A Strategic Approach to Climate Change in the Philippines

An Assessment of Low-Carbon Interventions in the Transport and Power Sectors

FINAL REPORT

April 2010

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CURRENCY EQUIVALENTS

Currency Unit - Philippine Peso (PhP)
PhP 1.00 = USD 48.00
USD 1.00 = PhP 0.0208

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
ALGAS	Asia Least-Cost Greenhouse Gas Abatement Strategy of ADB
AusAID	Australian Agency for International Development
BAU	Business-as-usual
BRT	Bus rapid transit
CAIT	Climate Analysis Indicators Tool
CARMA	Carbon Monitoring for Action
CDM	Clean Development Mechanism
CNG	Compressed natural gas
CO2e	Carbon dioxide equivalent
DENR	Department of Environment and Natural Resources
DFA	Department of Foreign Affairs
DOE	Department of Energy
DOH	Department of Health
DOST	Department of Science and Technology
DOTC	Department of Transportation and Communications
DPWH	Department of Public Works and Highways
ECAP	Energy and Clean Air Project of USAID
EST	Environmentally Sustainable Transport
EV	Electric vehicle
GEF	Global Environment Facility
GHG	Greenhouse gas
IACCC	Inter-Agency Committee on Climate Change
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ISDR	United Nations International Strategy for Disaster Reduction
JICA	Japan International Cooperation Agency
LEAP	Long-range energy alternative planning model
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
LUCF	Land use change and forestry
MCC	Millennium Challenge Corporation
MDG	Millennium development goals
MMDA	Metropolitan Manila Development Authority
MTPDP	Medium-Term Philippine Development Plan
MVIETS	Motor vehicle inspection and emission testing system
MVIS	Motor vehicle inspection station
NEEDS	National Economic, Environment and Development Studies for Climate Change
NGVPPT	Natural Gas Vehicle Program for Public Transport (program of DOE)
OBR	Organized Bus Route (proposed bus dispatch project of MMDA)
ODA	Official Development Assistance
PACC	Presidential Adviser on Climate Change
PEP	Philippine Energy Plan
PSSD	Philippine Strategy for Sustainable Development
PTFCC	Presidential Task Force on Climate Change
RRECCS	A Regional Review of the Economics of Climate Change in Southeast Asia of ADB
RORO	Roll-on, roll-off (for vessel or service)
RRTS	Road RORO Terminal System

SNC	Second National Commitment for the Philippines
SRNH	Strong Republic Nautical Highway
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UPNCTS	University of the Philippines National Center for Transportation Studies
USAID	United States Agency for International Development

Units

MMBFOE	million barrels of fuel oil equivalent
$MtCO_2e$	million tons of CO_2 equivalent
MTOE	million metric tons of oil equivalent
GJ	gigajoule
GW	gigawatt
GWh	gigawatt-hour
Mb	million barrels
Mt	million tons
MW	megawatt

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This Study was initiated by the World Bank in accordance with its new strategic framework: *Development and Climate Change: A Strategic Framework for the World Bank Group* (October, 2008) and in the interest of interpreting this development agenda from the perspective of the Philippines. The Study concept was discussed with the Philippine Government authorities, particularly with the Department of Transportation and Communications (DOTC) and the Department of Energy (DOE).

This report was prepared by George Esguerra (Team Leader), Samuel Custodio, Nabor Gaviola, and Cindy Tiangco. The Study team worked under the overall guidance and supervision of Jan Bojö, Sector Leader, Environment, Social, Environment, and Rural Unit, Sustainable Development Department, East Asia & Pacific Region, World Bank and Victor Dato, Infrastructure Specialist, World Bank Office in Manila. Valuable comments on the draft final report were provided by Baher El-Hifnawi, World Bank, the technical directors from both DOTC and DOE and staff from the Clean Air Initiative-Asia.

EXECUTIVE SUMMARY

Facing financial pressure from spiraling oil prices and the international concern on global warming, the Philippines has embarked on a development path that aims to achieve a delicate balance between pursuing economic growth and responding to mounting concerns over the environment. Recently identified as a climate change hotspot that suffered storms, floods, and extreme weather conditions, the Philippines has significant potential to be a major participant in on-going greenhouse gases (GHG) reduction efforts in the transport and power sectors. Philippine officials and policymakers are well-positioned to participate in this emerging global agenda through the enhancement of their understanding as to the nature of climate change, specific opportunities to mitigate GHG emissions, and various modalities and mechanisms for increased technology application, international cooperation, and capital assistance.

Opportunities and Challenges

Growth in energy use and the associated greenhouse gas emissions have accompanied the economic expansion seen after the recovery from the Asian financial crisis (Figures 1 and 2). Energy demand is met partly by indigenous resources including coal, natural gas, hydropower and traditional biomass energy. The Philippines is one of few countries in the world where renewable energy (RE) accounts for the largest share (35% renewable energy, and 2% hydro) of total primary energy supply (Figure 3). In recent years, there has been increasing use of natural gas for power generation. In terms of overall greenhouse gas (GHGs) emissions, the Philippines is ranked 39th in the world in 2005 with about 142 million tons of carbon dioxide equivalent ($MtCO_2e$), excluding emissions due to land use change.[1] Principal GHG emissions sources are the power and transport sectors (Figure 4). Overall energy intensity peaked in 1997 but has since shown improvement (Figure 5). Energy intensity in 2006 is now below the previous lows recorded in the early part of the 1980s even as real GDP has more than doubled over the past 30 years. GHG emissions increase significantly through the years with high dependence on fossil fuels (Figure 6)

The Philippine Government has opted to phase out petroleum as a primary fuel for power generation, with petroleum fuels used primarily for the transport sector. Biofuels have been given a prominent role in liquid fuel supply with the Biofuels Act of 2006 taking effect in early 2007. Substantial private sector investment is being mobilized for development of 1st generation biofuels, mainly sugar cane and cassava-base ethanol and coconut methyl ester (CME) for biodiesel. The Biofuels Act mandates that gasoline be blended with 10% ethanol (E10) and 5% biodiesel blend (B5) by 2011.

The government continues to promote power sector reforms, and development of renewable energy through private sector investment. In January 2009, the Renewable Energy Act of 2008 (RE Act) became effective, which includes the establishment of a RE Trust Fund to be capitalized in part by levies on fossil energy use. The National Renewable Energy Board was established in February 2009 to attain the objectives of the RE Act. In May 2009, the DOE released the implementing rules and regulations of the RE Act and in July 2009, created the Renewable Energy Management Bureau (REMB). Specific rules for the RE Act relating to Renewable

[1] Climate Analysis Indicators Tool (CAIT) Version 6.0. (Washington, DC: World Resources Institute, 2009)

Portfolio Standard (RPS), feed-in tariffs and net metering for qualified end-users are expected to be released in early 2010.

Figure 1. GDP growth

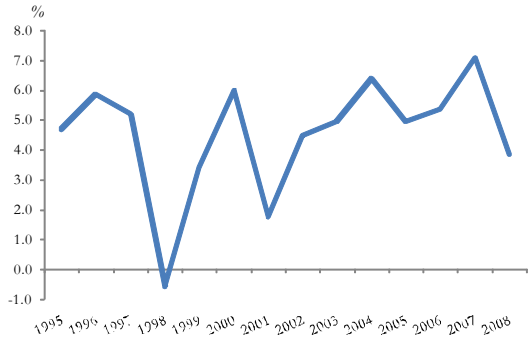


Figure 2. Energy consumption

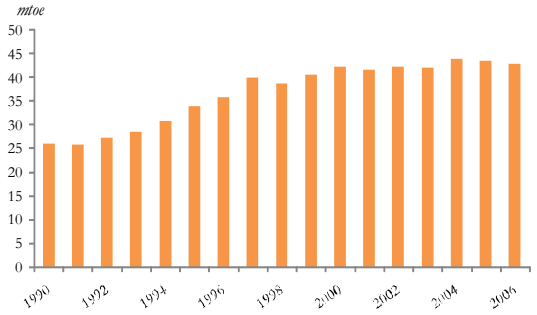


Figure 3. Primary energy mix, 2007

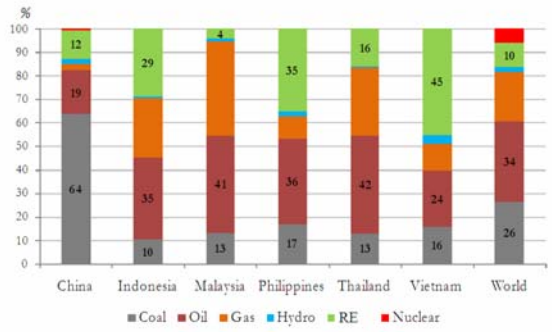
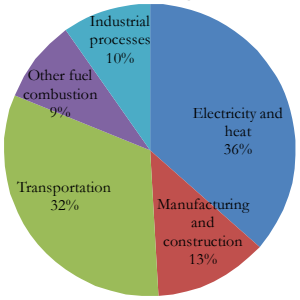


Figure 4. GHG emissions by source, 2005*



*excludes land use change, agriculture, and forestry

Figure 5. Energy intensity

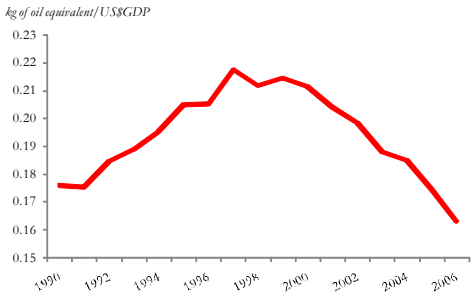
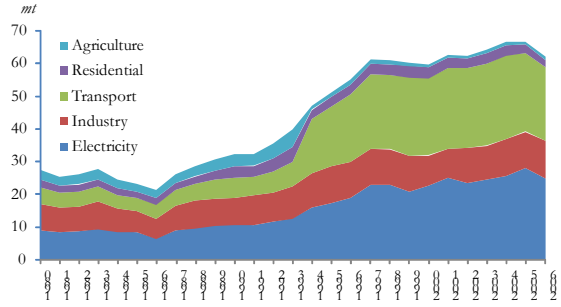


Figure 6. CO_2 emissions from fossil fuels



Source: World Bank, IEA and CAIT/World Resources Institute

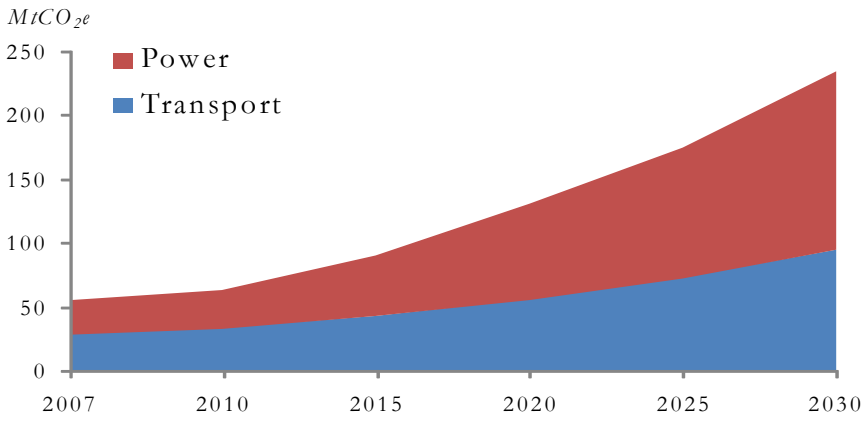
In an effort to reduce the country's carbon footprint and improve local air quality, President Gloria Macapagal-Arroyo instructed the Department of Transportation and Communications (DOTC) and other transport-related agencies to formulate a National Environmentally Sustainable Transport Strategy (NESTS) for the country. NESTS will promote, among others, the development of Bus Rapid Transit (BRT) systems, expansion of the urban rail network in Metro Manila, deployment of hybrid

vehicles in the public transport fleet, and acceleration of fuel-switching in certain public transport modes.

Low-Carbon Development Strategy

Recent analytical work by the ADB and World Bank provided preliminary GHG abatement cost profile for the Philippines. Under a business as usual (BAU) scenario, total GHG emissions are projected to increase most rapidly in the power and transport sectors. Dependence on imported coal for power generation and petroleum for transport will increase under this BAU scenario. During the period 2007-2030, power emissions will increase from less than 30 to about 140 MtCO2e/y or more than 400% increase, and transport sector emissions will increase from 29 to over 68 MtCO2e/y or about 133% increase (Figure 7).

Figure 7. Baseline GHG emissions estimates for the power and transport sectors

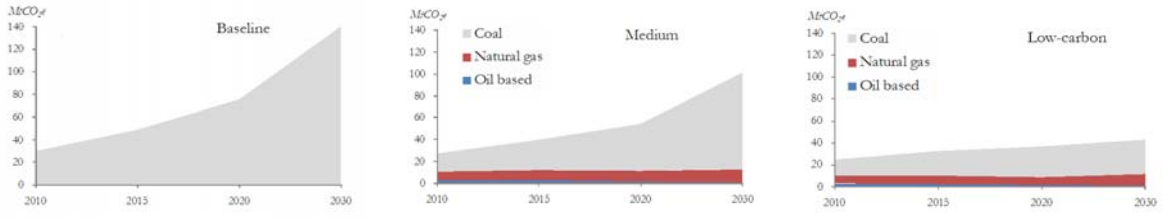


Source: Study estimates

The Study evaluated two alternative abatement scenarios referred to as the medium and low-carbon scenarios. Power sector emissions in the low-carbon scenario show that emission levels can be contained to just 30% of the BAU level in 2030 (Figure 8). The medium scenario assumes a 10% reduction in power demand due to energy efficiency improvements coupled with a shift from coal to lower emission technology like natural gas-based power generation and renewable energy-based power generation that includes hydro, geothermal, wind, and biomass (doubling RE capacity). On the other hand, the low-carbon secnario assumes a 15% reduction in power demand due to energy efficiency improvements and an aggressive roll out of wind and biomass (40 times more than the baseline) and an ambitious target of 2,000 MW installed solar power from the baseline projection of 1 MW. Figure 8 also indicates the proposed path to low-carbon scenario.

Transport sector emissions in the low carbon scenario are likewise, 62% less compared with the BAU level in 2030 (Figure 9). The analysis indicates that substantial GHG reductions are possible in the medium and low-carbon scenarios. More specifically, the medium scenario targets, among others, 50 km of BRT system in Metro Manila and Cebu, organized bus route enhancement, and north and south extensions of the Light Rail Transit (LRT) 1. Targets for the low-carbon scenario include 100 km of BRT system in Metro Manila, Metro Cebu, and other cities, construction of more LRT lines, fully financed road maintenance, and nationwide coverage of vehicle inspection, among other intervention measures.

Figure 8. Power sector emissions scenarios, 2010-2030



Source: Study estimates

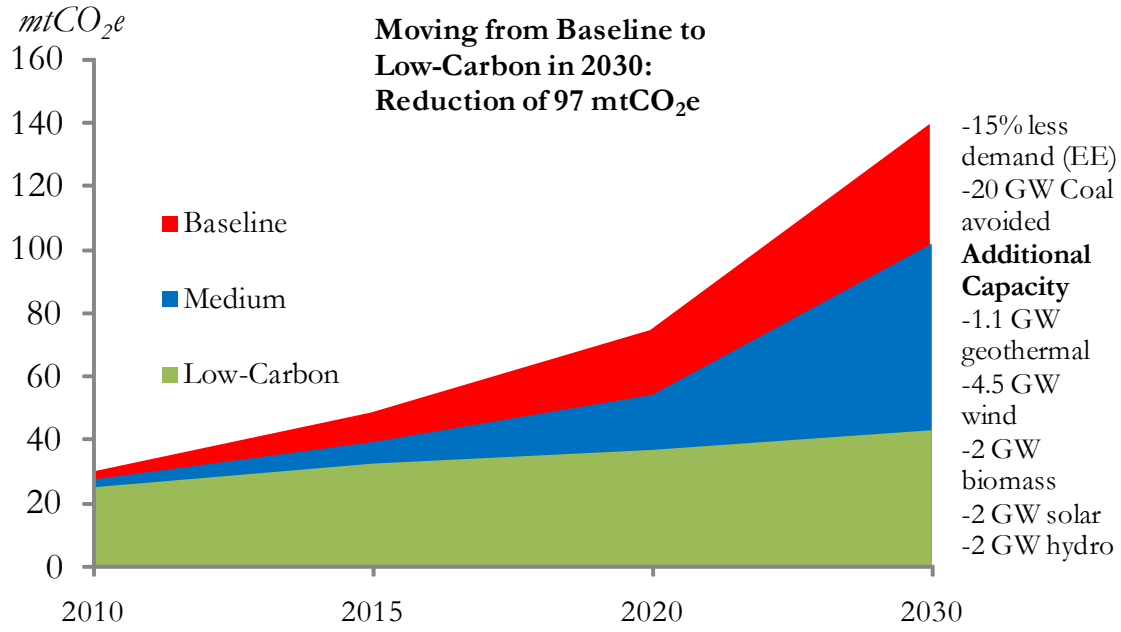
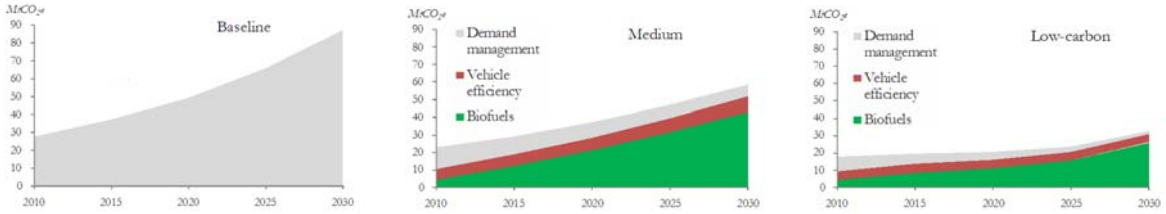
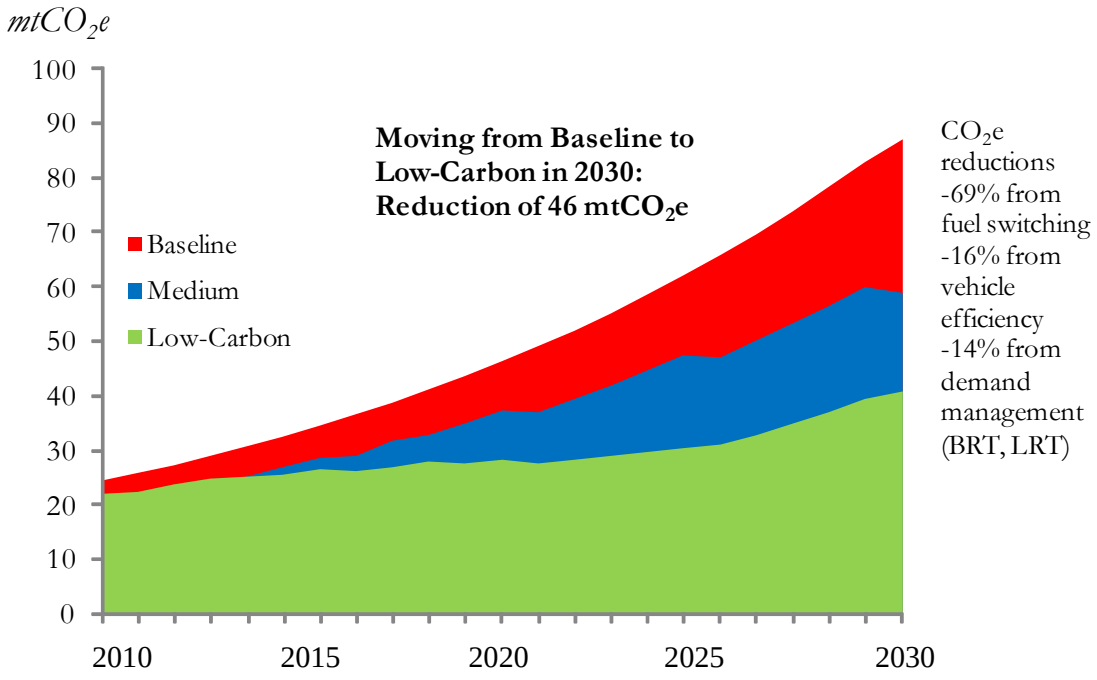


