the Application Preparation of Euro II Standards on New Type Vehicles in 2005. Borobudur Hotel Jakarta, 15 Desember 2004.

9.5. The Strategy Towards EURO 4

The first step that Indonesia should take to achieve Euro 4 target is **improving the quality of oil fuel**. For diesel fuel, only two oil refineries which are in Dumai and Balongan that has fulfilled Euro 4 specification in the production. Other refineries are only able to reach Euro 2 quality. The need for investment to improve the quality of oil refineries up to Euro 4 will cost 800 to 1400 million USD (8 to 14 trillion IDR). Compared with the national budget on subsidized fuel in 2010 that reached 89 trillion IDR, the value to improve fuel quality in Indonesia by upgrading the refineries is only 11% of the budget allocation.

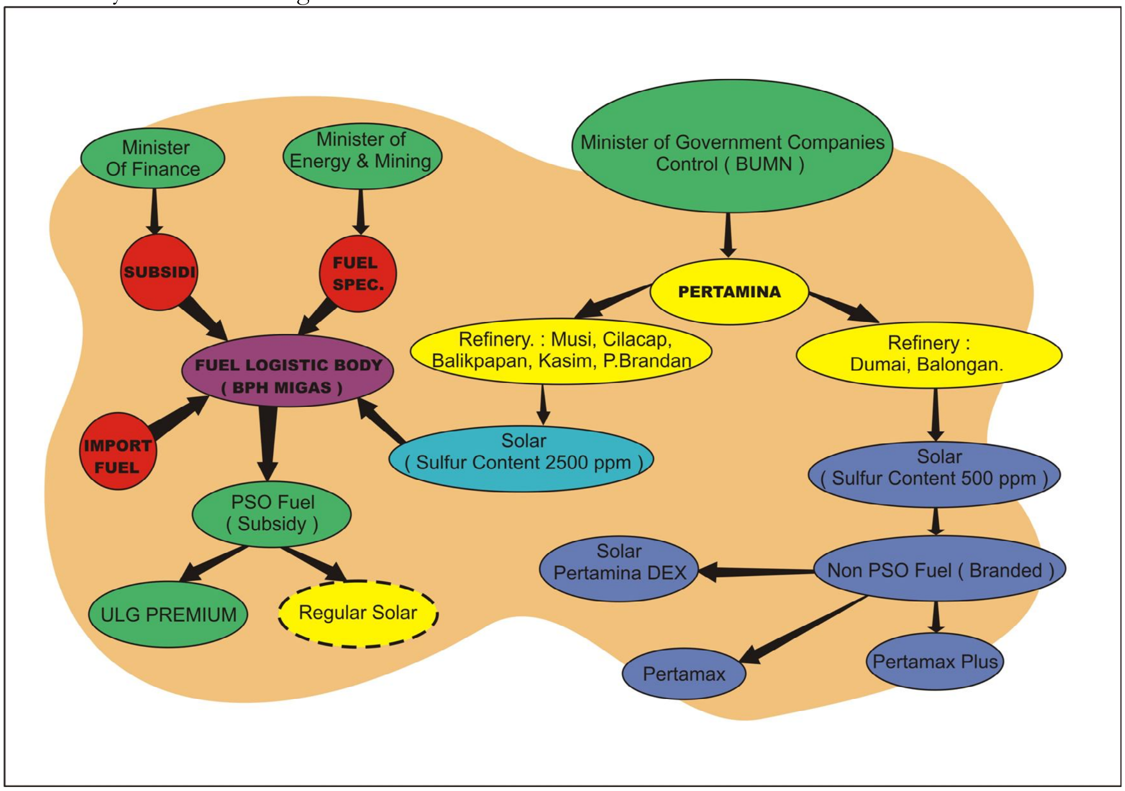


Figure 29:

The figure below explains the relation between sectors on fuel provision in Indonesia. There are two Ministries and a state-owned enterprise (BUMN) directly related in this case. The Ministry of Finance is responsible for the subsidy aspect, while the Ministry of Energy and Mineral Resources in charge of constructing the specification of fuel produced and traded. Pertamina has a function as business entity that provides fuel supply in Indonesia.