Figure 9. Transport sector emissions scenarios, 2010-2030

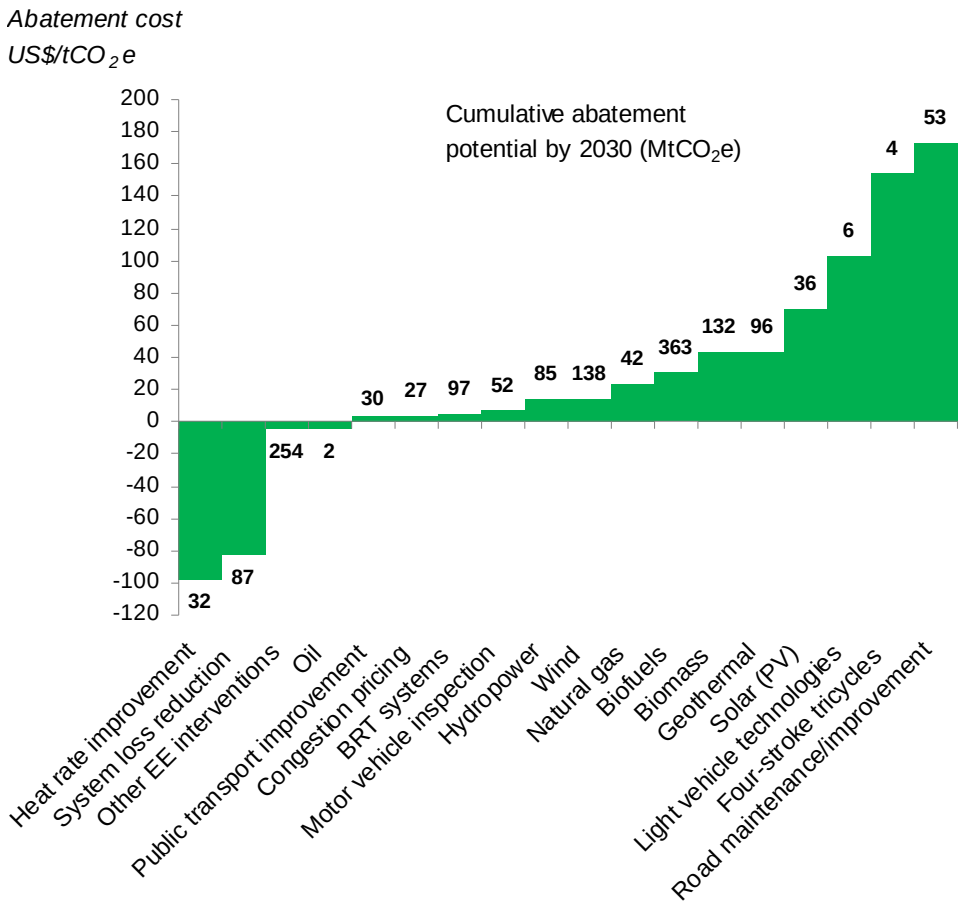


Source: Study estimates



The cost-effective low-carbon strategy for the transport sector includes a diverse and integrated package of measures that promotes biofuels, low-cost vehicle efficiency improvements and transport demand management, including BRT development, urban rail expansion promoting the shift to lower-emitting transport modes (Figure 10). For the power sector, energy efficiency programs present a huge potential for mitigation with negative abatement cost (Figure 10). On the supply side, hydro and wind present large mitigation potential at a cost of less than USD15/tCO_2e, with wind power providing the highest mitigation potential.

Figure 10. Abatement Cost and Cumulative Abatement Potential for the Power and Transport Sectors, 2008-2030*,**



* When co-benefits of transport sector abatement options are taken into account, most of these costs are negative.
****** Based on investment costs without co-benefits except heat rate improvements and system loss reduction.

Based on trend in emission growth, policy conditions affecting primary energy supply and demand, and estimated abatement costs, the GHG emission reduction priorities should be in the power and transport sectors which account for about 64 percent of total energy CO2 emissions (see Figure 4). High-priority interventions are: (i) supply- and demand-side energy efficiency and conservation (EE) in power, industry, commercial, and residential sectors, including smart grid technology and system loss reductions; (ii) scale-up of clean and renewable energy (RE), primarily geothermal power, small hydropower, wind, advanced biomass energy, and possibly marginal gas fields; and (iii) public mass transport systems and traffic demand management, (iv) advanced vehicle technology, and fuel switching; and (v) establishment, and enforcement of, vehicle inspection and emission testing standards. Substantial opportunities exist for supply and demand side efficiency gains, expansion of renewable power supplies, and transport system improvements. The EE program of the DOE focuses on four main issues: (i) system loss reduction for electric cooperatives; (ii) rehabilitation of inefficient power plants; (iii) efficiency improvements in manufacturing plants, and; (iv) the creation of the Super ESCO. These interventions rely heavily on the active participation of the private sector, with the first and the last to be implemented in close coordination with the relevant government agencies.

I. INTRODUCTION

1.1 Background

Globally, the Philippines is a minor emitter of greenhouse gases (GHGs), but cost-effective mitigation present opportunities that should be captured, noting that the country is one of the signatory member states to the 1992 United Nations Framework Convention on Climate Change (UNFCCC)[2] and its Kyoto Protocol.[3] The country accounts for less than 0.3 percent of global GHG emissions in 2004.[4] However, emissions are on the rise from both energy-use and land-use changes. Even if the absolute scale will remain small, there are increasing number of development projects under preparation, which offers opportunities for cost-effective mitigation and adaptation measures.

The Philippine Government's response to the climate change challenge has been active institutionally noting the recent restructuring of the Presidential Task Force on Climate Change. However, a clear strategy and action plan are still lacking. The international donor community, including development partners such as the Asian Development Bank (ADB), the United Nations International Strategy for Disaster Reduction (ISDR), the Millennium Challenge Corporation (MCC), and the United Nations Development Programme (UNDP), is actively engaged in addressing climate change in the Philippines. There are several initiatives on capacity building for GHG accounting, monitoring and reporting, for preparation of a second National Communication to the UNFCCC,[5] governance, renewable energy, urban air quality management, and forest management. There are likewise several World Bank-supported climate change-related activities, with nine active operations. These encompass primarily energy sector operations.

1.2 Objectives and Outputs of the Study

The main objective of the study is to evaluate the potential for GHG reduction in the Philippines over the immediate, medium and long terms, up to 2030, in the transport and power sectors. It will evaluate low-carbon interventions using a common methodology based on cost-effectiveness, with the objective of determining the least cost options per ton of CO_2e.

Key deliverables in this study are:

(i) Synopsis of available information, studies and institutional arrangements with a view to deriving lessons learned from previous and planned policy and planning work;
(ii) Identified emission reduction options covering specific programs, projects and activities as identified by key stakeholders;
(iii) Proposed approach and methodology for assessing cost-effectiveness of the various low-carbon interventions in the transport and power sectors;
(iv) Baseline and future year carbon emission estimates (immediate to long term, up to 2030) for low-carbon scenarios for transport and power sectors;
(v) Proposed implementation strategies taking into account policy, regulatory,

[2] Signed UNFCC in June 1992 and ratified in August 1994.
[3] Signed the Kyoto Protocol in April 1998 and ratified in November 2003.
[4] CAIT. 2008. "Climate Analysis Indicators Tool (CAIT) Version 5.0." Online.
[5] Philippines' initial national communication on climate change prepared in December 1999 with UNDP/GEF support.

institutional, market development and other barriers; and

(vi) Design and conduct of major stakeholders' consultation of the study findings and recommendations.

Attached as **Appendix 1** is the Study Terms of Reference.

1.3 Study Approach and Methodology

1.3.1 Task 1: Review of Developments in the Transport and Power Sectors

The diagnostic analysis of transport and power sectors' performance focused on: (i) the policy environment; (ii) key sector strategies and programs as enunciated in the Medium-Term Philippine Development Plan, 2004-2010 (MTPDP) and sector development plans such as the Philippine Energy Plan, 2007-2014 of the Department of Energy (DOE), the Department of Transportation and Communications (DOTC) Transport Development Plan, 2007-2010, the Department of Public Works and Highways (DPWH) Highway Development Plan, 2007-2010 and Department of Environment and Natural Resources (DENR) Environmental Protection and Management Programs; and (iii) recent initiatives of the Presidential Task Force on Climate Change (PTFCC), which was reorganized under Executive Order (EO) 774,[6] dated 26 December 2008, and its key Task Force agencies, notably DOTC, DOE and DENR.

Past and on-going work on climate change were considered, e.g., *Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS)* of ADB, GEF, and UNDP (1998), the Working Paper, entitled: *In the Eye of the Perfect Storm: What the Philippines Should Do About Climate Change*, by Manila Observatory (2008), *A Regional Review of the Economics of Climate Change in Southeast Asia* (RRECCS) of ADB, which was completed in April 2009. For other relevant activities, such as of the Manila Observatory on the Second National Communication to the UNFCCC and its GHG inventory, and the National Economic, Environment and Development Studies (NEEDS) for Climate Change sponsored by UNFCCC, which will both be underway for the duration of the Study, liaison and coordination with concerned research staff were undertaken to gather interim results, if available.

1.3.2 Task 2: Identification of Emission Reduction Interventions

Work under this task involved preparing a long list of emission reduction initiatives based on the following: (i) potential for overall emissions reduction; (ii) cost-effectiveness of interventions; and (iii) feasibility that interventions can be implemented in the immediate, medium and long terms, among other considerations.

For the transport sector, the three broad types of GHG emission reduction measures were considered, namely, (i) projects reducing emissions per vehicle-kilometer; (ii) projects reducing emissions per unit transported; and (iii) projects reducing trips. To a limited extent, measures to reducing the loads (weight, rolling and air resistance and accessory loads) on vehicles, thereby reducing the engine power needed to operate them were noted.

An initial set of transport and power mitigation options was drawn from the ALGAS list of interventions as presented in **Appendix 2**. Besides the transport options

[6] PTFCC is now chaired by the President of the Philippines, with Cabinet secretaries serving as chairs/members of the 14 new Task Groups such as the Task Groups on Fossil Fuels (led by DOTC) and on Renewable Energy (led by DOE).

considered in ALGAS, Wright and Fulton (2005)[7] and World Bank (2003)[8] examined the size and cost of potential emission reduction options from the urban transport sector of developing countries, which provided valuable insights on appropriate strategies from fuel technology options to reductions from measures promoting modal shift (e.g., bus rapid transit systems).

On the other hand, low carbon options reviewed in the power sector covered those involving supply sources and transmission, demand side management, energy efficiency, and renewable energy resources. The Study was guided by the main strategies identified in the Philippine Energy Plan, 2008-2030.

A key reference document for the Study was IPCC (2007),[9] which identified mitigation technologies, policies and practices that are currently available commercially and being adopted by countries.

1.3.3 Task 3: Development of an Approach and Methodology for Assessing Cost-Effectiveness

The approach from a cost-effective perspective generally focused on achieving some policy objective at minimum cost. Cost minimization was used to compare alternative means to meet some climate policy objective such as a specific GHG emissions or concentration target. The work was guided by the United Nations Framework Convention on Climate Change provision that cost-effectiveness is an important criterion to be used in formulating and implementing climate policies. As stated in Article 3.3 of the convention "…*taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure that global benefits at the lowest possible cost* (UNFCC, 1992)".

The policies and technology options considered were generally restricted to those that directly affect energy use or other activities with a direct impact on GHG emissions. Cost-effectiveness analysis seeks the lowest cost of achieving an environmental target by equalizing the marginal costs of mitigation across space and time. The assessment of individual or any package of low-carbon initiatives took into account the impacts of interventions, which can be defined as the changes that policies cause relative to some "business-as-usual" (BAU) or "baseline" situation.

Noting wide variations in the reported costs of GHG reduction in the transport sector from international experience, due mainly to the exclusion in the analysis of co-benefits (e.g. health impacts of reduced air pollutants), the array of transport mitigation options were considered on the basis of the range of potential impacts and marginal costs. The marginal abatement cost is estimated as the additional incremental cost of adopting a particular mitigation option compared to the BAU scenario. The estimation of cost-effectiveness was carried out on components of emission reduction scenarios and later aggregated with reference to different price levels and on the basis of past market performance.

For the power sector, GHG emissions reduction is introduced as an explicit goal of power capacity expansion. The Study did not attempt to re-optimize the power

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[7] Wright, L., L. Fulton (2005), "*Climate Change Mitigation and Transport in Developing Nations*," Transport Reviews, Vol. 25, No. 6.

[8] World Bank (2003), Climate Change Mitigation in the Urban Transport Sector: Priorities for the World Bank, Washington D.C.

[9] IPCC (2007), Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

expansion plan of the Baseline scenario by imposing an arbitrary GHG mitigation constraint. Instead, a range of power supply policy options and technologies are evaluated for their GHG emission reduction potential and cost-effectiveness.

Where local program or project appraisals were not available, comparative studies from similarly situated countries were utilized as basis in determining the scale of costs and economic benefits. In instances of varying costs, "levelized" costs[10] were determined from the review of cost components and applicability to the Philippine context.

1.3.4 Task 4: Estimation of Carbon Emissions for Baseline and Low-Carbon Scenarios

The preparation of the Second National Commitment (SNC) involves the estimation of carbon emissions using LEAP (Long-range Energy Alternative Planning Model), which is a widely used software tool for energy policy analysis and climate change mitigation assessment tool developed at the Stockholm Environment Institute. Noting the cumbersome process of setting up the input data and parameters, the Study relied on Excel-based spreadsheet calculation.

The CO_2 equivalent emissions for the transport and power mitigation options were estimated using standard emission coefficients provided by the IPCC guidelines.[11] Initial estimates were prepared using the IPCC Reference Approach (top-down), which is based only on the quantities of fuel produced locally, imported, and exported and change in stock. The sectoral approach (bottom-up), which is based on domestic consumption of fuels by the transport and power sectors, was later applied to assess the impacts of GHG emissions mitigation options.

The results of initial estimation were compared and validated using results from other sources such as those from recent studies[12] and international databases such as the IPCC, International Energy Association (IEA), and US-based Carbon Monitoring for Action (CARMA). For instance, CARMA is a massive database containing information on the carbon emissions of over 50,000 power plants and 4,000 power companies worldwide. It is the first global inventory of a major, emissions-producing sector of the economy and is produced and financed by the Confronting Climate Change Initiative at the Center for Global Development, an independent and non-partisan think tank located in Washington, DC.[13] CARMA's database provides the CO_2 equivalent emissions for 512 grid-connected and off-grid power plants in the Philippines for the year 2000, as well as projected emissions for 2007 and the next decade. The DOE provides data for grid-connected power plants.

1.3.5 Task 5: Identification of Barriers to Implementation and Recommended Action Plan

The Study identified the barriers - policy, regulatory, institutional, market development, etc. - to implementation in the transport and power sectors for each identified climate change intervention. The implementation and operational risks associated with the identified barriers were analyzed, and remedial measures were formulated to ensure the feasibility of implementing the recommended interventions.

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[10] Present value of the total cost of the facility over its economic life, converted to equal annual payments. Costs are levelized in real dollars (i.e., adjusted to remove the impact of inflation.

[11] IPCC (2006), Guidelines for National Greenhouse Gas Inventories, Institute for Global Environmental Strategies, Kanagawa, Japan.

[12] APERC (2006), APEC Energy Demand and Supply Outlook 2006, Tokyo.

[13] www.carma.org

As barriers add to the cost of implementation of the identified measures and reduce the realizable potential in terms of cost savings and GHG emission reduction, the Study took into account the deliberations and agreements of previous stakeholders' conferences on transport and energy convened by the DOTC, DOE, and DOST, notably: the Land Transport Summit, Energy Summit, Science & Technology Roadmap: Regional Roles and Perspectives, and the Carbon Cutting Congress held in November 2008.

1.4 Consultation Process

The Study TOR explicitly specified the consultation with concerned officials and representatives the DOTC, DOE, DENR, PTFCC and other concerned agencies, as necessary, throughout the Study. Other donors, private investors, civil society, and academics were also engaged in the consultation and dissemination process. Direct stakeholder consultations were carried in the course of the Study, while formal and structure meetings were held such as the consultation workshop on 29 May 2009 to discuss the contents of the Draft Final Report.

In the course of the Study, the following key agencies were consulted:

- DOTC - Planning Service;
- DOE - Energy Policy and Planning Bureau;
- DENR - Environmental Management Bureau;
- Manila Observatory, Ateneo de Manila University;
- UP National Center for Transportation Studies - EST Team;
- Clean Air Initiative-Asia Center;
- Office of the Presidential Adviser on Climate Change; and
- other research groups and individuals involved in the preparation of SNC.

Project-related meetings were also conducted with the ADB Clean Cities Development Initiative for Asia on Cebu BRT Project and USAID Energy and Clean Air Project (ECAP).

As part of the dissemination of intermittent and final outputs, the Study team participated in the Project Coordination Workshop on Cebu Bus Rapid Transit Studies convened by Cebu City on 9 May 2009.

Further technical discussions were held with DOTC and DOE to validate the Study assumptions and align the proposed low-carbon scenarios with existing and future plans and programs of these agencies. More specifically, the draft conclusions and recommendations of the Study were presented and discussed during the 18th DOTC Road Cluster meeting held on June 10, 2009 in Baguio City and the roundtable meeting with DOE officials held on June 11, 2009 in Manila. The detailed comments from these technical meetings provided valuable inputs to the revision in the key assumptions and input parameters to the low-carbon scenarios. In particular, the Study was guided by the updated targets under the Philippine Energy Plan, 2008-2030 and the status of DOTC transport development programs.

II. COUNTRY AND SECTOR CONTEXTS

2.1 GHG Emissions in the Philippines

From independent estimates, the country's GHG contribution in 1990 totaled 118.6 million tons of CO_2 equivalent ($MtCO_2e$). In 2000, this increased to 169.8 $MtCO_2e$, or a significant increase of 43%. **Table 2.1-1** shows the GHG contributions of the Philippines for the years 1990, 2000 and 2004.

In 1990, land use change and forestry (LUCF) accounted for 66.9% of Philippine GHG emissions, energy accounted for 30.4% and industrial processes contributed only 2.7%. In 2000, the share of land-use change and forestry decreased to 55.9 percent of GHG emissions, while the share of the energy sector increased to 40.6 percent, and the share of industrial processes increased to 3.5%.

In 2000, the latest year with data on land use change and forestry, emissions were 0.51% of the world total, ranking the Philippines in the 36th place.

Table 2.1-1: Philippine's GHG Emissions by Sector, 1990, 2000 and 2004

	1990		2000		2004*		% Change	
							1990-2000	2000-2004
Sector	$MtCO_2$	%	$MtCO_2$	%	$MtCO_2$	%		
Land use change & forestry*	79.4	66.9	94.9	55.9	N/A	N/A	20%	N/A
Energy	36.0	30.4	68.9	40.6	72.6	91.8	91%	5.37%
Electricity & Heat	14.2	11.9	26.8	15.8	28.9	36.5	89%	7.84%
Manufacturing & Construction	8.3	7	9.2	5.4	11.2	14.1	11%	21.74%
Transportation	6.2	5.2	23.5	13.9	25.4	32.1	279%	8.09%
Other fuel combustion	7.4	6.2	9.4	5.5	6.8	8.6	27%	-27.66%
Fugitive Emissions	0	0	0	0	0.3	0.4	0%	
Industrial processes	3.2	2.7	6.0	3.5	6.5	8.2	88%	8.33%
TOTAL	118.6		169.8		79.1		43%	5.61%
* Land use change and forestry data available every ten years only. No data for 2004								

Source: Climate Analysis Indicators Tool (CAIT) Version 6.0. (Washington, DC: World Resources Institute, 2009), *online.*

However, contrary to the above CAIT estimates, the LUCF sector was considered a net sink of CO_2 in 1994 according to the Philippines Initial National Commitment on Climate Change (1999) with net CO_2 uptake of 126 Gg. Of the non-LUCF sectors, energy accounted for 50% of the estimated 100.8 $MtCO_2$ total emissions with power and transport sectors as main contributors. DENR projections for the year 2008[14] put the total national GHG emissions at 195.1 $MtCO_2$ or an increase of 94 percent from the 1994 estimates. This represented an average annual growth rate of 4.8% across all sectors.

[14] Merilo, G.A., 2001, "*Greenhouse Gas Mitigation Strategies: the Philippine Experience*," a paper presented at the Workshop on Good practices in Policies and Measures, 8-10 October 2001, Copenhagen.

The Second National Commitment on Climate Change, which is being prepared by the DENR-led Inter-Agency Committee on Climate Change, is expected to be officially issued by April 2010.

2.2 Policy and Institutional Framework

The 1987 Philippine Constitution made a landmark provision for the environment and sustainable development by stating that it is "*the policy of the State to protect and advance the right of the Filipino people to a balanced and healthful ecology in accord with the rhythm and harmony of nature*".

This policy was further strengthened in 1991 with the formulation of the Philippine Strategy for Sustainable Development (PSSD) and the Philippine Agenda 21, which laid down the national agenda for sustainable development for the 21st century geared towards having a "*harmonious integration of a sound and viable economy, responsible governance, social cohesion and harmony and ecological integrity to ensure that development is a life-enhancing process. The ultimate aim of development is human development now and through future generations*."[15]

In the same year, the Inter-Agency Committee on Climate Change (IACCC) was created with DENR taking the lead and officially recognized as the technical focal point recognized by the UNFCCC and international community. The Philippines' commitment to address global environmental issues was further manifested by its support to the UNFCCC and by being a signatory to at least ten more international conventions. The Philippine was one of the first countries to set up a national committee to discuss and develop positions on climate change prior to the establishment of the Intergovernmental Negotiating Committee. The UNFCCC, which was officially ratified on April 15, 1998, committed the country to the provisions set for a Non-Annex 1 Party, to curb GHG emissions.

In 1999, the Clean Air Act was enacted, entrenching further the policy on environmental protection and sustainable development. The law not only set air quality standards but also provides that the DENR together with concerned agencies and LGUs prepare and implement national plans that are in accordance with UNFCC and other international agreements, conventions and protocols on reducing greenhouse gas emissions.

The Philippines signed the Kyoto Protocol on August 2, 1994 and ratified it on November 20, 2003. The country then set out to participate in the Clean Development Mechanism (CDM) of the Kyoto Protocol.

In 2007, Administrative Order 171 was issued, creating the Presidential Task Force on Climate Change (PTFCC) to promote national projects, programs and actions on climate change. Its main mandate is to address and mitigate the impact of climate change in the Philippines, paying special attention to adaptation, mitigation and technological solutions. In particular, the PTFCC was tasked to design concrete risk reduction and mitigation measures and adaptation responses, especially on short-term vulnerabilities on sectors and areas where climate change will have the greatest impact.

Originally, the Secretary of Energy served as the Chair, while the Secretary of the DENR served as the Vice Chair of the PTFCC. The IACCC serves as the technical arm of the PTFCC. An Advisory Council on Climate Change Mitigation, Adaptation

[15] Asuncion D. Merilo 2008

and Communication, composed of leading Climate Change experts in the country, provides additional assistance to the PTFCC,

In August 2008, the Office of the Presidential Adviser on Climate Change (PACC) was formed with former Sen. Heherson Alvarez as the Presidential Adviser, with Cabinet rank.

On 26 December 2008, President Arroyo issued Executive Order 774, reorganizing the PTFCC, naming the President as the Chair and organizing 14 Task Groups. The Task Groups that are directly involved in mitigation work are:

- Task Group on Fossil Fuels (DOTC, DPWH, DILG, OPACC, DBM) – reduce consumption on fossil fuels; reform transport sector, to include walking, cycling, and other human-powered vehicles; conduct consultations, mass media social marketing and mobilization campaign; and

- Task Group on Renewable Energy (DOE) - implement Renewable Energy Law with urgency.

2.3 National Climate Change Actions

The Medium Term Philippine Development Plan (MTPDP) for 2004-2010 mentioned climate change in connection with the potential of participating in the CDM and emerging carbon market[16]. The updating exercise on MTPDP, 2004-2010 showed heightened awareness in the mainstreaming of climate change in decision-making.

In the Philippine Energy Plan (PEP), 2004-2013, the new and renewable energy (NRE) sources are envisaged to contribute significantly to the country's electricity requirements. The primary energy supply from NRE by 2013 is projected to increase to 53 percent of the total supply (400.91 MMBFOE) from 51 percent of total supply (273.98 MMBFOE) in 2004. Furthermore, although the main objective of both the Biofuels Act of 2006 and Renewable Energy Act of 2008 is to pursue energy sufficiency and security by encouraging the development and use of alternative energy resources, they also in a way help reduce the emission of greenhouse gases.

The Philippines' Midterm Progress Report on the Millennium Development Goals, noted that "*With the impact of climate change now being felt globally, large-scale debt-for-equity programmes could be channeled for reforestation, clean water, irrigation and food production*" and "*the effects of climate change now felt worldwide and the series of natural disasters and their broad devastating impact, including on the attainment of the MDGs, have highlighted the importance of climate change adaptation and a long-term disaster risk management programme*." The Report also identified various Official Development Assistance (ODA) windows that can be tapped to implement projects in support of this initiative.

Through the IACCC, the National Action Plan on Climate Change was first formulated in 1997. With DENR as the technical focal point recognized by the UNFCCC and international community, the IACCC recently reformulated the mitigation strategies to include:

- Accelerated use of renewable energy and alternative energy sources (e.g. biofuels); promote efficient power generation and conservation (DOE);
- promote production efficiency and use of low carbon technologies (DTI);

[16] MTPDP 2004-2010, Chapter 10 Section II.A.3.f

- promote reduction in fuel consumption through strict registration and franchising, anti-smoke belching and PETC monitoring; conversion of engines and vehicles into fuel efficient units (DOTC);
- develop dry land cultivation and minimize waste decomposition; promote wider use of organic fertilizer and reduce pesticide use (DA);
- promote wider use of 3Rs (Reduce, Recycle and Re-use) by LGUs and conversion of waste to energy (DILG); and
- Better management of air quality, especially in urban areas through the airshed council; reduce air pollution through strict stack monitoring and prevent open burning; expand vegetation cover through the Green Philippines Program (DENR).

The PTFCC prepared the first draft of the Philippine Climate Change Strategic Framework and Response Action Plan in October 2007 which provided the strategic directions to be taken to address climate change-related development issues. Specifically, the Action Plan involves the introduction of technologies establishing low-carbon infrastructure for transport, energy, agriculture, industry and settlements.

III. TRANSPORT SECTOR

3.1 Transport Sector Performance

Modal Share

Being an archipelago, the Philippine transport system is basically intermodal in nature where people and goods are moved by road, rail, water and air transport modes. Among the four modes of transport, the road subsector is the dominant mode in terms of both passenger and cargo traffic. As shown in **Figure 3.1-1**, the road sub-sector carried approximately 1.71 billion passengers and 25.9 million tons of freight in 2006, representing 98% share in passenger traffic and 58% share in cargo traffic.

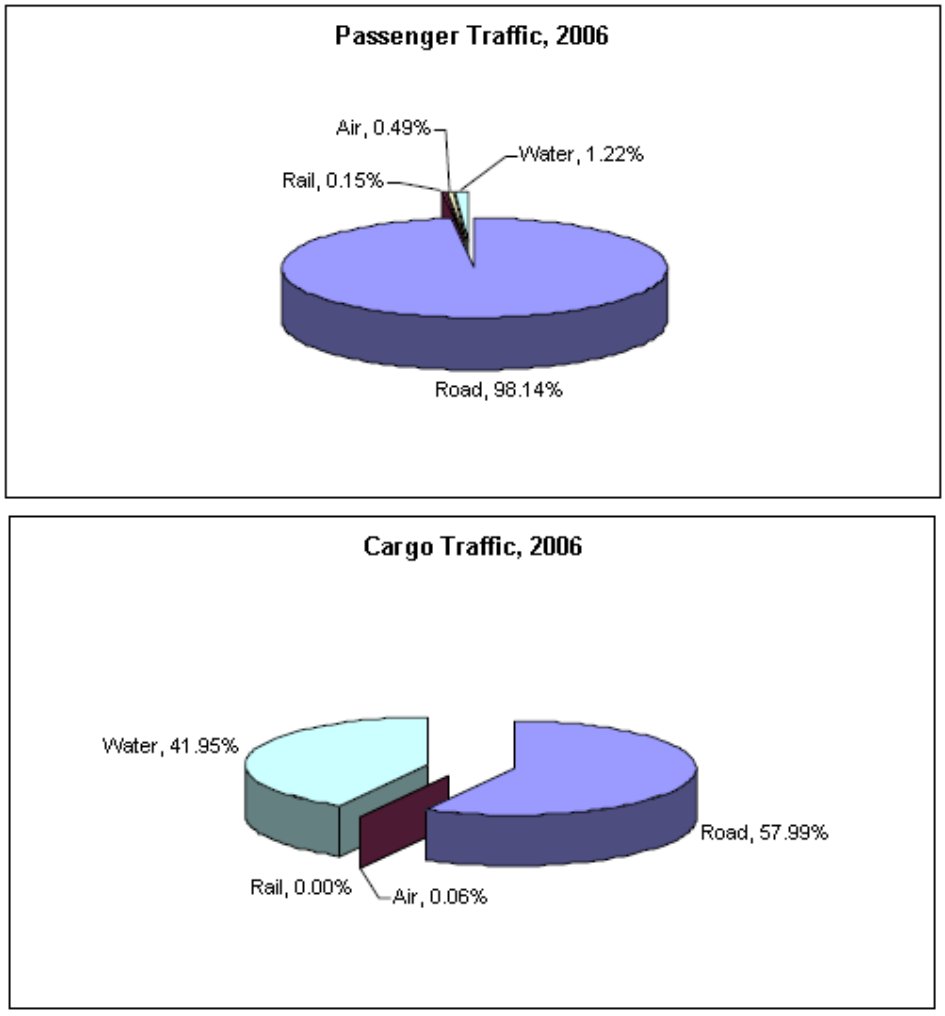

Figure 3.1-1: Transport Modal Share
Source: NTPP Estimates[17]

Road Infrastructure and Road Transport

In terms of road infrastructure, The Philippines has 203,000 kilometers of road as of 2008. About 14.5% of this or 29,370 kilometers are classified as national roads. On

[17] AusAID National Transport Policy and Planning, Activity 1 Report (2008).

the other hand, local roads, consisting of provincial, municipal, city and barangay roads constitute about 85.5% of the total road kilometer in the country, which is about 173,000 kilometers. Of the national roads, about 72% are paved with concrete and/or asphalt. For local roads, only about 22% (or 44,000 km) are paved by either concrete or asphalt, while the rest are gravel-surfaced and earth roads. Overall, road network, in terms of paved road coverage and service performance (as measured by road density), is characterized by 0.15 km of paved road per sq. km. of land area and 0.5 km of paved road per 1,000 population.

A total of 5.9 million motor vehicles were registered in the country in 2008, including trailers (**Figure 3.1-2**). Based on historical trends, both the number of cars and utility vehicles are increasing at declining rates indicating significant scrappage of old units. The number of buses is declining at an average rate of -1.6% p.a. Of the total vehicle population in 2008, close to 2 million were motorcycles and tricycles, which exhibited phenomenal annual growth at the rate of 11.6%. The level of motorization is growing at a steady rate of 6% per year, driven mainly by the increase in motorcycle/tricycle ownership.