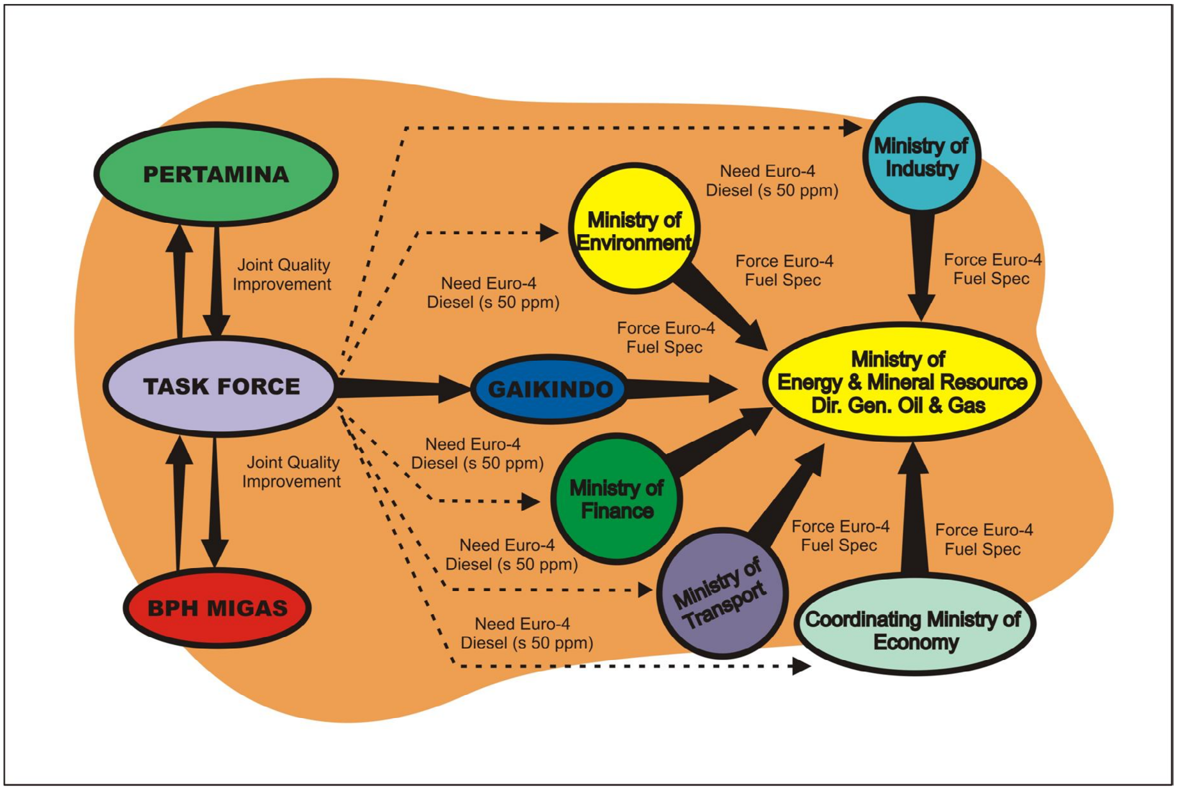


Figure 30:

Regulatory rules are required so that policies toward Euro 4 can be achieved. First is **to revise the Decision of General Director of Oil and Gas (Kep. Dirjen Migas)** No.3674K/24/DJM/2006 on standards and quality (specification) of gasoline type fuel that is sold in the country; and Kep. Dirjen Migas No.3675 K/24/DJM/2006 on standards and quality (specification) of diesel type fuel that is sold in the country. Next, is **to revise PP No. 41** on Air Pollution Control so that it includes more strict provisions on the quality standard of emission and the exhaust emission limit. The criteria listed in the article such as the dominant and critical parameter; the quality of fuel and raw materials; and the existing technology, should be changed so the technology could conform to the standards applied. A **Presidential Regulation (Peraturan Presiden) is worth considering** if that could accelerate the process towards Euro 4 (learning from the difficulties faced in Euro 2).

Many stakeholders associated with the plan to achieve Euro 4 require **the formulation of multi-sectoral task force** which serves to review, communicate between sectors, and recommend policies that can be implemented and measured. The figure below explains the linkages between sectors in achieving Euro 4.

9.5.1. Vehicle maintenance strategy

Vehicles that are not maintained well is producing 80% of emission. The measures to be taken such as:

1. Differentiating the treatment on different group of vehicles such as old vehicles, trucks, and buses.
2. Developing workshop equipments used for testing and repairing.
3. In certain cases, early scrapping is needed to be encouraged.

9.5.2. Fuel standardization strategy

An appropriate fuel standard for a State does not depend on the air pollution level being set.

1. The main priority is to achieve unleaded fuel.

2. The sulfur content in gasoline should be as low as possible reaching 500 ppm.
3. The sulfur content in diesel to be pursued up to 2000 – 3000 ppm level.
4. Promote gas fuel as substitution for diesel used in public transportation.

9.5.3. Vehicle standardization strategy

Vehicle standardization is a complement of fuel standards.
1. Emission standard for new vehicles is to be increased to the level suitable for expected fuel quality.
2. Emission standard in two-stroke engine should be differentiated with four-stroke engine.
3. The installation and maintenance of catalytic converter in gasoline fuel vehicle have to be done on a continuous basis.
4. Introducing particulate filtering and other tools to reduce emissions from diesel vehicles.

9.5.4. Vehicle inspection and maintenance strategy

An effective vehicle inspection program is necessary so the standard implementation could as well be effective.
1. Modern vehicle testing center, an automaton with a simple and independent procedure can be very effective.
2. An incentive scheme to encourage scrapping on high-polluting vehicle should be considered.
3. Education campaign is necessary to increase the maintenance of two-stroke vehicles.

9.5.5. Institutional development strategy

A right institution is required to ensure a consistent and integrated transportation and environmental policy.
1. An effective air quality monitoring institution should be built in major cities with adequate authority and facilities.
2. An institution to administer and enforce emission standard compliance law should be established with the primary task of identifying and reducing polluting vehicles operating on the road.

9.5.6. Law enforcement strategy

Penalties for law violators need to follow the existing legal rules to function effectively.
1. To prevent the entry of low-quality fuels from neighboring countries.
2. To prevent the import of high-polluting vehicles.
3. To ensure that the testing center follows the correct procedures.

10. Coclusion and Recommendation

- A policy evaluation is needed by government when they want to issue a regulation, particularly if that proposed policy will affect market prices, import duties, taxes, subsidies or other charges imposed on production and distribution process.
- Base on the costs-benefits and effectiveness analysis, the scrapped old vehicle policy has the largest of net economic benefit and potential subsidy saving, however its not viable policy in near future due to equality issue and required an expensive cost to compensate it.

- The second policy options to introduce fuel efficiency standard is the most rational choice and best option as it result the greatest net economic gain and fuel saving. However this option is not the most cost-effectiveness to reduce emission.
- The next best option is to provide public transportation. Although this policy largely depend on people behavior but this research shows the result as the third greatest of net economic gain and fuel saving. Furthermore, this policy is among the best of cost-effectiveness to reduce emission.
- The policy is the most cost of effectiveness means it provide estimated smallest cost needs to lower emission per million tonne. The use of CNG for transportation and the introduction of hybrid technology are among the lowest cost to reduce emission. However both of them have some darwbacks related to avalaibility of gas supply and expensive cost of gas converter and hybrid technology.
- The different of net economic benefit to faster implementation of Euro 4 at 2016 compare to implement Euro 4 at 2020 is large and imply the higher benefits of increased air quality imply health care cost savings, the lower cost of subsidies and the larger potential reduction in production costs. Therefore, government may consider this exercise in designing roadmap of standard emission in Indonesia.
- The second option of introduction of fuel efficiency standards demonstrate a relatively small degree of risk in terms of economic benefits and savings subsidies. Its sensitivity is relatively stable output with respect to social discount rate, health cost savings, and vehicle kilo travelled. Its relatively easier to implement than the politically and fiscal policy than others.

8. Prior the Next Steps

5. Timely to improve fuel quality by up grading fuel refineries with possibility through modification and or new design/construction matter, as prepartion and precondition to implement Policy Option 1, and 9.

6. To implement fuel efficiency policy in term to reduce fuel consumption, and CO2 emissions, by conducting action as follow:
   e. Labelling the fuel economy standard (labelling to the fuel quality standard which are comply to fuel economy vehicle): Part of public campaign/education to accelarate Policy Option 1, and 9)
   f. Labelling the fuel economy vehicle: Part of public campaign/education to accelarate Policy Option 1, and 9)
   g. Policy reformulation on fuel quality and fuel economy (Option 1 and 9):
      - Polcy Dialog on Set up Fuel Economy Standard (Fuel and Vehicle)
      - Fuel Quality Standard for Euro 4 by 2016 with possibility to proposed Euro 5 by 2016 with consideration within investment cost is insignificant.
      - Fuel Economy Vehicle Standard (Euro 4) by 2016
      - Fuel Economy Vehicle Standard (Euro 5) by 2022
      - Policy Drafting on Fuel Economy Standard (Fuel and Vehicle) refer to the result of Policy Dialog
      - Issuing the Policy on Fuel Quality and Fuel Economy
   h. Set up Fuel Efficiency Roadmap (Option 2)

7. To conduct Policy Dialog on acceleration to achieve the most optimal national fuel efficiency targets by addopting anothers 6 of 9 policy options:
   c. Appropirate fiscal incentives

   a. Tax differentiation with possibility of tax exemption for lower emission vehicles with better fuel economy
   b. Tax differentiation with possibility of tax exemption for vehicles comply with higher/ advanced EURO standards
   c. Incentives for consumers to use higher/ better fuel quality (lower charge or exemption for registration tax/ annual vehicle tax/carbon tax)
d. Non fiscal incentive:
   a. Trade in or financial incentive to regenerating car ownership with advance/lower emission and better fuel economy
   b. Contracyclical policy
   c. Monetery policy:
      - The credit scheme for car ownership
      - Interest rate of car ownership credit scheme

8. To strengthen National Stakeholder Forum to escort policy reformulation, and its implementation.

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Appendix

Table 50. Appendix 1. Incremental Cost for Euro 4

Vehicle	Assumption	1 A$= IDR 7500		
	Passenger Cars	Buses	Trucks	Motor Cycles
Euro3-Euro4	Rp2,437,500	Rp2,690,625	Rp48,750,000	Rp 1,000,000
New Technology	Rp4,800,000	Rp5,181,944	Rp21,500,000	Rp 1,000,000

Sources: Calculated based on Coffey, 2005

Table 51. Appendix 2. Australian Refinery Cost

Assumption 1 AUD=Rp 7500 Fuel Quality Improvement	Average Cost Estimate Capital (Rp Billion/Refinery)	Operating (Rp/L)	Capital Op Cost (Rp/L)	Standard
Octane Enhancement	563		Rp90	Euro 2
35% Aromatics	863	Rp26	Rp90	Euro 2
50ppm S in PULP	255	Rp36	Rp75	Euro 3
10ppm S in PULP	600	Rp49	Rp143	Euro 4
10ppm S in Diesel	150	Rp30	Rp5397.5	Euro 4

Table 52. Appendixe 3. Adopted Emission Factors (g/km) at 80,000 km

Vehicle Category	Year	Standard	CO	Nox	HC	PM
Passenger Car-Petrol	< 2005	Euro0	2.1	0.62	0.26	0.028
(75% of Total)	2005	Euro2	1.18	0.25	0.25	0.0007
	2015	Euro3	1.06	0.15	0.2	0.0007
	2020	Euro4	0.71	0.08	0.1	0.0007
Passenger Car-Diesel	< 2005	Euro0	1.675	0.74	0.465	0.23
(25 % of Total)	2005	Euro2	0.26	0.54	0.06	0.08
	2015	Euro3	0.21	0.405	0.055	0.053
	2020	Euro4	0.16	0.27	0.05	0.025
Buses	< 2005	Euro0	8.6	15.4	2.74	0.94
	2005	Euro2	3.49	9.35	2.38	0.32
	2015	Euro3	0.82	3.13	0.36	0.12
	2020	Euro4	0.6	3.13	0.25	0.024
Truck	< 2005	Euro0	9.97	17.07	2.05	1.12
	2005	Euro2	2.63	8.15	0.64	0.21
	2015	Euro3	2.2	8.15	0.64	0.21
	2020	Euro4	1.61	6.71	0.64	0.064
Motor Cycle	< 2005	Euro0	2.1	0.62	0.26	0.028
	2005	Euro2	1.18	0.25	0.25	0.0007
	2015	Euro3	1.06	0.15	0.2	0.0007
	2020	Euro4	0.71	0.08	0.1	0.0007