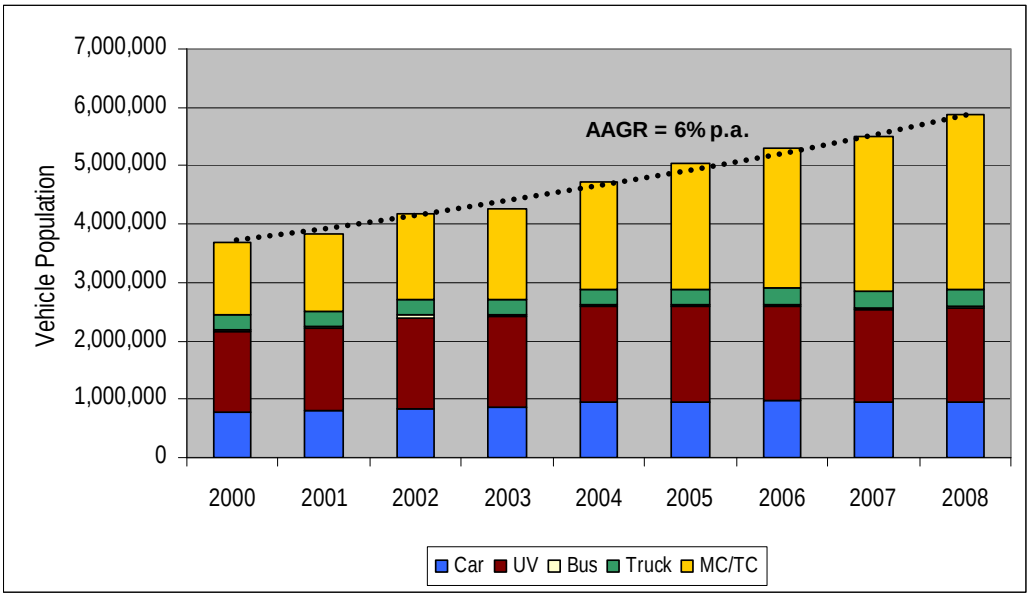

Figure 3.1-2: Motor Vehicle Population, excluding Trailers, 2000-2008
Source: Land Transportation Office

Figure 3.1-3 shows the geographical distribution of motor vehicles in the Philippines. More than 56% of all registered vehicles in 2008 were located in Metro Manila and its adjacent regions, which comprises the expanded Greater Capital Region (including Central Luzon and CALABARZON Regions). In this regard, a low-carbon transport strategy could target vehicles in these regions with expected high returns on investment.

Road Transport Energy Use

The current estimate [18] of the country's on-road fuel economy is 14 liters/100 kilometers, way below China's rate of 9.5 liters/100 kilometers. **Figure 3.1-4** indicates that only motorcycles and tricycles have attained fuel efficiency above the national average. Noting that ALGAS estimates were taken from road traffic characteristics in

[18] Based on ALGAS estimates as adjusted using data from recent road transport studies.

Metro Manila,[19] it is likely that urban traffic congestion was a major factor for the low values.

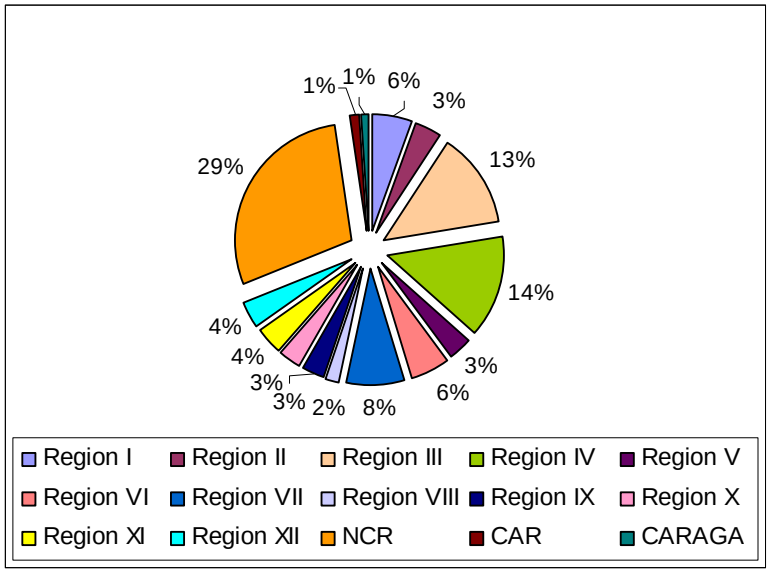

Figure 3.1-3: Regional Distribution of Motor Vehicles, 2008
Source: Land Transportation Office

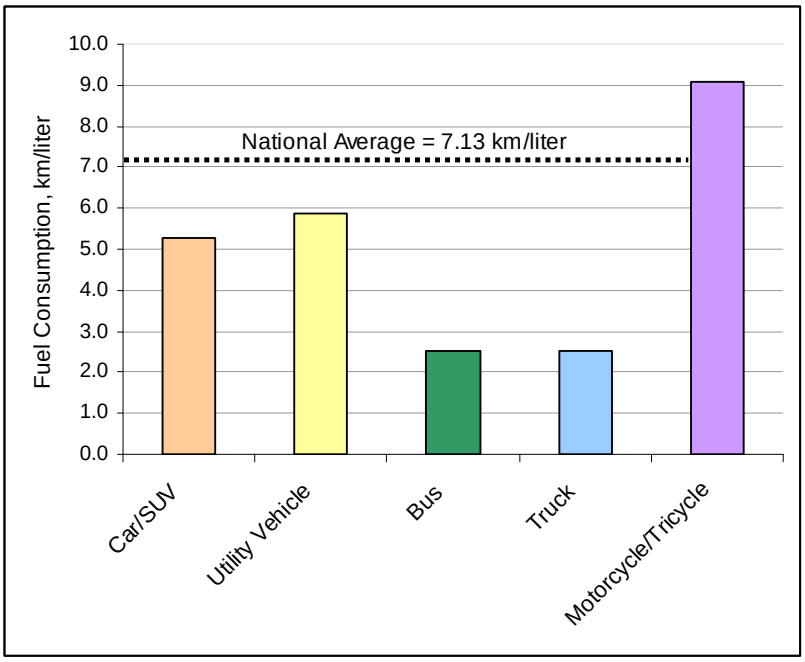

Figure 3.1-4: Fuel Consumption by Vehicle Type, 2008
Source: Study estimates

The transport energy use in the Philippines has been increased significantly from 1.9 MTOE in 1980 to 10.9 MTOE in 2008, about 6.4 percent per year, which exceeds the global 2.7 percent rate of annual increase. With all this energy derived from

[19] ADB (1992)

petroleum (transport sector accounts for 65.6% of total oil consumption), increases in future transport energy use translate into large carbon emission increases.

The Alternative Fuels Program of DOE included the conversion of in-use vehicles and acquisition of new vehicles to run using LPG and CNG. As reported by DOE, there are currently 14,500 LPG taxi units in operation in Metro Manila and other key cities like Cebu, Davao and Baguio and 112 auto-gas filling stations nationwide, excluding the 64 garage-based stations used exclusively by taxi companies and associations. Under the Natural Gas Vehicle Program for Public Transport (NGVPPT) of DOE, which was launched in 2002, there are now 34 imported CNG buses in the country, of which 25 buses are operating on provincial routes between Batangas/Laguna and Metro Manila and served by the sole CNG refilling station located in Biñan, Laguna, part of the Shell mother-daughter refueling station pilot project.

In support of the Alternative Fuels Program, the government announced in March 2008 the release of PhP 1 billion to finance the conversion of jeepneys to LPG. With unit cost of conversion ranging from PhP60,000 to PhP70,000, this lending program to be undertaken by the DOTC will benefit about 14,000 to 16,000 jeepneys plying routes in Metro Manila and other major cities. However, to this date, no funds have been disbursed; and the implementing guidelines, including the specification of conversion technology, have yet to be issued by the DOTC.

One of the major transport programs being implemented by the Philippine Government at present is the Road RoRo Terminal System (RRTS) Development Program (**Figure 3.1-5**). This involves the construction and/or improvement of RoRo port terminals along the Maharlika Highway, Strong Republic Nautical Highway (SRNH) and Palawan routes. This system aims to strengthen and enhance the efficiency of existing inter-island connections from Luzon to Mindanao and through the Visayas regions.

Expansion of Road-RORO Ferry Services

To complement the RRTS program, which seeks to decentralize development towards the countryside, boost trade and tourism and reduce transport and logistics costs, the Philippine Ports Authority (PPA) expanded the network of RORO port facilities to include other priority ports for development. From 63 RORO-capable ports in 2002 when the SRNH Project was first launched, the RRTS development during the last five years has brought to 100 the number of ports equipped with RORO ramps (18 base ports, 55 terminal ports, and 27 municipal ports) or close to 65% of the target 155 ports for RORO port improvement. The development of RoRo routes in the country expanded the coverage of bus and truck services to inter-island connections, thereby increasing the overall average distance traveled by these types of vehicles. Recent studies on inter-regional passenger and freight flows[20] indicated that vehicle kilometers traveled for cars, provincial buses and trucks have increased to as much as 20 percent since 2000.

[20] JICA Survey on Inter-Regional Passenger and Freight Flows (2005) and AusAID Managing Truck Overloading in the Philippines (2008).

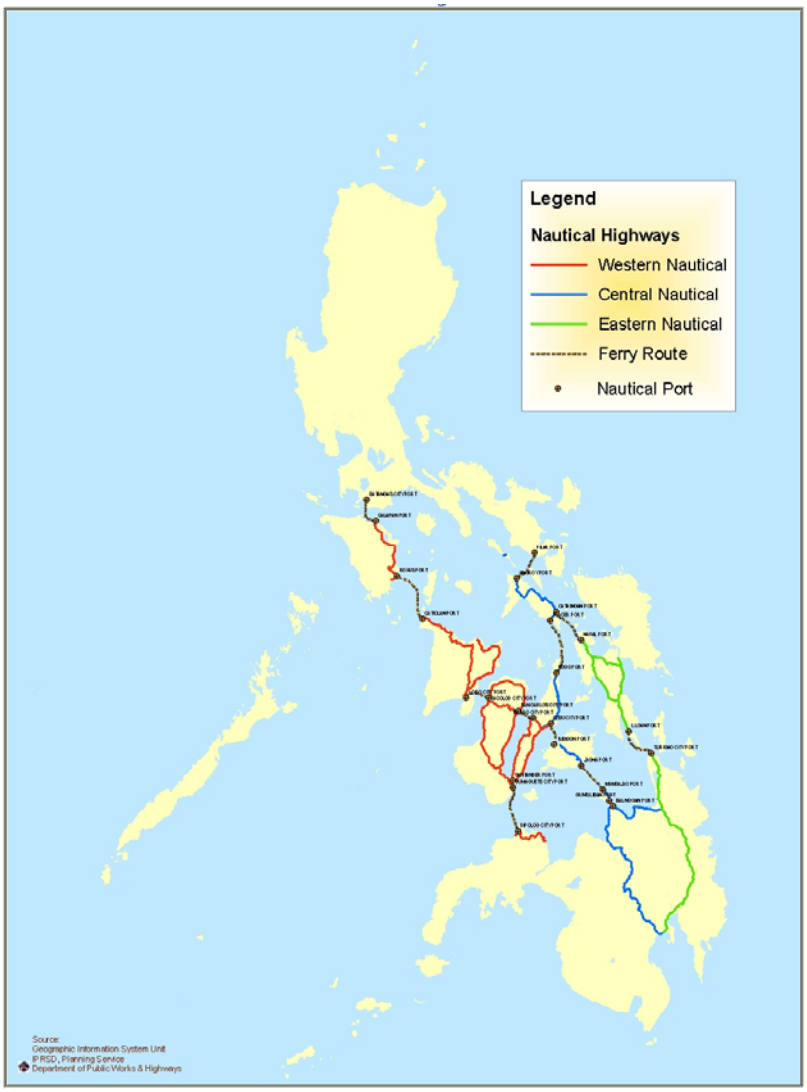

Figure 3.1-5: Road RORO Terminal System
Source: DPWH Atlas 2007

Rail Services

Inter-regional railway services are provided by the Philippine National Railways (PNR), a government-owned and controlled corporation. It operates a railway line measuring 491 km running along the Main Line South from Manila to Legaspi, Albay. It previously operated a Main North Line running from Manila to San Fernando, La Union, but this line has been closed since 1981. PNR currently offers three types of services: long-distance passenger service, commuter service, and freight and express cargo services. The Metro Manila Commuter Service operates between Caloocan and Calamba for a revenue line of about 56 km. The Commuter Line runs north – south through the CBD (central business district) of Metro Manila as shown in **Figure 3.1-6**. There was a high potential demand for the line, but the low service frequency did not enable the line to meet the peak demand. Furthermore, as trains did not run on the schedule, the number of passengers declined from its peak of 22,000 persons/day in 1977 to about 15,000 persons/day in 1990. The decline in passenger traffic continued with only 7,500 persons/day in 2007.

Figure 3.1-6: PNR Commuter Express Service

Urban railway services are operated currently in Metro Manila only. It consists of a network of electrified, rail-based mass transit systems that augment the road network system in meeting the transport demand in the metropolis. Three railway transit systems are now operational and four more are in the planning stage or already in the pipeline for construction. The three railway transit systems in operation (**Figure 3.1-7**) are the following:

- LRT Line 1, from Monumento in Caloocan City to Baclaran in Pasay City;
- LRT Line 2, from Santolan in Marikina to CM Recto in the City of Manila; and
- MRT Line 3, from North Avenue in Quezon City to EDSA in Pasay City.

LRT Line 1 is operating along a 15 km elevated railway system servicing the Taft Avenue - Rizal Avenue corridor. It currently handles about 290,000 passengers per day, with peak traffic reaching 480,000 daily riders. Due to the increased ridership of LRT 1, a train acquisition project was conceptualized with the primary objective of expanding the LRT Line 1 capacity by 50% from a nominal carrying capacity of 18,000 passengers per peak-hour per direction to 27,000 or 235,000 additional commuters to be carried by the system daily. This objective was achieved in 2000 through the procurement of seven new, air-conditioned 4-car trains and the transformation of the existing 2-car trains to 3-car trains with corresponding modifications to the existing vehicles, systems, facilities, and structures to support the operation of the expanded system. Recently, the Light Rail Transit Authority (LRTA) has completed Phase II of the LRT 1 Capacity Expansion Project, which effectively increased the capacity of LRT Line 1 to 40,000 passengers per hour per direction from the current capacity (Phase I) of 27,000 hourly passengers. In 2007, the average weekday ridership reached 374,000 passengers per day.

Figure 3.1-7: Metro Manila Urban Rail System

While the Philippines has extensive networks of ports and airports which serve widely disperse island provinces and cities, the Study did not consider any change in baseline conditions for the maritime transport and civil aviation sectors in the future. More importantly, the GHG emissions from these transport subsectors while significant at about 18% of transport sector emissions, have limited scope for country-level abatement measures. The focus on road transport would also take into account its dominance in moving passengers and freight in the country.

3.2 Baseline Analysis

3.2.1 2007 GHG Estimates

Using 2006 IPCC guidelines on fuel emission factors by fuel type, the transport sector GHG emissions for 2007 were estimated at 29.3 $MtCO_2$, of which road transport contributed about 24 $MtCO_2$, while maritime and aviation emitted a total of 5.3 $MtCO_2$. **Figure 3.2-1** presents the GHG emissions by fuel type consumed in 2007.

From the ALGAS 1990 emission level of 10.64 $MtCO_2$, the 2007 estimate represents a 276% increase over the 17-year period or an annual growth of 6.1%. **Figure 3.2-2** shows the growth in transport GHG emissions by subsector. The contribution of maritime transport and aviation significantly increased from 1998 to about 18% of transport sector emissions due mainly to the improvement in shipping and air services with the expansion of the port and airport systems in the country. Since 2000, the road transport GHG emissions have been increasing at an average growth rate of 3.1% p.a. Assuming that the vehicle composition remains the same and the annual growth rate of vehicles is maintained at 6% p.a. (from 2000 to 2008), the projected emissions from road transport in 2015 and 2030 are 31.7 and 50.4 $MtCO_2e$, respectively.

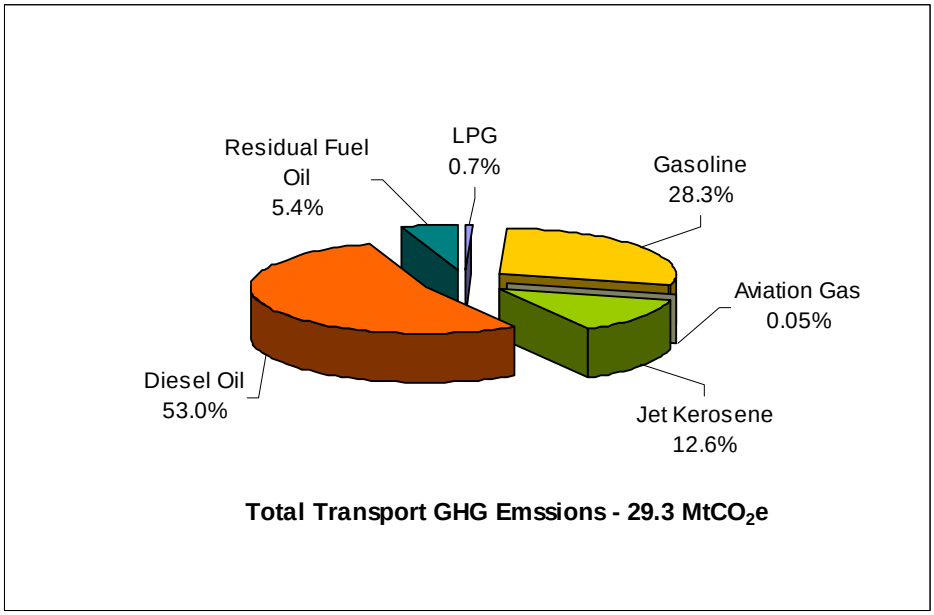

Figure 3.2-1: Transport GHG Emissions by Fuel Type, 2007

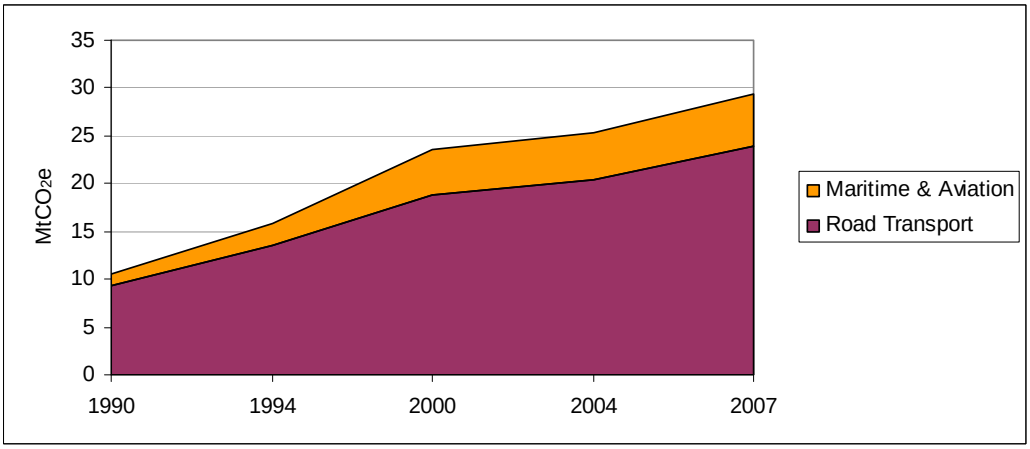

Figure 3.2-2: Growth in Transport GHG Emissions, 1990 to 2007

Using the sectoral approach and ALGAS values for average distance traveled by vehicle type, as adjusted using recent transport studies,[21] and vehicle population, estimates of road vehicle emissions by vehicle type were determined as shown in **Figure 3.2-3**. The estimated road transport GHG emission in 2007 is 23.8 $MtCO_2e$, slightly lower than the 24.0 $MtCO_2$ determined using the IPCC reference method. The difference is attributed to the variations in data reporting by fuel end-users and government agencies monitoring the fuel consumption.