Sources: Adopted from Coffey,2005

Table 53. Appendixe 4. Pertamina's fuel improvement plan

Year	2008-2010	2011-2015	2016-2020	2021-2025
Fuel standard	Euro 2	Euro 3	Euro 3	Euro 4
Gasoline	Produced by all refineries	Produced by Cilacal & Kasim	Produced by all refineries	Produced by all refineries
Diesel	Produced by Dumai & Balongan	Produced by all refineries		No plan
Investment required	New additional refinery w/ capacity 300 MBCD: - Gasoline: 4,716,000 kL - Diesel: 2,354,000 kL	Additional desulphurization unit	Additional benzene splitter unit, desulphurization unit, selective hydrogen unit	Additional selective hydrogen unit, desulphurization unit
Domestic production:				
Gasoline - kL/yr	47,151,787	89,953,870	94,990,184	94,990,184
Diesel - kL/yr	57,307,712	89,948,102	92,302,102	92,302,102
Domestic demand:				
Gasoline - kL/yr	69,556,681	94,930,781	105,481,408	119,522,922
Diesel - kL/yr	68,863,947	96,104,693	111,039,180	130,211,966
Improted fuels:				
Gasoline - kL/yr	22,404,894	4,976,911	10,491,224	24,532,738
Diesel - kL/yr	11,556,236	6,156,592	18,737,079	37,909,864

Source: Pertamina, 2008

Table 54. Appendixe 5. Emission Reduction (Milion tonnes)

Option 1					**Option 4**				
Year	**CO**	**NO**	**HC**	**PM**	**Year**	**CO**	**NO**	**HC**	**PM**
2008-2010	0	0	0	0	2008-2010	0	46	0	0
2011-2020	3,802	2,726	899	300	2011-2020	3,475	5,637	899	227
2021-2030	8,297	5,562	1,977	603	2021-2030	7,830	8,841	1,977	510
Total	12,099	8,288	2,876	903	Total	11,305	14,525	2,876	737
Percentage Reduction	***21.36***	***11.38***	***21.47***	***37.07***	***Percentage Reduction***	***19.95***	***19.95***	***21.47***	***30.24***
Option 2					**Option 5**				
Year	**CO**	**NO**	**HC**	**PM**	**Year**	**CO**	**NO**	**HC**	**PM**
2008-2010	225	343	55	10	2008-2010	0	0	0	0
2011-2020	5,012	4,537	1,181	333	2011-2020	5,048	4,813	1,199	331
2021-2030	9,830	7,766	2,318	626	2021-2030	11,122	10,560	2,661	654
Total	15,067	12,647	3,555	969	Total	16,170	15,373	3,860	984
Percentage Reduction	***26.59***	***17.37***	***26.53***	***39.78***	***Percentage Reduction***	***28.54***	***21.11***	***28.82***	***40.39***
Option 3					**Option 6**				
Year	**CO**	**NO**	**HC**	**PM**	**Year**	**CO**	**NO**	**HC**	**PM**
2008-2010	7	6	0	0	2008-2010	0	0	0	0
2011-2020	3,867	2,784	899	302	2011-2020	3,808	2,728	900	300
2021-2030	8,507	5,737	1,977	607	2021-2030	8,326	5,568	1,981	604
Total	12,380	8,526	2,876	909	Total	12,134	8,296	2,881	904
Percentage Reduction	***21.85***	***11.71***	***21.47***	***37.33***	***Percentage Reduction***	***21.42***	***11.39***	***21.51***	***37.09***

Source : Author Calculation (2012)

Vehicle Emission

1. Calculation of motor vehicles emissions

Various types of data, namely population, types or categories: passenger vehicles, light trucks and buses (2.2 – 4.5 tons), medium trucks and buses (4.5 – 15 tons), heavy trucks and buses (15 – 22 tons) and motorcycles; these categories represent engine displacement (cc), are needed to calculate total motor vehicles emissions that have local (CO, VOC, NOx, particles), regional (SOx) and global (CO_2) impacts. Other categories include engine types, such as diesel or petrol and four stroke or two stroke. The combustion technology, the treatment of post-combustion exhaust gas (Euro, Tier, Hybrid), and the vehicle operation (Euro, FTP) are also considered. The last one is the type of fuel (WWFC categorization, alternative fuel: Bioethanol, Biodiesel). These data affect the amount of emission. In this report, UNEP/TNT Toolkit for Clean Fleet Strategy Development software is used to calculate the amount of total emission mentioned above. Besides, the impact of air pollutants can also be determined, particularly health implications from particulates, impacts on climate change and a compensation in the form of planting a number of trees in a certain amount of land surface area or paying "Certified Emission Reduction" (CER) in a certain amount. Effects of reducing air pollution, reducing CO_2 emissionsand saving fuel from follow-up actions such as eco-driving, maintenance, better quality fuel and alternative fuel mentioned above, treatment of post-combustion exhaust gas (diesel oxidation catalyst and diesel particle filter) and new vehicles (Euro V diesel trucks, hybrid electric vehicles with emission control, compressed natural gas (CNG) with emission control and fuel cell with renewable hydrogen).

2. Vehicle types and quantity inventory

Inventorizing the types and quantity of vehicles faces a difficulty in obtaining comprehensive data as needed by the software. The available data is in categories: passenger cars, buses, trucks, motorcycles up to the year 2006. As mentioned above, the software needs more data than what is available. Therefore, the categories are streamlined into passenger cars, medium trucks and buses (4.5 – 15 tons) and motorcycles (assuming four-stroke engine for all). However, as there is only Premium (petrol) and Solar (diesel) usage data from the year 2003, the vehicle inventory is for that year.

Table 55. Types and population of vehicles in Indonesia in 2003

Vehicle Category	Combustion technology and treatment of post-combustion exhaust gas	Number of vehicles (unit)
Passenger cars	Without catalyst	3,885,228
Medium trucks and buses (4.5 - 15 tons)	Pre-Euro	2,845,101
Motorcycles	Four-stroke engine	19,976,376
Total		**26,706,705**

3. Inventorizing fuel types, total annual fuel consumption, total annual kilometers, average annual kilometers per vehicle and average fuel efficiency

Inventorizing the amount and types of fuel faces the same difficulty in obtaining a comprehensive data as needed by the software. The available data is only monthly Premium and Solar transportation consumption data for a year. The recent and complete data is only for the year 2003. Besides, Premium consumption data for motorcycles is not available either. Therfore the calculations involve assumption and estimation. The first assumption is that the average daily travel of a motorcycle is 33.3 km and the fuel consumption estimation – which is acquired from a table provided in the software – is 1 liter for 33.3 km. Using the second assumption which declares that a motorcycle operates 300 days in a year, the total annual motorcycle consumption of Premium can be calculated. Therefore, the total annual consumption of Premium for passenger cars equals the total annual transportation consumption of Premium that is subtracted by the total annual motorcycle consumption of Premium.

Table 56. Fuel types, total annual fuel consumption, total annual kilometers, average annual kilometers per vehicle and average fuel efficiency in 2003

Vehicle category	Total annual fuel consumption (L/year)	Total annual kilometers (km/year)	Average annual kilometers per vehicle (km/year)	Average fuel efficiency (km/L)
Passenger vehicles	8,409,797,200	99,235,606,960	25,542	11.8
Medium trucks and buses (4.5 - 15 tons)	11,946,017,000	3,063,081,282	1,077	0.3
Motorcycles	5,992,912,800	199,563,996,240	9,990	33.3
Total	**26,348,727,000**	**301,862,684,482**		

4. Calculation resultsof exhaust gas emission

These software calculation results are an estimate and merelygive indications (especially those concerning air pollution). Local conditions affect emissions, including driving condition, fuel quality, vehicle standard, maintenance and altitude. However, CO_2 emissions are not influenced by local conditions and consequently can be used as the definiteemission. These calculations are based on emission factors from a study by the University of California, Riverside and UNEP in Nairobi (IVE model 1. 1. 1a).

Table 57. Emissions of vehicles in Indonesia in 2003

Particular			Air Pullution (ton/year) Polusi udara (ton/tahun)					Climate change (ton/year)
	Quantity	**km/year**	**CO**	**VOC**	**NOx**	**SOx**	**PM10**	**CO_2**
Pasenger cars	3,885,228	99,235,606,960	5,259,487.2	877,242.8	250,073.7	4,961.8	992.4	19,763,023
Medium trucks and buses (4.5 - 15 tons)	2,845,101	3,063,081,282	26,311.9	5,054.1	46,957.0	2,113.5	2,052.3	31,059,644
Motorcycles	19,976,376	199,563,996,240	3,193,023.9	997,820.0	197,568.4	3,991.3	41,908.4	14,083,345
Total	**26,706,705**	**301,862,684,482**	**8,478,823.0**	**1,880,116.8**	**494,599.1**	**11,066.6**	**44,953.1**	**61,919,508**

5. Consequences of air pollution and climate change

If the air pollution from 44,953.06-ton-per-year particulate matter were to be emitted to the Netherlands, it would cause an estimated 17,981.2 early deaths per year. Impacts on climate change from CO_2 emissions can be compensated by planting trees. Estimated tree-planting equivalent of one ton of CO_2 is between one and seven trees for as long as the trees' life. The number of the compensating trees depends on climate, rainfall, species and soil type. With a total of 61,919,508 tons per year of CO_2 emission, 61,919,508 to 433,436,559 trees need to be planted in order to compensate. This needs an area of 281,452 ha to 562,905 ha. Another form of CO_2 emission compensation is the "Certified Emission Reduction" (CER). With the assumption of CER rate of 15 EUR per ton of CO_2 for the year 2008, 928,792,627 EUR per year is needed if 100% of the CO_2 emission is to be compensated for.

6. Impacts of air pollution reduction, CO_2 emission reduction and fuel saving actions

Table 58. Impacts of air pollution reduction, CO_2 emission reduction and fuel saving

	Option	Air pollution reduction	CO_2 emission reduction	Fuel saving
Driving & maintenance	Optimal tire pressure &wheel alignment	2 - 4%	2 - 4%	2 - 4%
	Maintenance improvement	~ 20 %	~ 7 %	~ 7 %
	Eco-driving	5-10 %	5-10 %	5-10 %
Fuel	Unleaded petrol utilization	Removes lead particles	None	None
	Ultra-low-sulfur diesel fuel utilization Penggunaan bahan bakar diesel belerang ultra rendah	Reduces SOx and ultra-fine particles Menurunkan SOx dan partikel ultra halus	None	None
	Biodiesel (maximum mix)	Removes SOx	~ 60 % (life cycle emissions)	None
	Bioethanol (maximum mix)	0 – 5 % depends on vehicle's technology	~ 60 % - 65 % (life cycle emissions)	0 – 5 %
Old vehicle	Diesel oxidation catalyst Katalis oksidasi diesel	20-60 % depends on pollutant type	None	None
	Diesel particulate filter Filter partikulat diesel	50-90 % depends on pollutant type	None	None
New vehicle	Euro V diesel truck	~90 % compared to pre-euro	None compared to diesel, 15 % compared to petrol Tidak ada dibandingkan diesel, 15 % dibandingkan bensin	None compared to diesel, 20 % compared to petrol Tidak ada dibandingkan diesel, 20 % dibandingkan bensin
	Hybrid Electric Vehicle (HEV) with emission control	>90 % compared to pre-euro	25 – 35 %	25 – 35 %
	CNGwith emission control	>90 % compared to pre-euro	5 – 10 %	Increases by 10 %
	Fuel Cellwith renewable hydrogen	99 % compared to pre-euro	100 %	~50 %

Eco driving can save 5 % to 10 % or 1,317,436,350 liters to 2,634,872,700 liters of diesel and petrol fuel annually. If the subsidized fuel price of Premium and Solar is Rp. 4,500,-, the annual saving from fuel cost is Rp. 5,928,463,575,000.- to Rp. 11,856,927,150,000.-. CO_2 reductionis 3,245,301 tons to 6,490,601 tons per year.