[21] JICA Survey of Inter-regional Passenger and Freight Flows (2005), JICA CALA Road Study (2006), AusAID Managing Truck Overloading Study (2008), among others.

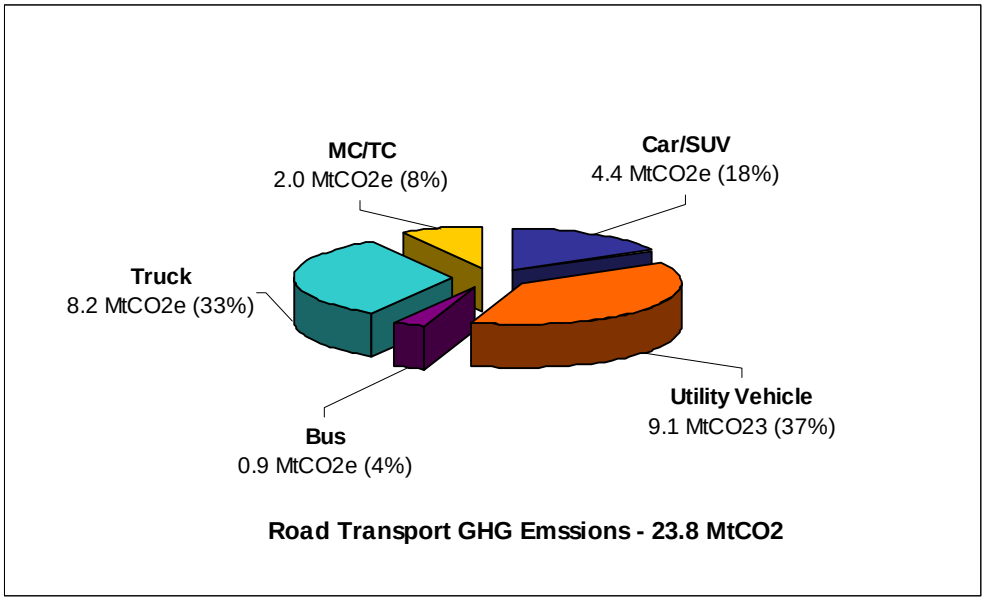

Figure 3.2-3: GHG Emissions by Vehicle Type in $MtCO_2e$, 2007

In identifying low-carbon strategies for the road subsector, the Study considered the relative contribution of vehicle types and services in GHG emissions. Notably, as the significant contributors of GHGs, the focus of mitigation options should be on utility vehicles, particularly the public utility jeepneys (37% of road transport GHG emissions), own-account and for-hire trucks (33%), and cars, including SUVs and taxis (18%).

The emission factors and other assumptions on road transport activities are presented in **Appendix 3**.

3.2.2 Baseline Scenario

The Baseline Scenario for CO_2 emissions from the transport sector was based on the actual transport energy data from 2000 to 2007, and the projected energy profile from 2008 to 2030 based on the 2008-2030 Philippine Energy Plan (PEP 2008). ALGAS utilized the MARKAL model in generating baseline scenarios, while the on-going SNC preparation is using the LEAP model, both of which has the capability to determine the optimal configuration of the Philippine energy situation between reference years with no GHGs emissions target imposed. In the Study, a simplified spreadsheet model was used as described in Appendix 3 using vehicle growth factors disaggregated by type of vehicle, by fuel type and nature of transport service (private transport vis-à-vis for hire modes).

To ensure that estimates of fuel consumed in the road transport subsector are within expected ranges, the PEP 2008 targets were considered. **Figure 3.2-4** presents the final energy demand projections of PEP 2008 with comparable estimates shown from the Asia Pacific Energy Research Centre (APERC).[22]

For consistency with DOE's PEP 2008, the Baseline Scenario was not adjusted to reflect the mandated years of roll-out of bio-ethanol and bio-diesel blends pursuant to the Biofuels Act of 2006. The overall annual increase in vehicle population from 2008 was set at 6% for all vehicle types (**Figure 3.2-5**), which was much lower that the

[22] APERC (2006), APEC Energy Demand and Supply Outlook 2006: Philippines, Tokyo.

resulting vehicle forecasts by vehicle type and use (private and public transport service) as indicated in Appendix 3. The projected CO_2 emissions from 2008 to 2030 resulting from the Baseline Scenario is presented in **Figure 3.2-6** with comparable forecasts from ALGAS and APERC.

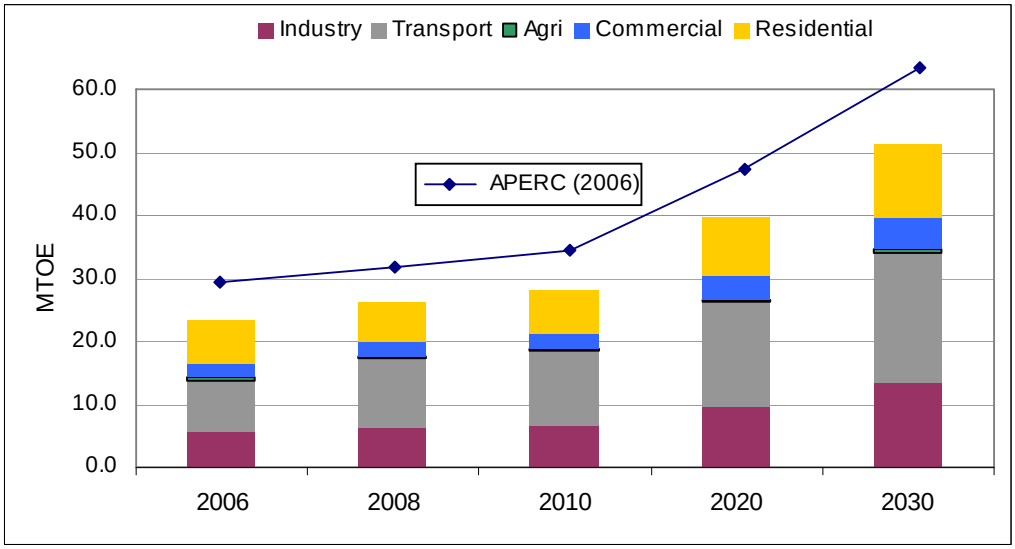

Figure 3.2-4: DOE Final Energy Demand Forecasts, 2010 to 2030
Sources: PEP 2008-2030 and APERC Analysis (2006)

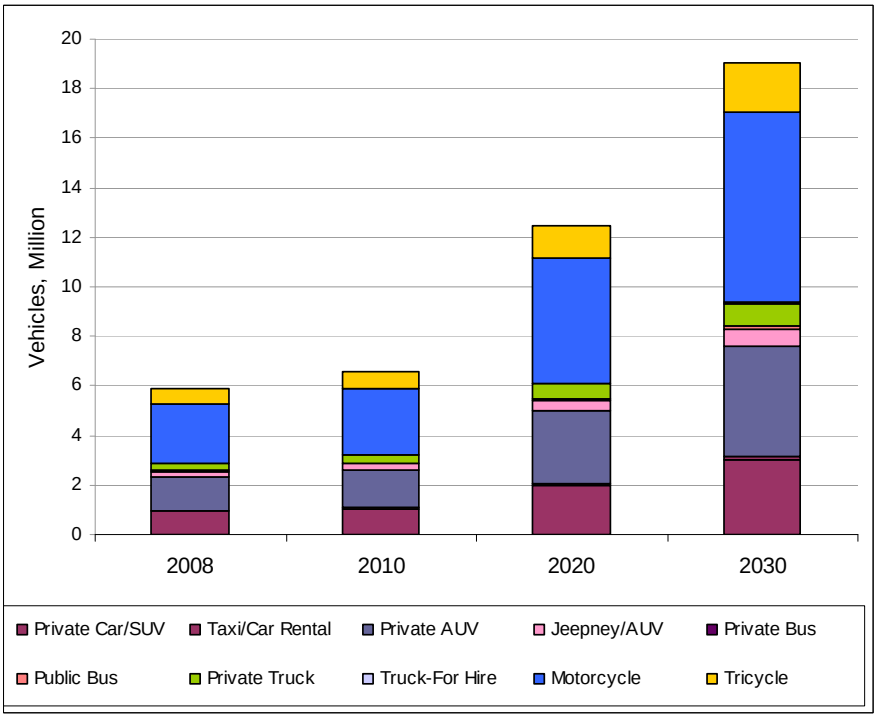

Figure 3.2-5: Projected Vehicle Population: Baseline Scenario
Sources: Study team estimates

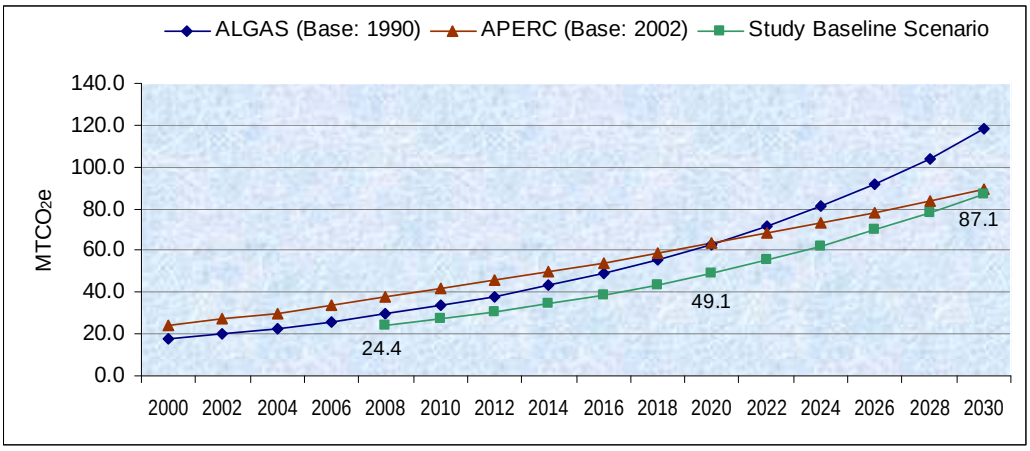

Figure 3.2-6: Projected GHG Emissions: Baseline Scenario
Sources: Comparable estimates from ALGAS (1998) and APERC Analysis (2006)

In Figure 3.2-6, the Baseline Scenario is compared with the projected CO_2 emissions in ALGAS (1998) and APERC (2006) estimates, where the latter used the IPCC Reference methodology based on estimates of total energy consumed by sector. The Baseline Scenario emissions are lower than the APERC projections because the fugitive emissions were not accounted for in the simplified Study model. To date, no estimates were available for the DOE PEP 2008.

3.3 Low-Carbon Scenarios

3.3.1 Review of Mitigation Options

In spite of numerous studies that indicate transport options tend to be less cost-effective compared to other GHG reduction strategies, there are various reasons to believe otherwise. Notably, there are large and high-valued co-benefits as these strategies contribute to energy security by reducing fossil fuel use, reduce emissions of local air pollutants, enhance traffic safety, and alleviate congestion. Moreover, many incremental, low-cost technologies are in actual use to reduce energy use such as innovations in engines and vehicle design which yield greater fuel efficiency. There are also extensive evidences that reductions in vehicle use are attainable. Finally, there are numerous policies that could reduce fuel consumption with substantial decrease in GHG emissions at less than or zero net cost.

Several interventions or measures which aim to reduce carbon emissions in road transport were initially taken from the ALGAS list (Appendix 2). These can be broadly classified as: (i) interventions which reduce emissions per kilometer; (ii) interventions which reduce emissions per passenger or cargo transported; and (iii) interventions which reduce vehicular trips. IPCC (2007) identified key mitigation technologies and practices for transport systems and road traffic management that are currently available and could be adopted. According to McKinsey (2009)[23] cited technical vehicle improvements (e.g. internal combustion engine improvements, hybrid vehicles, electric vehicles and biofuels) as having high abatement potentials (**Figure 3.3-1**).

[23] McKensy & Company (2009), Pathways to a Low Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve, New York.

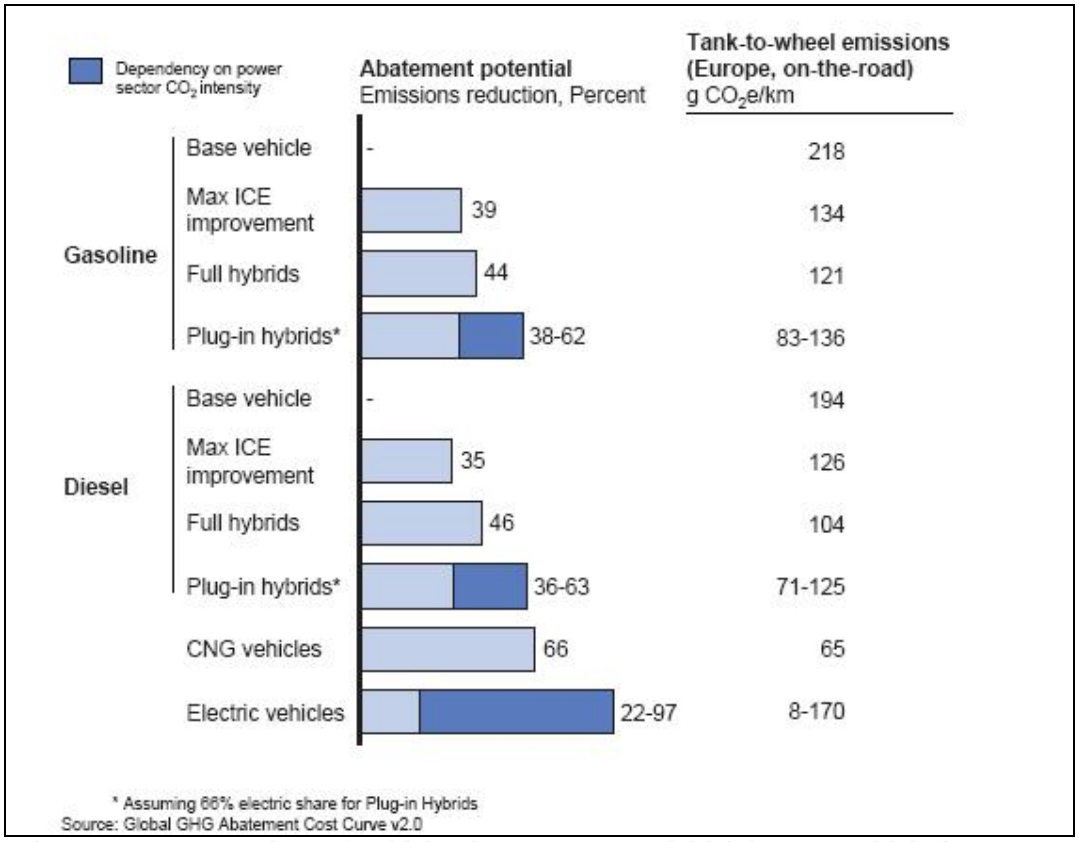

Figure 3.3-1: Comparison of Vehicle Abatement Potential (Light Duty Vehicles)
McKensy & Company (2009), Pathways to a Low Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve

The Study focused on several abatement policies and technologies which are part of the DOTC and DOE plans and programs as well as those identified in previous studies on the Philippines, particularly ALGAS. RRECCS (2009)[24] concluded that fuel efficient vehicles which are already tested and validated need to be promoted throughout Southeast Asia, including the Philippines, for broad implementation.

Table 3.3-1 presents the list of mitigation options considered in the Study with corresponding status of their promotion and/or implementation in the Philippines. Detailed description of these abatement measures are presented in Appendix 3.

Table 3.3-1: Potential Abatement Policies and Technologies

Category	Key Options	Status and Performance Targets
Vehicle Efficiency	▪ Road maintenance and improvements	▪ Existing Road Fund from motor vehicle registration collection of about PhP8 billion yearly (2008) with maintenance backlog in 2007 estimated at PhP9 billion[25] ▪ Truck overloading study (2008)[26] proposed the

[24] ADB (2009), The Economics of Climate Change in Southeast Asia: A Regional Review.
[25] World Bank (2009), Philippines Transport for Growth: An Institutional Assessment of Transport Infrastructure, Report No. 4781-PH.
[26] AusAID (2008), Reform Agenda 009-01: Managing Truck Overloading in the Philippines, Final Report.

Category	Key Options	Status and Performance Targets
		rehabilitation of 15 existing weighbridge sites and 20-34 new sites to strengthen the enforcement of axle load limits for trucks ▪ Major national road improvement projects set for implementation with financing from ADB, JICA and the World Bank[27]
	▪ Traffic management measures	▪ MMDA and Local Government Units (LGUs) undertaking traffic flow improvements
	▪ Vehicle inspection and maintenance system	▪ LTO currently operating Motor Vehicle Inspection Stations (MVIS) in Metro Manila and in regional cities ▪ Full implementation involves the construction of 124 MVIS inspection lanes nationwide
Vehicle Efficiency	▪ Improved driving practices and driver education and awareness campaign	▪ Fuel Conservation and Efficiency in Road Transport Program (Road Transport Patrol), an IEC program of DOE launched in 1998 and continued till 2000; program targeted 5% fuel reduction by road transport users ▪ DOE continuing tri-media campaign under the National Energy Efficiency and Conservation Program (NEECP), 2008-2030, which targets energy savings equivalent to 48 million TOE
	▪ Efficiency improvements in conventional gasoline and diesel motorcycles, cars, utility vehicles, buses and trucks	▪ Fuel economy runs sponsored by DOE to establish fuel mileage rating and future vehicle labeling as part of NEECP ▪ DOST through PCIERD undertaking road tests of vehicles and engine devices ▪ Some LGU regulations requiring conversion to four-stroke engines for motorcycles/tricycles such as Mandaluyong City in Metro Manila ▪ DENR approved CDM project[28] on retrofitting carbureted two-stroke engine tricycles with direct in-cylinder fuel injection for three cities: Vigan, Puerto Princesa and

[27] National Road Improvement and Management Project (NRIMP) Phase 2.
[28] PDD: Envirofit Tricycle-Taxi Retrofit Program for Vigan, Tugegarao and Puerto Princesa, Version 3.0, October 2008.

Category	Key Options	Status and Performance Targets
		Tuguegarao; targeting 6,000 tricycles in these cities
	▪ Vehicle economy standards	▪ DOE/DOST undertaking studies ▪ No immediate plan to set standards
Low carbon fuels	▪ Biofuels	▪ Government agencies required to reduce its fuel consumption for transport by percent of their average monthly consumption through substitution or blending of petroleum with biofuels[29] ▪ Biofuels Act of 2006 mandates use of 2% blend of CME in diesel by 2009, and 5% bioethanol mix by 2010 and 10% bioethanol by 2011 ▪ PEP 2008 targets: 5-10% biodiesel and 20% bioethanol by 2020; and 20% biodiesel and 20-85% bioethanol by 2030
	▪ LPG	▪ About 14,500 gasoline-fed taxis converted to LPG ▪ Trials on-going for LPG-fed tricycles ▪ DOTC to implement conversion of jeepneys to LPG using PhP2 billion from Road Fund ▪ LTFRB providing an additional three years in the franchise of taxi operators who convert to LPG, extending the validity period of their certificates of public convenience from five to eight years
	▪ CNG	▪ DOE launched the Natural Gas Vehicle Program for Public Transport (NGVPPT) in 2002 ▪ About 25 OEM CNG provincial buses running in Metro Manila and adjacent provinces ▪ PEP 2008 targets 200 CNG buses by 2010; and 5,000 CNG buses by 2026 (PEP 2006 previously targeted 9,000 CNG buses by 2030) ▪ Trials on-going for CNG tricycles
	▪ Hybrids (gasoline-electric vehicles)	▪ Toyota Phils. recently introduced its Prius at purchase cost of PhP2.5 million ▪ Government considering

[29] Administrative Order No. 110, Directing the Institutionalization of a Government Energy Management Program, dated October 25, 2004.

Category	Key Options	Status and Performance Targets
		proposals to provide tax incentives for hybrid vehicles
	▪ Electric vehicles	▪ E-jeepneys in operation in Makati City ▪ Some commercial districts in Metro Manila using electric vehicles for shuttle service (e.g. Bonifacio Global City)
	▪ Hydrogen and Fuel Cell vehicles	▪ DOE conducting in-house researches on hydrogen and fuel cell technologies ▪ Independent studies[30] noted market penetration to increase after 2030
Vehicle demand reduction	▪ Intelligent transport system (ITS) technologies	▪ MMDA pursuing EDSA bus operation optimization using RFID (see section on Mass Transit Systems) ▪ No area-wide application of ITS planned for Metro Manila and highly urbanized cities
	▪ Congestion pricing, incentives and vehicle taxes	▪ Previously recommended for Metro Manila, but current regulation centered on vehicle restrictions, e.g. truck ban hours and number plate vehicle restriction[31] ▪ Current public transport sentiment largely opposed to congestion pricing and vehicle tax based on fuel standards, therefore elected officials expected to be reluctant to support it
	▪ Inclusion of GHG impacts in land use and transport planning	▪ Consideration under the AusAID-assisted NTPP Phase 2 to developed transport policy framework to start in August 2009 to February 2010[32] ▪ Transport authorities in developed countries[33] cited integrated transport and land use planning as the most promising long term strategy for reducing transport GHG emissions, but require a high degree of collaboration among agencies and among plans
	▪ Car-less day and carpooling	▪ Included in DOE Voluntary Agreement Program under NEECP

[30] 20% market penetration in the European Union by 2030, including hydrogen in vans and buses.
[31] Modified Unified Vehicular Volume Reduction Program (UVVRP) during peak hours enforced by MMDA; except in Makati, Mandaluyong and San Juan which implement UVVRP restrictions from 7 a.m. to 7 p.m.
[32] Reform Agenda 008-01: Preparation of Approach and Methodology for National Transport Policy and Planning (NTPP), Phase 2 - Formulation of National Transport Policy Framework.
[33] U.S. Federal Highway Administration (2008), Integrating Climate Change into the Transportation Planning Process, Final Report,

Category	Key Options	Status and Performance Targets
Promotion of mass transit systems	▪ Public transport route restructuring and optimization of operation	▪ MMDA plans to enhance the EDSA Organized Bus Route (OBR) Program[34] through RFID application, construction of bus terminals and bus stop improvements, and new regulation on short-running of buses to meet hourly demands; fuel savings estimated to be about 9,500 liters of diesel per bus per year[35] ▪ DOTC studies on public transport strategic development covering Metro Manila and Metro Cebu to start in August 2009
	▪ Introduction of BRT System	▪ USAID/ECAP 2007 study[36] identified two pilot BRT routes out of 11 high priority public transport; expected reduction in fuel consumption in the range of 8-26% ▪ Study on Ayala CBD to Bonifacio Global City BRT Line completed in 2008 ▪ Manila BRT study under World Bank loan grant to MMDA to start in August 2009 ▪ World Bank-assisted Cebu BRT study to start in July 2009
	▪ Manila MRT/LRT system expansion	▪ LRT Line 1 North Extension on-going construction (Monumento to North Avenue); estimated 4,150 TOE of diesel saved[37] ▪ LRT Line 1 South Extension to Bacoor, Cavite planned under World Bank loan/PPP arrangement; substantial reduction in jeepney and bus runs would be realized due to the transfer of public transport passengers to the LRT 1 system, thereby increasing travel speed from 13.2 kph in 2013 (opening year) to 12.5 kph in 2030 ▪ LRT Line 7 Project (Commonwealth Avenue Line) approved for implementation

[34] TTPI (2009), OBR Feasibility Study and Implementation Plan, Draft Final Report, Version 2.
[35] CDM Board (2009), Project Design Document for EDSA Bus Dispatch System, Manila, Philippines, Version 3.
[36] C5 (SLEX -Commonwealth Avenue) with route length of 21 km and EDSA-Binangonan (24km).
[37] Esguerra, G. (2008), Carbon Financing for the LRT Line 1 North Extension Project, UP School of Urban and Regional Planning.

Category	Key Options	Status and Performance Targets
		under PPP scheme ▪ MRT Line 3 West Extension pre-feasibility study on-going ▪ LRT Line 2 East Extension study proposed by LRTA
Promotion of non-motorized transport	▪ Segregated cycle paths	▪ Marikina's 50 km of segregated on-road bicycle lanes and 16.6 km of bikeways along the Marikina river, connecting to the LRT Line 2 Santolan Station constructed; assessed to be serving 12% of households (work-related trips) ▪ Quezon City has designated bicycle lanes; while the University of the Philippines Diliman Campus implemented a bikeway project as a component of its Comprehensive Campus Transportation and Traffic Management Plan
	▪ Walkways and pedestrian zones	▪ Selected LGUs implementing clearing and improvement of sidewalks

3.3.2 Formulation of Low-Carbon Scenarios

In the context of the Philippine road transport subsector, two low-carbon scenarios were prepared to illustrate the prospects of technical innovations and policies in reducing GHG emission levels. A preliminary screening of the abatement options taking into account the existing transport-related plans and programs of DOTC and DOE, potential impacts from different measures, targeted vehicle types and category of services, and general indication of CO2 cost-effectiveness. The Study was guided by benchmark assessment results from reference studies, notably: Wright and Futton (2005),[38] Hook and Wright (2002),[39] and IPCC (2007).

Table 3.3-2 shows the evaluation of technological and policy options for the identification of abatement measures for the Low-Carbon Scenarios.

[38] Wright, L. and Fulton, L. (2005), *Climate Change Mitigation and Transport in Developing Nations*, Transport Reviews, Vol. 25, No. 6.

[39] Hook, W., and Wright, L. (2002), *Reducing GHG Emission by Shifting Passenger Trips to Less Polluting Modes*, Background Paper for the Brainstorming Session on Non-Technology Options for Stimulating Modal Shifts in City Transport Systems held in Nairobi, Kenya.

Table 3.3-2: Assessment of Technological Options and Policy Instruments

Option	CO2 Effect/ Cost-Effectiveness	Co-Benefits	Financial Impact	Socio-Political Acceptance	Implementation Speed/ Conclusion
Road maintenance and improvements	H (5-10% fuel efficiency improvement)	High	High	High	MT/LT Include in Scenario testing
Traffic management	M (2-5% fuel efficiency improvement)	Medium	Medium	High	ST Include in Scenario testing
Vehicle inspection and maintenance system	M (2-5% fuel efficiency improvement)	Medium	Medium	Medium	MT Include in Scenario testing
Driving practices and driver education/Eco-driving	M (2-5% fuel efficiency improvement)	Medium	Low	Low Involves behavioral change	MT/LT Include as support initiative
In-use vehicle ICE	H (5-10% fuel efficiency improvement)	High	Low	Medium (Need incentives)	ST/LT Include in Scenario testing
Vehicle economy standards/CO_2 emission standards	H (10-20% fuel efficiency improvement)	High	Medium	Low (Need incentives/ subsidies)	LT Include in Scenario testing
Biodiesel (up to 10% mix)	M (2-5% fuel efficiency improvement)	Medium	Medium	High	MT Include in Scenario testing
Biodiesel (10-20% mix)	H (10-20% fuel efficiency improvement)	High	High	Medium	LT Include in Scenario testing
Bioethanol (up to 20% mix)	M (2-5% fuel efficiency improvement)	High	High	Medium	MT Include in Scenario testing
Bioethanol (> 20% to 85% mix)	H (10-20% fuel efficiency improvement)	High	High	Medium	LT Include in Scenario testing
LPG	M (2-5% fuel efficiency improvement)	Medium	Low	Low (Safety concern)	ST/LT Include in Scenario testing
CNG	H (10-20% fuel efficiency improvement)	High	High	Medium	MT/LT Include in Scenario testing
Hybrids	M (2-5% fuel efficiency improvement)	Medium	High	Medium	MT/LT Excluded (better option is Euro IV compliant new light duty vehicles)

Option	CO2 Effect/ Cost-Effectiveness	Co-Benefits	Financial Impact	Socio-Political Acceptance	Implementation Speed/ Conclusion
Electric vehicles	H (10-20% fuel efficiency improvement)	High	High	Low (lack of technical information)	MT/LT Exclude (better option is Euro IV compliant new light duty vehicles)
Hydrogen and Fuel Cell vehicles	H (10-20% fuel efficiency improvement)	High	High	Low (lack of technical information)	LT Exclude due to major market barrier
Intelligent transport system (ITS) technologies	L/M (1-5% fuel efficiency improvement)	Low	Medium	Low (lack of technical information)	MT/LT Exclude due to major market barrier
Congestion pricing	H (10-20% fuel efficiency improvement)	High	Medium	Low	MT Include in scenario testing
Vehicle tax	M (2-5% fuel efficiency improvement)	Medium	Beneficial to Govt	Low (unpopular)	MT/LT Exclude due to low acceptance
Integrated land use and transport planning	H (10-20% fuel efficiency improvement)	High	Low	Medium	LT Include as part of public transport route restructuring
Vehicle restriction	H (10-20% fuel efficiency improvement)	High	Low	Low	MT/LT Include in scenario testing
Public transport route restructuring	H (10-20% fuel efficiency improvement)	High	Low	Medium	MT Include in scenario testing
BRT system for major cities	M (2-5% fuel efficiency improvement)	High	High	Medium	MT/LT Include in scenario testing
LRT/MRT for Metro Manila	M (2-5% fuel efficiency improvement)	High	High	Medium	MT/LT Include in scenario testing
Non-motorized transport	L/M (1-5% fuel efficiency improvement)	Medium	Low	Low (Relatively unpopular)	MT/LT Include in scenario testing

L - low (<2% share of total road transport emissions)
M - medium (2-5%)
H - high (>5%)

ST - short-term
MT - medium-term
LT - long-term

3.4 Potential Interventions and Their Cost-effectiveness

3.4.1 Selection of Technologies and Policies

From the shortlist of abatement options as indicated in Table 3.3-2, promising or more priority alternatives were further evaluated on the basis of emission reduction impact and other criteria as previously used in ALGAS. The selection of options to include in the low-carbon scenarios was based on: potential for GHGs reduction, scope and range of application, commercial readiness of the option, indicative marginal cost, and identified constraints that will prevent or restrain the application of the option including financial, institutional, policy, information and other barriers.

In the field of transport, local air pollutants and GHGs have a common source in vehicle traffic, which may also induce congestion, noise and accidents. Addressing these problems simultaneously, if possible, offers the potential of large cost reductions, as well as reductions of health and ecosystems risks. In the review of potential abatement policies and measures, the co-benefits were identified, which address the current local problems like health impacts and welfare concerns due to congestion as well as future climate change impacts from CO_2 emissions. As co-benefits are highly sensitive to the valuation method applied, and are likely to be controversial, they are presented in the assessment to illustrate likely range in economic benefits. The comparison of abatement options mainly focused on costs without any non-market benefits.

The results of the assessment and selection of technologies and policies are presented below.

Alternative Fuels

The DOE Alternative Fuels Program has three major subprograms, namely: Biofuels Program, Natural Gas Vehicle Program for Public Transport (NGVPPT), and Autogas Program. **Table 3.4-1** presents the results of detailed evaluation.

Table 3.4-1: Evaluation of Alternative Fuels Scenarios

Scenarios	Energy Use Impact, Fuel Saved/year MTOE	Emission Impact, GHG Reduced/year MtCO2	Indicative Cost of GHG Reduction, USD per tCO_2
Biodiesel			
S1: PEP 2008 (20% CME by 2030)	1.1	3.4	30.8[40]
S2: 20% CME by 2020	1.8	3.5	
Bioethanol			-9.8 (with co-benefits)
S1: PEP 2008 (E85 by 2030)	1.4	5.2	
S2: E85 by 2025	4.7	11.3	
Natural Gas			
S1: PEP 2008 (5,000 CNG buses by 2026)	0.02	0.06	442[41]
S2: 10% of all buses and trucks by 2020, 25% by 2025, and 50% by 2030	1.8 (2020-2030)	1.6 (2020-2030)	No estimate for with co-benefits
Auto Gas			
S1: 100% conversion of gasoline-fed taxis by 2015	0	0.04	9.7[40]
S2: 25% conversion of gasoline-fed private cars by 2020, 50% by 2030	0	1.0	

[40] Study estimates
[41] Wright and Fulton (2005), "Climate Change and Transport in Developing Nations", Transport Reviews

Biofuels provide greater impacts in reducing GHG emissions and substituting imported petroleum with indigenous energy resources. The use of liquid biofuels has the added advantage as compared with gaseous fuels or electricity that it can be blended with petroleum fuels in small quantities and avoids the need for changes to the vehicle stock or major investments in refueling infrastructure. DOE's study of alternative fuels indicates that there is sufficient potential in conventional feedstocks and available land to produce the needed feedstock. With potential cumulative GHG reduction of about 363 $MtCO_2$ from 2008-2030 and total cost of USD 11.2 billion over the same period (using USD 29.50 per liter of biofuel used[42]), the mitigation cost was estimated at USD30.8 per tCO_2 without co-benefits. Based on USD 100 per liter of fuel saved[43] to account for health effects, the mitigation cost adjusted for co-benefits was -USD 9.8/ tCO_2.