Proper maintenance can save 4 % to 7 % or 1,053,949,080 liters to 1,844,410,890 ofdiesel and petrol fuel per year. The annual fuel-cost saving from subsidized price is Rp. 4,742,770,860,000.- to Rp. 8,299,849,005,000.-. CO_2 reductionis 2,596,241 tons to 4,543,421 tons per year.

Reducing sulfur concentration in diesel fuel from 5,000 ppm – which emits 11,066.6 tons of SOx per year – to 500 ppm reduces SOx emission to 1,106.66 tons per year or decreases by 90 %. By lowering it further to 50 ppm, the SOx emission is reduced to 110.67 tons per year or decreases by 99 %. Choosing low-sulfur diesel fuel also reduces fine particle (PM10) and ultra-fine particle (PM2.5) emissions.

Vegetable fuel mixture can also reduce CO_2 emissions. In low concentration, for example biodiesel 10 % (B10) or bioethanol 10 % (E10), the CO_2 emission decreases from 61,919,508 tons per year to 58,823,533 tonsto 55,727,558 tons per year.This is equal to 3,095,975 tonsto 6,191,951 tons of CO_2 reduction per year or a 5 % to 7 %reduction. A high-concentration vegetable oil, such as biodiesel 100 % (B100) or bioethanol 85 % (E85), can reduce the CO_2 emission to 27,863,779 tons to 0 ton per year. In other words, the CO_2 emission is reduced by 34,055,730 tons to 61,919,508 tons per year or 55 % to 100 % per year.

Old diesel vehicles in Indonesia are mostly pre-Euro and run on diesel fuel that contains more than 500 ppm of sulfur. Therefore, they cannot be retrofitted with a diesel oxidation catalyst – which requires less than 500 ppm of sulfur. Diesel particulate filter has even higher requirements, which are Euro III and less than 50 ppm of sulfur. As a result, most of the old diesel vehicles cannot utilize both particulate-reducing technologies mentioned above.

Replacing petrol-fueled vehicles with light diesel vehicles opens the possibilities of reducing CO_2 emissions because one liter of diesel fuel emits 11 % more than petrol fuel (2.6 kg/L CO_2 for diesel fuel compared to 2.35 kg/L CO_2 for petrol fuel). However, diesel vehicles emit 25 % less compared to equivalent petrol vehicles. Nevertheless, old diesel vehicles emit much more particles compared to petrol vehicles of comparable size and age. When switching to a diesel vehicle, make sure to choose modern diesel vehicle with low particle emission (Euro IV, Euro V or equipped with a diesel particle filter). Low-sulfur diesel fuel (<500 ppmat least) is required for these models. As we know already, sulfur concentration in diesel fuel in Indonesia is still >500 ppm.
Switching from conventional vehicles to hybrid electric vehicles (HEV) can improve the fuel economy up to 19.6 km/L according to US EPA's data and depends on driving cycle (Toyota Prius). HEV is estimated to be Rp. 20,000,000.- more expensive. The calculation results can be reviewed in table 59 below.

Table 59. Switching from passenger cars to HEV

	Petrol passenger vehicles	Passenger HEV
Quantity (unit)	3,885,228	3,885,228
Total kilometers (km/year)	99,235,606,960	99,235,606,960
Fuel consumption (L/year)	8,409,797,200	5,063,041,171
Cost (Rp/year)	37,844,087,400,000	22,783,685,271,429
CO_2emission (ton/year)	19,763,023	11,898,147

Rp. 15,060,402,128,571.- per year can be saved from the fuel cost. It is equal to 40 % of the cost of petrol passenger vehicles. CO_2 emission is reduced by 7,864,877 tons per year, or 40 % compared to petrol vehicles. This means a 2.2 ton reduction of CO_2 emission per year and fuel-cost saving of Rp. 3,876,324.- per year for each car. Thus, the over-investment for HEV can return within approximately 5.2 years. In addition, HEV emits less PM and other air pollutants compared to conventional passenger vehicles. HEVs are a little more expensive, but the return for the over-investment can be earlier. This depends on the number of kilometers per year as well as the fuel price.

The scenario of replacing all pre-Euro III trucks and buses with HEV or CNG vehicles or Euro V trucks and buses is also calculated. HEV trucks and buses are assumed to reduce fuel consumption and CO_2 emission by 30 %. CNG trucks and buses are assumed to reduce CO_2 emission by 5 % while Indonesian data is still needed to estimate the fuel-cost savings. Switching to Euro V trucks and buses basically does not reduce fuel consumption. However, as new vehicles are generally more fuel efficient, it is assumed that Euro V vehicles are 5 % more efficient than pre-Euro III vehicles. Euro V vehicles need low-sulfur fuel. HEV and CNG vehicles are assumed to meet the Euro V standards. The calculation results can be reviewd in table 60.