It would appear that natural gas for transport is the least effective low-carbon strategy noting the large capital investment in developing pipelines and fueling infrastructure (estimated at USD 5 billion for a network of 420 kilometers of main and distribution lines and about 13 daughter stations, including nine in Metro Manila. The transport industry preference is on dedicated CNG buses (OEM) because of higher reliability. However, CNG buses cost more to purchase than diesel buses, and operating expenses are also significantly higher. According to the IEA, a CNG bus costs USD 25,000 to 50,000 more than comparable diesel bus. Recent acquisition cost of Chinese-made OEM NGVs is PhP5.5 million (USD 114,600). Generally, CNG buses are between 15% and 40% less fuel efficient than diesel buses, and have substantially lower driving range. While NGVs have high potential to reduce levels of local air pollutants, recent life cycle analysis suggests some GHG emission reduction relative to gasoline, and insignificant decrease relative to diesel as revealed in the above Study evaluation. With varying government views on the natural gas reserves and the minimal impact on GHG emission abatement, NGVs should not form part of the low-carbon strategy for the country.

The DOE Alternative Fuel Program included the expansion of coverage of auto-gas vehicles (LPG-fed), particularly those currently running on gasoline engines. Unlike other countries such as Thailand, Malaysia and India, the rate of taxi conversion even with the incentive package offered by the government[44] has been low with total LPG vehicles just about 20,000 in 2007. Taking only the average conversion cost of USD 850 per vehicle for in-use cars, with no fuel cost savings, the calculated cost of emission reduction is about USD 9.7/tCO_2e.

A similar finding is shown for LPG use for road transport with demonstrated insignificant impact on GHG abatement. Comparative emission data from Manila Auto Gas validated independent studies that CO_2 emissions are 5-10% less when compared to gasoline vehicles. The efficacy of the DOTC-planned conversion of diesel-fed jeepneys and other Asian Utility Vehicles (AUVs) for hire to LPG is doubtful considering that CO_2 emissions are only 2% less when compared to diesel vehicles. In this regard, LPG as an alternative fuel should not be considered in setting the low-carbon strategy. More importantly, diesel-to-LPG conversion is known to cause an increase in fugitive emissions.

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[42] IEA (2008), From 1st- to 2nd-Generation Biofuel Technologies.

[43] World Bank (2000), Environmental Cost of Fossil Fuels: A Rapid Assessment Method with Application to Six Cities.

[44] Concessional loans from government banks and 10-year franchise, renewable for another 10 years from the original franchise period of five years, renewable for another five years.

Vehicle Efficiency Improvements

The IEA estimates that a 5%-10% reduction in average fuel consumption per kilometer could be achieved through a combination of the following measures: stronger inspection and maintenance programs to target fuel efficiency, adoption of on-board technologies that improve in-use fuel efficiency and improve driver awareness of efficiency; better and more widespread driver training programs, and better enforcement and control of vehicle speeds.

The IEA also noted the variety of potential policies to improve freight truck efficiency, including improvements to the technical efficiency and in-use energy intensity of vehicles, improvements in the system efficiency of freight movement through better logistics planning and freight terminals, and through the shifting freight movement from trucks to much more efficient modes such as rail and water transport. McKinsey (2009) argued that, if a portion of long-haul truck fleet is replaced by longer trucks with 50% added load capacity (two trucks instead of three), the GHG abatement potential could be 15% of emissions of that portion of the fleet. However, a number of potential technical measures are largely not implemented by trucking companies in the Philippines. Moreover, past studies have rejected proposals for integrated freight terminals noting rapidly changing freight traffic patterns. In this Study, the potential contribution of road freight traffic to GHG abatement has been considered under the category of improved vehicle inspection and maintenance system.

Table 3.4-2 presents the results of detailed analysis of vehicle efficiency improvement measures, including available vehicle and engine technologies.

Table 3.4-2: Evaluation of Vehicle Efficiency Measures

Scenarios	Energy Use Impact, Fuel Saved/year MTOE	Emission Impact, GHG Reduced/year MtCO2	Indicative Cost of GHG Reduction, USD per tCO_2
National road maintenance and improvements, including traffic management			
S1: Current investment level for asset preservation (43% of requirements)[45]	0.4	1.0	172.6
S2: 100% of asset preservation needs	0.9	2.3	-2.1[46] (with co-benefits)
Vehicle inspection and maintenance system, including driver training on eco-driving (5% fuel efficiency improvement)[47]			
S1: Metro Manila and Regions III & IVA (56% of total vehicle population)	11.6	1.4	7.7
S2: Nationwide coverage	20.7	2.5	-5.0[43] (with co-benefits)
Energy saving technologies for new gasoline cars and utility vehicles			
S1: Direct injection (DI) and variable valve systems (10% fuel efficiency improvement))	1.2	0.1	103.4
S2: S1 and improvements in transmissions, vehicle aerodynamics, tires, and light-weighting (20% fuel efficiency)	2.5	0.2	0[48] (with co-benefits)

[45] World Bank (2009), Philippines Transport for Growth: An Institutional Assessment of Transport Infrastructure.

[46] Based on 1% improvement in IRI yielding 4% reduction in vehicle operating cost and NRIMP 2 estimate of PhP 1 invested in road upkeep/improvement returns PhP1.01 as net economic benefits.

[47] ADB (2004), Feasibility Study for the Privatization of Metro Manila Airshed MVIS Lanes.

[48] Using USD100/ton of gasoline fuel as environmental cost, excluding GHG emissions (Source: World Bank, Environmental Cost of Fossil Fuels: A Rapid Assessment Method with Application to Six Cities, 2000) and payback period of two years for fuel savings with energy saving technologies.

Scenarios	Energy Use Impact, Fuel Saved/year MTOE	Emission Impact, GHG Reduced/year MtCO2	Indicative Cost of GHG Reduction, USD per tCO_2
Four-stroke Tricycles (20% GHG emission reduction)[49]			
S1: Metro Manila and Regions III & IVA (53% of total tricycles)	0.4	0.1	154.8[50]
S2: Nationwide coverage	0.7	0.2	0[50] (with co-benefits)

The recent World Bank assessment of transport infrastructure development in the Philippines[45] noted an overall road maintenance funding gap of PhP8.6 billion between the national road subsector needs and resources made available in 2007. Three DPWH national road upgrading and rehabilitation projects with loan assistance from the World Bank, ADB and JICA are expected to narrow the backlog of maintenance investment, but the needs for asset preservation of national roads have to be met in the medium to long-term to address the deteriorating road conditions. Earlier studies on road maintenance such as the Better Philippines Road Study (1999) and recent work on NRIMP Phase 2 under the World Bank underscored the importance of keeping the road conditions within international standards. These studies noted that a 1% improvement of the International Road Index (IRI) for national roads would yield a 4% reduction in vehicle operating cost, which in a large part comprised of fuel efficiency-related vehicle running cost. The current level of road maintenance funding of about PhP10 billion per year should be increased to PhP23 billion per year in the long-term to meet the total asset preservation and upgrading needs. Using an annual maintenance funding of PhP20 billion, the total investment of USD 9.2 billion and potential cumulative GHG reduction of 53.3 $MtCO_2$, the estimated mitigation cost was USD172.6/tCO_2. With the reduction in health cost, the mitigation cost decreased to USD -2.1/tCO_2.

Vehicle emission control can best be achieved by both government regulation, i.e., motor vehicle inspection and vehicle owner responsibility, i.e., proper vehicle maintenance. The motor vehicle registration process includes motor vehicle inspection. The objective here is to ensure that a motor vehicle is safe, properly maintained and free from harmful emission before it can be registered. In line with this, the Land Transportation Office (LTO) is set to implement a nationwide Motor Vehicle Inspection System (MVIS) modernization program. This consists of the establishment of MVIS centers in key urban areas. The ADB study on the privatized motor vehicle inspection stations in Metro Manila[51] concluded that strict vehicle inspection during annual registration of vehicles encourage engine tune-up and could result to 2-5% improvement in fuel consumption at a total investment of USD 469 million, resulting in an abatement cost estimate of USD 7.7/tCO_2. With health effects, the cost of mitigation was equivalent to USD -5/tCO_2.

As shown in Table 3.3-4, an improvement in the country's motor vehicle inspection and maintenance system coupled with unrelenting driver training would earn significant returns in terms of GHG emissions reduction. Results from US and EU studies indicated possible improvement of 5-10% in fuel economy from eco-driving training, which targets fuel-efficient driving practices with conventional ICE vehicles (including topics on smooth deceleration and acceleration, low engine revolutions, reducing maximum speeds, and proper tire pressures). The DOE-led Fuel

[49] PDD: Envirofit Tricycle-Taxi Retrofit Program for Vigan, Tugegarao and Puerto Princesa, Version 1-0, October 2008.
[50] Study estimates based on USD300 cost of DI kit for tricycles and unit fuel savings of USD384/year (five-year analysis period).
[51] ADB (2004), Feasibility Study for the Privatization of Metro Manila Airshed MVIS Lanes (TA2835-PHI).

Conservation and Efficiency in Road Transport Program should be revived, possibly with funding support from the DOTC-administered Vehicle Emission Control Fund. Wider dissemination of DOE's Fuel Economy Runs will provide added impetus to sustain the IEC campaign for Filipino drivers.

Numerous climate change and transport studies pointed to the commercial availability of vehicle technologies at low costs with large valued co-benefits. With the automotive industry becoming more competitive, innovations in engines, transmissions, aerodynamics and lightweight materials have recently been introduced in the Philippine market. The incremental vehicle efficiency improvements assessed in the Study included: more efficient combustion through gasoline direct injection, variable valve systems, cylinder deactivation and more efficient transmissions for automatic and manual vehicles. Focusing mainly on new gasoline cars and utility vehicles to be registered in the future, the evaluation revealed that there are modest GHG impacts at zero cost of mitigation. Further research work is required on a potential engine replacement program for in-use vehicles.

A number of programs have been initiated in the country to improve the environmental performance of the tricycles, ranging from engine modifications, fuel and additive quality improvement, proper vehicle use and maintenance promotion to traffic management enhancement. The emerging consensus of local authorities, having direct control on the entry and operation of tricycles pursuant to the Local Government Code, is the conversion of the two-stroke engines in tricycles to four-stroke engines. Noting their low levels of fuel economy compared to small gasoline cars, there is heightened interest in the potential of direct injection systems to improve fuel efficiency as well as to reduce local air pollutants. The assessment on this mitigation measure suggests fairly small GHG emissions reduction, but should be considered noting the negligible cost of abatement.

Vehicle Demand Reduction

Curtailing the demand for private transport, particularly in urban areas, and the introduction of efficient, mass public transport systems have become key components of climate change mitigation in developing countries. A range of transport demand management (TDM) activities can affect vehicle demand and use such as parking controls and traffic restraints/restrictions as in the truck ban and the Unified Vehicular Volume Reduction Program of MMDA and other LGUs. A recent study by Fulton and Schipper (2002) shows that the main benefits of bus transport are achieved by moving people out of small paratransit modes and private cars. Substantial modal shifts are also attained in the operation of urban rail systems such as those in Metro Manila, where rail transport has increased modal share to about 8% overall.

Bikeways and walkways have in the past been the focus of World Bank assistance in Metro Manila, particularly in Marikina City. Previous experiences in non-motorized transport suggest a moderate shift to NMT could result in substantial energy savings and reductions in congestion, emissions, and accidents.[52]

Table 3.4-3 presents the results of the evaluation of vehicle demand reduction options.

[52] World Bank (2003), Climate Change Mitigation in the Urban Transport Sector.

Table 3.4-3: Evaluation of Vehicle Demand Reduction Measures

Scenarios	Energy Use Impact, Fuel Saved/year MTOE	Emission Impact, GHG Reduced/year MtCO2	Indicative Cost of GHG Reduction, incl. Co-benefits USD per tCO_2
Congestion Pricing for Metro Manila[53]			
S1: Within C-3 (G.Araneta Avenue)	0.2	0.6	3.7
S2: Within C-4 (EDSA)	0.4	1.2	-0.2[48] (with co-benefits)
Public Transport Optimization in Metro Manila			
S1: EDSA Organized Bus Route Enhancement[51]	0.03	0.03	3.3[54]
S2: Metro Manila-wide public transport route restructuring and service optimization	1.4	1.38	-19.8[54] (with co-benefits)
Bus Rapid Transit System, including Non-Motorized Transport[52]			
S1: Metro Manila (50 kilometers)	0.2	2.1	5.1
S2: Metro Manila, Metro Cebu and emerging metropolitan areas (100 kilometers)	0.4	4.2	-29.7[55] (with co-benefits)
Metro Manila LRT/MRT Expansion			
S1: LRT 1 South and North Extensions	0.3	0.07	766.7
S2: S1 + LRT 7, proposed extensions of LRT 2 and MRT 3	0.9	0.19	-33.8[56] (with co-benefits)

Congestion pricing is a potent urban transport policy tool available to local officials to reduce unnecessary driving, promote environmentally sustainable transport, and finance related transport infrastructure improvements. It involves the practice of charging motorists more to use a roadway, bridge or tunnel during peak periods by restraining mainly private transport use during periods of peak congestion, thereby easing traffic flows and encouraging commuters to walk, bike or take mass transit as an alternative. Congestion charges have proven effective and popular in a number of cities around the world. London, the largest city to have adopted a central area congestion charging scheme, provided a reference mitigation policy for the Study. The London congestion pricing regulation has led to a 20% reduction in four-wheeled traffic within the charging zone during charging hours, cutting an estimated 40-50 million liters of vehicle fuel consumption inside the zone and a total 100,000 tons CO_2 emissions annually across London. Its replication in Metro Manila could potentially reduced emissions to as high as 1.2 $MtCO_2$ per year at an abatement cost of USD3.7 per ton of CO_2 (no co-benefits).

In general, public transport modes use less energy and generate less greenhouse gases than private transport vehicles. Non-motorized transport such as walking and biking emit even less GHGs. The key therefore in developing a low-carbon strategy for the Philippines is to improve public transport systems, particularly in urban centers where road vehicles are frequently used, to increase the market share of low-emitting modes. Three broad abatement options were examined in the Study, notably: improving the current public transport services in Metro Manila, introduction

[53] Study estimation based on unit costs from London Congestion Pricing.
[54] PDD, Manila EDSA Bus Dispatch System, February 2009.
[55] Study estimation based on Mexico Low-Carbon Study (2009)
[56] Estimated using World Bank LRT Line 1 South Extension traffic forecasts, economic costs and benefits

of BRT system in key cities, and further expansion of the urban rail systems in Metro Manila.

The optimization of public transport operation in Metro Manila is a type of intervention which reduces emission per kilometer and per passenger transported. Optimizing road-based public transport operation means reducing public vehicle trips with low passenger occupancy. This can be achieved by efficient fleet operations management through a rationalized dispatching scheme. One example of this intervention is the Organized Bus Route (OBR) program for Metro Manila as implemented by MMDA along EDSA, the principal bus route. This program, which is submitted for CDM support through the World Bank, involves more efficient bus dispatch system using radio frequency identification (RFID) instead of the current manual system to improve bus fleet operations by being responsive to passenger demand trends. This program is expected to generate 26,000 tCO_2/year in GHG reduction. If expanded to cover public jeepneys and the current point-to-point AUV express services, the public transport improvement program could potentially reduce emissions by about 1.4 $MtCO_2$/year. The DOTC-led Study on the Development of Mega Manila Public Transportation Planning Support System[57] is expected to detail the scope of public transport system improvements and estimate the emission impacts.

Both Bus Rapid Transit (BRT) and urban rail systems, e.g., LRT systems, are high capacity mass transit systems which cater to high passenger demand corridors. Both systems are also environment friendly because the carriers involved have low emissions, i.e., BRT being associated with buses using Compressed Natural Gas (CNG) and LRT being electrically-operated. Taking into consideration that both systems are servicing corridors with high passenger demand thus satisfying public transport efficiency and reliability, their impact on the overall transport system is emission reduction per passenger transported. Both systems therefore satisfy both transport efficiency and emission reduction objectives. They are most suited in highly urbanized areas such as Metropolitan Manila and Metro Cebu. With recent preliminary studies for the introduction of two BRT lines in Metro Manila (total length of about 50 kilometers) and the World Bank and ADB pre-feasibility studies for another two BRT lines for Metro Cebu, it is expected that four BRT lines would be constructed in the future with a total length of 100 kilometers with potential GHG emission reduction of 4.2 $MtCO_2$ per year at the cost of USD 5.1 and -29.7/$MtCO_2$ without and with savings in health cost, respectively.

The Philippine Government announced expansion plans for the Metro Manila LRT System consisting of the on-going LRT Line 1 North Extension (Monumento to North Avenue), proposed LRT Line 1 South Extension to Bacoor, Cavite, and the private sector-led LRT Line 7 (North Avenue to San Jose del Monte City, Bulacan). There is also on-going project preparation study for the west extension of MRT Line 3 (EDSA Line) and a proposed Japanese MITI-funded LRT Line 2 east and west extension. When the on-going and proposed lines are operational, the expected GHG emissions reduction can reach 0.2 $MtCO_2$.

[57] The study is to be undertaken by the UP National Center for Transportation Studies under a memorandum of agreement between DOTC and the University of the Philippines.

3.4.2 Proposed Climate Change Mitigation Strategies

For the Low-Carbon Scenarios, the energy use and CO_2 emissions of road transport mitigation options were compared with the Baseline Scenario. The following table summarizes the two scenarios developed and corresponding GHG impacts. Figure 3.4-1 presents the direct CO_2 emissions under the different road transport scenarios.