Table 60. Switching from pre-Euro III trucks and buses to HEV, CNG and Euro V vehicles

	Pre-Euro III trucks and buses	**Switched toHEV**	**Switched to CNG**	**Switched to Euro V**
Quantity (unit)	2,845,101	2,845,101	2,845,101	2,845,101
Total km (km/year)	3,063,081,282	3,063,081,282	3,063,081,282	3,063,081,282
Diesel fuel consumption (L/year)	11,946,017,000	8,362,211,900	n/a	10,751,415,300
Fuel cost (Rp/year)	53,757,076,500,000	37,629,953,550,000	Unknown	48,381,368,850,000
Fuel-cost saving (Rp/year)	n/a	5,668,383	Unknown	1,889,461
CO_2emission (ton/year)	31,059,644	21,741,751	29,506,662	27,953,680
PMemission (ton/year)	2,052.26	123.14	123.14	123.14

Table 61. IO Code

Sector Code	Sector Description	Backward		Forward	
		Type I	Type II	Type I	Type II
1	Paddy	1.34	1.92	2.60	5.21
2	Corn	1.33	1.82	2.32	3.06
3	Cassava	1.19	1.55	1.33	1.65
4	Sweet potatoes	1.08	1.44	1.05	1.11
5	Other cassava and potatoes	1.17	1.62	1.18	1.47
6	Nuts	1.22	1.68	1.21	1.38
7	Soybean	1.31	1.94	1.25	1.35
8	Other nuts	1.23	1.63	1.13	1.17
9	Vegetables	1.20	2.13	1.41	2.24
10	Fruits	1.15	1.60	1.77	3.41
11	Other foods	1.26	1.69	1.22	1.27
12	Rubber	1.45	2.91	2.44	2.54
13	Sugar Cane	1.41	2.42	2.22	2.40
14	Coconut	1.30	1.95	1.79	2.00
15	Palm Oil	1.51	2.40	1.63	1.88
16	Fiber plant products	1.17	1.62	1.10	1.10
17	Tobacco	1.77	2.79	1.27	1.34
18	Coffee	1.56	2.34	1.48	1.63
19	Tea	1.29	2.35	1.22	1.24
20	Clove	1.28	1.97	1.07	1.13
21	Cacao	1.31	1.93	1.16	1.19
22	Cashew	1.20	1.84	1.40	1.45
23	Other plantation products	1.65	2.14	1.55	1.61
24	Other agricultural products	1.58	2.47	1.06	1.10
25	Husbandry and its products except fresh milk	1.40	2.16	1.91	2.48
26	Fresh milk	1.64	2.52	1.06	1.10
27	Poultry and its product	1.70	2.75	1.77	3.20
28	Other animal husbandry products	1.35	2.52	1.01	1.02
29	Wood	1.22	1.89	2.23	2.33
30	Other forest product	1.23	1.94	1.48	1.56
31	Sea food and other sea product	1.16	1.71	1.75	2.74
32	Inland fish and its product	1.32	1.84	1.12	1.49
33	Shrimp	1.44	2.29	1.37	1.95
34	Agricultural services	1.29	2.23	1.65	1.87
35	Coal	1.27	1.91	1.76	1.90
36	Crude Oil	1.07	1.35	4.32	4.84
37	Gas and Geothermal	1.16	1.38	2.99	3.24
38	Tin ore	1.19	1.79	1.49	1.53
39	Nickel ore	1.14	2.09	1.09	1.09
40	Bauxite ore	1.41	1.89	1.00	1.00
41	Copper ore	1.42	1.83	1.24	1.25
42	Gold ore	1.35	1.86	2.31	2.34
43	Silver ore	1.36	1.94	1.14	1.14
44	Iron ore	1.61	2.56	1.17	1.17
45	Other metallic ore	1.10	1.61	1.01	1.01

46	Non metallic mining	1.49	2.62	1.14	1.16
47	Salt	1.18	1.80	1.02	1.02
48	Other similar mining	1.29	2.35	1.90	1.94
49	Meats	1.88	2.75	2.19	3.30
50	Processed meats	2.26	3.12	1.03	1.06
51	Food and beverage from milk	2.30	3.18	1.22	1.68
52	Processed vegetables	1.73	2.72	1.05	1.15
53	Dried and salted fish	1.80	2.41	1.18	1.55
54	Processed fish	2.01	2.67	1.25	1.63
55	Dried coconut pieces	1.96	2.76	1.15	1.21
56	Oil from animals and plants	2.16	3.11	2.07	3.10
57	Rice	2.07	2.68	1.93	5.47
58	Wheat flour	1.08	1.33	1.77	2.19
59	Other flour	2.05	2.62	1.41	1.61
60	Bread, biscuit and similar products	2.15	2.96	1.04	1.39
61	Noodles, macaronis and similar products	1.95	2.64	1.02	1.46
62	Sugar	2.05	3.00	1.89	2.19
63	Opened seeds	1.92	2.61	1.23	1.31
64	Chocolate and sweets	2.04	2.87	1.29	1.48
65	Ground coffee	2.06	2.93	1.23	1.71
66	Processed tea	1.87	2.96	1.18	1.26
67	Soybean products	1.72	2.50	1.13	1.67
68	Other foods	2.22	2.93	1.31	1.93
69	Animal food	1.98	2.59	2.78	3.44
70	Alcohol beverage	1.87	2.53	1.04	1.07
71	Non alcohol beverage	1.97	2.79	1.08	1.40
72	Processed tobacco	2.03	3.12	1.15	1.25
73	Cigarette	1.46	1.92	1.05	3.11
74	Cleaned Cotton	1.69	2.52	1.03	1.03
75	Thread	1.63	2.07	2.40	2.77
76	Textile	1.86	2.49	1.89	2.67
77	Textile other than finished cloths	2.12	2.82	1.11	1.24
78	Knitted products	1.95	2.61	1.06	1.31
79	Finished cloths	1.94	2.65	1.09	1.79
80	Rugs and other textile	1.49	2.34	1.21	1.31
81	Leathers	2.10	3.30	1.68	1.76
82	Leather products	1.99	3.09	1.16	1.26
83	Footwear	1.98	3.13	1.03	1.26
84	Sawn and preserved wood	1.81	2.66	1.80	1.86
85	Plywood and similar products	1.64	2.27	1.37	1.42
86	Building material from woods	1.85	2.66	1.05	1.06
87	Household appliances from wood and rattan	1.95	2.76	1.04	1.24
88	Other products from woods, bamboo and rattan	1.86	2.79	1.14	1.23
89	Knitted products except from plastics	1.45	2.08	1.03	1.06
90	Pulp	2.25	3.04	1.96	2.03
91	Paper and carton	1.67	2.29	2.40	2.75
92	Products form paper and carton	1.99	2.82	1.43	1.73
93	Printed products	1.75	2.40	1.45	1.74
94	Basic chemical except fertilizer	1.49	1.98	2.57	2.86

95	Fertilizer	1.68	2.49	2.91	3.27
96	Pesticide	1.39	1.80	1.39	1.44
97	Sinthetic pastic and fiber	1.55	1.99	2.22	2.54
98	Paints	1.59	2.45	1.26	1.30
99	Medicines	1.70	2.30	1.44	1.84
100	Traditional medicines	2.09	3.11	1.04	1.10
101	Soap and cleaning materials	1.63	2.29	1.19	1.46
102	Cosmetics	1.70	2.36	1.03	1.26
103	Other chemical products	1.41	1.76	1.57	1.69
104	Product from oil refinery	1.08	1.82	7.02	8.75
105	Natural Liquid Gas	1.54	1.71	1.03	1.03
106	Smoked rubber	2.02	3.30	1.63	1.73
107	Tire	1.70	2.42	1.50	1.82
108	Other product from rubber	2.10	3.02	1.40	1.61
109	Products from plastics	1.61	2.10	2.31	3.55
110	Ceramic and goods from clay	1.68	2.75	1.01	1.03
111	Glass and glass products	1.51	2.27	1.27	1.40
112	Building material from ceramic and clay	1.82	2.90	1.01	1.01
113	Cement	1.75	2.46	1.31	1.33
114	Other non metalic goods	1.62	2.51	1.20	1.23
115	Ferrous and basic steel	1.73	2.23	1.41	1.46
116	Goods from ferrous and basic steel	1.66	2.01	1.63	1.72
117	Non ferrous basic metal	2.01	2.63	1.70	1.74
118	Goods from non ferrous basic metal	1.94	2.61	1.46	1.49
119	Kitchen, workshop and agriculture tools from metal	1.71	2.61	1.27	1.31
120	Household appliances from metal	1.83	2.59	1.08	1.26
121	Building materials from metal	1.74	2.34	1.29	1.33
122	Other metal products	1.59	2.33	1.75	1.90
123	Motorized machinery	1.85	2.57	1.25	1.26
124	Machineries and equipments	1.33	1.84	2.92	3.23
125	Electric generating machineries	2.03	3.11	1.61	1.64
126	Electric machineries and equipments	1.89	2.65	1.41	1.51
127	Electronics, communication tools and equipments	1.68	2.20	1.44	2.85
128	Electrical household appliances	1.78	2.45	1.08	1.17
129	Other electrical appliances	1.76	2.36	1.29	1.40
130	Batteries	1.58	2.15	1.27	1.90
131	Ship and ship repair services	1.54	2.21	1.15	1.16
132	Train and train repair services	1.53	2.28	1.10	1.11
133	Motorized vehicle except motorbike	1.43	2.01	1.46	2.94
134	Motorbike	1.73	2.53	1.61	3.54
135	Other transportation vehicle	1.90	2.58	1.20	1.25
136	Airplanes and Airplane repair service	1.33	1.95	1.17	1.22
137	Metering tools, photography, optical and watches	1.69	2.47	1.08	1.14
138	Jewelry	1.57	2.12	1.02	1.12
139	Musical instruments	2.04	2.95	1.01	1.03
140	Sporting goods	1.98	3.05	1.02	1.03
141	Other industry products	1.81	2.53	1.13	1.17
142	Electric and Gas	1.85	2.54	4.23	5.84
143	Clean water	1.95	2.98	1.53	1.74

144	Residential and Non Residential buildings	1.82	2.55	1.73	2.21
145	Agricultural infrastructure	1.80	2.83	1.59	1.66
146	Road, bridges and ports	1.73	2.63	1.74	1.83
147	Building, installation, electric, gas, clean water, and communication	1.85	2.71	1.10	1.15
148	Other buildings	1.92	2.77	1.15	1.17
149	Trade services	1.47	2.28	12.05	21.28
150	Restaurant services	1.94	2.87	2.14	7.36
151	Hotel services	1.66	2.51	1.25	1.53
152	Railways services	1.98	3.22	1.08	1.20
153	Highway services	1.74	2.70	4.76	7.90
154	Sea transportation services	1.65	2.34	2.05	2.65
155	Inter island and inland water transportation services	1.49	2.39	1.19	1.40
156	Air transportation services	1.62	2.41	1.54	2.40
157	Transportation supporting services	1.55	2.56	2.32	2.89
158	Communication services	1.27	1.91	2.65	4.74
159	Banks	1.49	2.31	5.17	8.00
160	Other financial institutions	1.37	2.18	1.75	2.06
161	Insurance and pension funds	1.38	2.49	1.63	2.12
162	Building and land rents	1.27	1.52	2.29	4.81
163	Business services	1.52	2.45	3.45	4.44
164	General government services	1.60	3.51	1.13	1.24
165	Public education services	1.65	3.50	1.00	1.03
166	Public health services	1.65	3.49	1.10	1.13
167	Other public services	1.75	3.60	1.18	1.21
168	Private education services	1.47	3.17	1.19	2.77
169	Private health services	1.87	2.81	1.21	2.42
170	Other social services	1.69	3.49	1.01	1.02
171	Movies and private distribution services	1.89	3.07	1.27	1.28
172	Private entertainment services	1.90	2.75	1.80	2.12
173	Workshop services	1.64	2.51	3.68	6.27
174	Personal and household services	1.32	2.38	1.14	2.31
175	Other unclassified goods and services	1.73	2.41	1.18	1.20

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