Table 3.4-4: GHG Emissions Reduction under Low-Carbon Scenarios, $MtCO_2e$

Scenario	2010	2015	2020	2025	2030
Medium Scenario					
Biofuels	0.83	3.11	6.61	12.13	20.59
Vehicle Efficiency	1.29	1.83	2.45	3.28	4.37
Demand Management	2.46	2.63	2.79	2.99	3.26
Total	4.59	7.58	11.85	18.40	28.23
Low-Carbon Scenario					
Biofuels	0.83	6.86	16.66	28.02	37.48
Vehicle Efficiency	2.77	3.70	4.95	6.62	8.82
Demand Management	6.17	6.54	6.86	7.27	7.82
Total	9.77	17.11	28.46	41.91	54.12

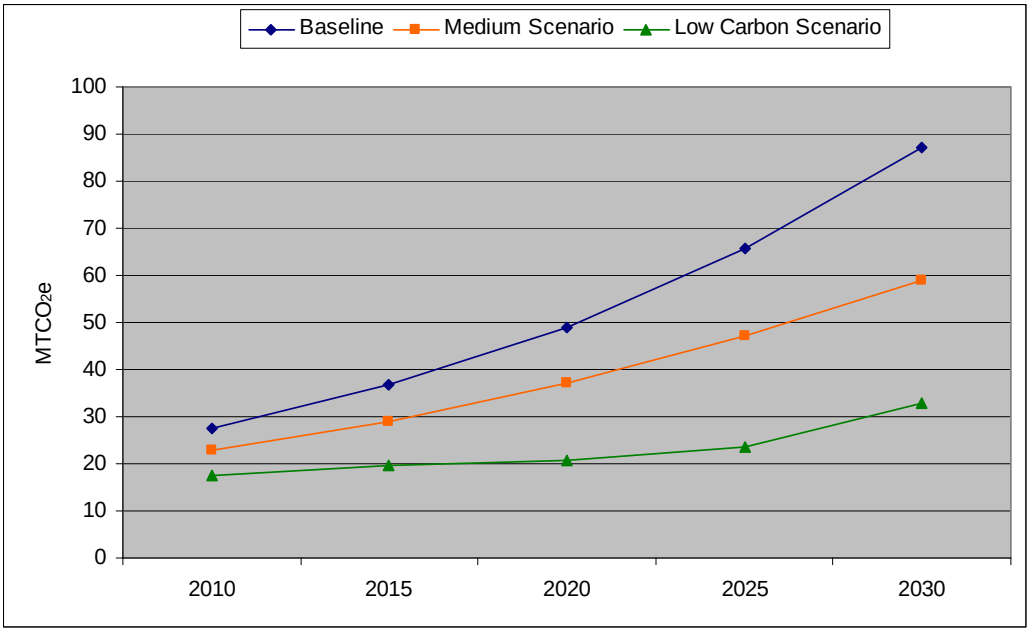

Figure 3.4-1: CO_2 Emissions for Road Transport Scenarios

The Medium Scenario corresponds to the situation in which the PEP 2008 targets on alternatives fuels are met, excluding the NGVPPT and the auto-gas components which were found to be ineffective abatement carbon reduction strategies, and specific cost-effective measures under the NEECP detailed out to include the application of available vehicle technologies to improve fuel efficiencies of new and in-use vehicles. Specific vehicle efficiency measures such as the roll-out of improved motor vehicle inspection stations and new transit systems (both BRT and LRT) were considered to be implemented in Metro Manila. Under this scenario, the projected baseline carbon emission of 87 $MtCO_2e$ in 2030 can be cut by nearly a third.

The Low-Carbon Scenario, on the other hand, assumes a more intensive application of the identified key strategies of biofuels, vehicle efficiency improvements, and

transport demand reduction. In particular, this scenario calls for accelerated nationwide implementation of 20% mix for biodiesel (by 2020) and attaining 85% bioethanol blend in 2025. Likewise, the fuel efficiency improvements and BRT lines should be pursued beyond Metro Manila and its neighboring regions. This intensive scenario is expected to bring down GHG emissions by as much as 62% from baseline estimate or a maximum potential reduction of 54 $MtCO_2e$.

The biofuels component of the proposed low-carbon intervention strategy has the largest contribution in GHG reduction accounting for 73% of potential emissions reduction. However, there are a number of issues about the potential drawbacks of these first generation biofuels. The IEA outlined these concerns as food security and best use of available land (externalities of land use change), true production and economic costs noting the modest GHG emission benefits with high cost of tCO_2e avoided, and other environmental impacts of production such as competing demands for water supply. The current high expectations generated by the passage of the Biofuels Act and the immediate response of private investors have to be tempered by serious consideration of costs, benefits, and resource impacts. The key issues for biofuels involve developing new feedstocks and production processes, determining land requirements and availability, and lowering of costs.

On the pragmatic side, the proposed low-carbon strategy capitalized on existing and commercially available technologies, which offer short-term to medium-term solutions while awaiting market penetration of more efficient types of vehicles. In spite of this, information barrier remains a key challenge for the government. In this regard, the suggested revival of the Road Transport Patrol IEC campaign is envisaged to facilitate the needed information transfer. The DOE Fuel Economy Run, which has been on-track since 2004, should be reoriented back to its original purpose of setting standards and labeling, instead of being pursued as part of NEECP's recognition awards and IEC program.

Cost-effective public transport improvement programs such as the BRT can provide substantially large benefits on climate change as well as local air quality. In the metropolitan areas such as Metro Manila, buses, jeepneys and elevated light rail systems have traditionally been seen as the public transport alternatives to private transport, but increasingly the low-cost BRT, operating on segregated roadways, is gaining wide interest in the country. However, due to lack of updated information and actual studies, its full potential can at best be gauged from successful projects in other countries. A key hurdle to be tackled immediately is the lack of supporting policy and regulation for its operation, which is crucial for the proposed BRT projects in Metro Manila and Cebu City as well as in scaling up this mass transport option.

In a number of options identified in the proposed low-carbon strategy, the primary barriers relate to policy and institutional frameworks: limited knowledge and regular updates on the status and progress of clean transport and energy policies and programs in other countries; limited training and preparation in the detailed design of implementing rules and regulations for government programs that mandate and guide sustainable transport development; and resulting undeveloped legal and regulatory frameworks, limited institutional capacity, and excessive bureaucratic procedures, particularly in areas where private sector investments are be directed. A major barrier to pursuing a climate change mitigation strategy for the transport sector is the absence of clear authority or scope for implementing agency, noting that both DOTC and DOE are taking uncoordinated steps, specifically in regard to alternative fuels for public transport and vehicle efficiency improvements. On the plus side is the demonstrated collaborative research and development by PCIERD with the transport industry in testing protocols and engine performance.

3.5 Conclusions

Given the limited time for the Study and inadequate local data, the Study produced an indicative framework for understanding the various GHG emission components from the transport sector, albeit limited to road transport; and generated various scenario analyses to determine the relative impacts and cost-effectiveness of different emission reduction options. The scenario analyses indicated that the benefits of fuel-based solutions ranged from about US$5 to US$12/ton of CO_2 reduced. In contrast, applying available vehicle technologies and shifting modal share from high-emitting private transport to public transport modes can lead to potential GHG emission reduction of 11.9 MtCO2e (Table 3.4-5).

Table 3.4-5: Mitigation Potential and Cost-Effectiveness of Low Carbon Interventions

Transport Sector Options	Potential Annual Mitigation, $MtCO_2e$	Cost Effectiveness, USD/tCO_2e (Without co-benefits)	Cost Effectiveness, USD/tCO_2e (With co-benefits)
Biofuels	15.8	30.8	(9.8)
Road maintenance/ improvement	2.3	172.6	(2.1)
Motor vehicle inspection	2.3	7.7	(5.0)
Light vehicle technologies	0.3	103.4	0.0
Four-stroke tricycles	0.2	154.8	0.0
Congestion pricing	1.2	3.7	(0.2)
Public transport improvement	1.3	3.3	(19.8)
BRT systems (100 km)	4.2	5.1	(29.7)
LRT/MRT lines (46 km)	0.2	766.7	(33.8)

The recommended cost-effective low-carbon strategy for the transport comprises of a diverse and integrated package of measures that promote biofuels, low-cost fuel efficiency improvements, transport demand management, and shifts to lower-emitting modes. The total investments would range from USD10.8 to USD25.5 billion as indicated below.

Table 3.4-6: Cumulative Transport Sector Emissions and Total Investments, 2008-2030

	Total GHG Emissions, $MtCO_2e$			Total Investments, USD Billion		
	Baseline	Medium	Low	Baseline	Medium	Low
	1,144.9	872.7	508.7	0.0	10.8	25.5
Change		-24%	-56%		10.8	25.5

IV. POWER SECTOR

4.1 Power Sector Performance

The Philippine Energy Plan 2007-2014 (PEP 2007) affirmed the government's commitment to pursue the energy independence agenda under the Five Point Reform Package of the government. It provided for attaining 60% energy self-sufficiency beyond 2010 and promoting a globally competitive energy sector. Three of the four goals enunciated in the PEP positively impacted on the climate change initiatives, namely:

- Intensifying renewable energy resource development;
- Increasing the use of alternative fuels; and
- Enhancing energy efficiency and conservation

On the way to achieving the first goal, the country posted an energy self-sufficiency level of 55.4% in 2006. In power generation, the self-sufficiency level rose to 66% in 2006, up from 65% in 2005. Natural gas was the biggest contributor at 16,366 gigawatt hours (GWh) or 29% of the total power generation. Coal came in a close second at 27%.

Two laws were recently enacted that put further impetus to the achievement of the goals of the government, RA 9367 (Biofuels Act of 2006) and RA 9513 (Renewable Energy Act of 2008).

The Biofuels Act seeks to reduce dependence on imported fuels with due regard to the protection of the environment and consistent with the country's sustainable economic growth. With the regulatory environment in place, the development of local biofuels industry is envisaged to accelerate government's efforts towards attaining energy self-sufficiency.

The Renewable Energy Act is also in support of the energy self-sufficiency goal, even considered as a catalyst in exceeding the 60% goal by 2010. The new act is also expected to mitigate the global problem of climate change.

In the PEP 2007, the DOE showed the CO_2 equivalent of the GHG emissions of the country's energy sector for 2005 and 2006. According to the DOE, total CO_2 emissions from the use of fossil fuels consisting of oil, coal and natural gas was 69.9 $MtCO_2$ in 2006.

For power generation, the total CO_2 emissions from fossil fuel-based power plants amounted to 22.9 $MtCO_2$ in 2006. This figure is consistent with the calculated 2006 emissions in this Study.

Energy Demand and Supply
Trends in final energy consumption and sectoral consumption of oil (**Figure 4.1-1**) indicate the high dependence of the transport sector. The power generation mix (**Figure 4.1-2**) shows greater reliance on coal as well as manifested decrease in self-sufficiency level for the country. The indicative power plant construction and retirement set under the PEP 2007 (**Table 4.1-1**) was used in the Study for the power sector Baseline scenario.

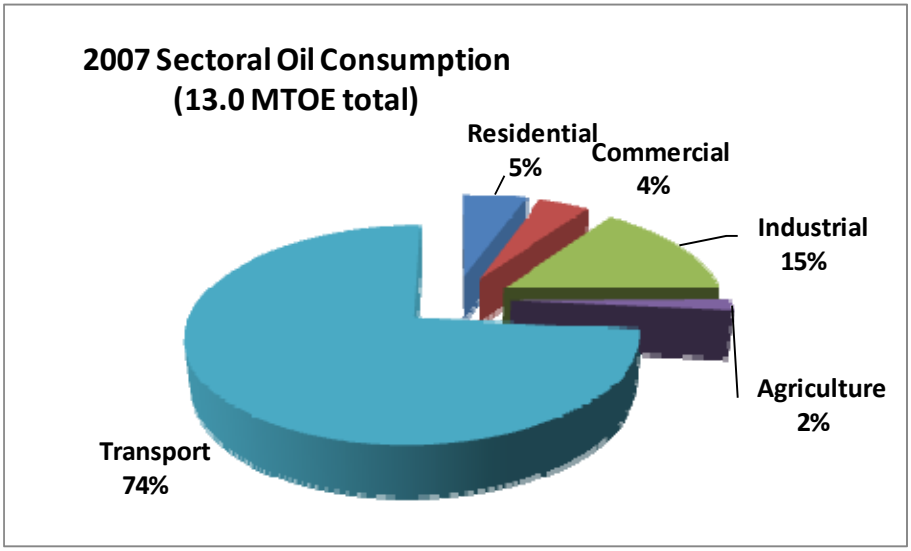

Figure 4.1-1: Sectoral Consumption of Oil, 2007
Source: Department of Energy

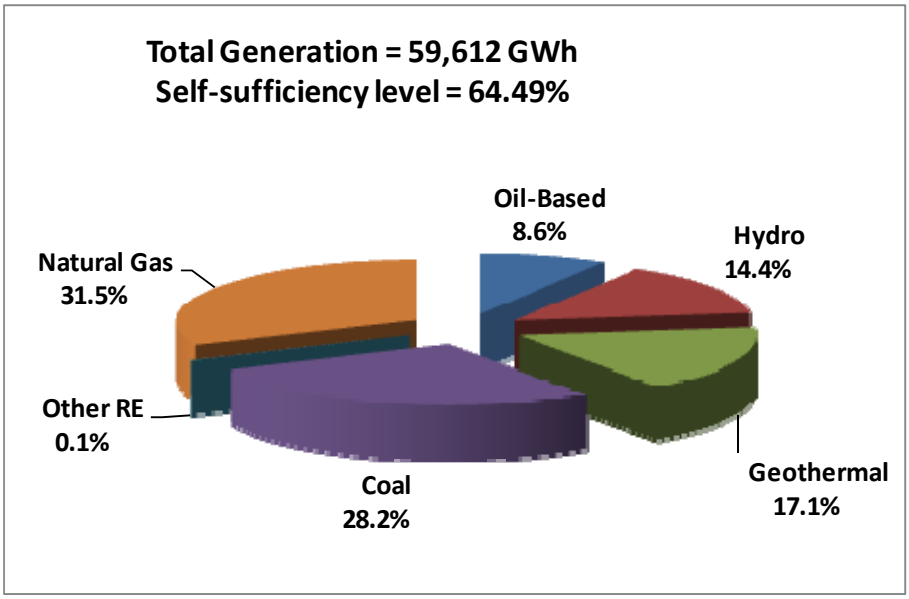

Figure 4.1-2: Power Generation Mix, 2007
Source: Department of Energy

Alternative and Renewable Energy Sources

RA 9513 or the Renewable Energy Act of 2008 aims to accelerate the exploration and development of renewable energy (RE) resources to achieve energy self self-reliance and reduce the country's dependence on imported fossil fuels. RA 9513 also provides for fiscal and non-fiscal incentives to increase the use of renewable energy. The Act likewise aims to prevent or reduce harmful emissions to protect health and the environment.

The Study assessed the resource potential, targets set and recent achievements in RE (**Table 4.1-2**)[58], together with the package of incentives under Task 5 on barriers

[58] New DOE RE targets, conceptualized and revised after the Study workshops, are included

to implementation. Other indicative targets set in the PEP 2007 guided the Study in identifying potential interventions giving maximum impact in terms of energy savings and GHG emission reduction while taking into account the limited indigenous energy resources.

The DOE emphasized during consultations for this Study that the Philippines RE potential and targets for the next decades are subject to discussion and possible revisions by the National Renewable Energy Board. There is a plan to reassess and update the entire national RE resource potential. Already, in the DOE's ongoing national planning, a different set of targets and power capacity mix is envisioned. A more aggressive hydropower development is being planned, wind and biomass will have a modest increase, while small solar and ocean energy generation are introduced. The department's plan is to double the renewable energy capacity by 2020, a decade earlier than previously planned. The current natural gas reserves is expected to last until 2024 and additional capacity from natural gas will have to be supplied by new gas fields or from imported sources.

Table 4.1-1a: Indicative System Capacity Addition (2007-2014)

(In Megawatts, MW)			
Project	Capacity	Year Available	Location
Luzon	**3,103.00**	2009	
Burgos Wind Power Project I (formerly Luzon Wind Power Project Phase I)	40.00	2009	Ilocos Norte
Ilijan CCGT Expansion	300.00	2009	Ilijan, Batangas City
Bulacan Biomass-to-Energy Project	15.00	2010	Bocaue, Bulacan
Burgos Wind Power Project II	46.00	2010	Ilocos Norte
2nd Phase CFB Coal-Fired Power	50.00	2010	Mabalacat, Pampanga
4 x 150 MW Coal-Fired Power	300.00	2011	Subic
San Gabriel Power Plant	550.00	2011	Sta. Rita, Batangas City
Kalayaan Pumped Storage Power Plant III (CBK expansion)	360.00	2011	Kalayaan, Laguna
Tanawon Geothermal Project	40.00	2013	Sorsogon
Rangas Geothermal Project	40.00	2013	Sorsogon
Manito-Kayabon Geothermal Project	40.00	2013	Sorsogon
Balintingon River Multi-purpose Project	44.00		General Tinio, Nueva Ecija
Pagbilao Expansion	400.00		Pagbilao, Quezon
Pantabangan Expansion	78.00		Pantabangan, Nueva Ecija
2 x 150 MW CCGT Power Station	300.00		Quezon, Province
Quezon Power Expansion Project	500.00		Mauban, Quezon
Visayas	**624.00**	2010	
Coal-fired Plant	100.00	Phase I - 2010	Concepcion, Iloilo Panay Island
Toledo Coal Expansion	246.00	Phase II - 2011 2010	Toledo City, Cebu
Panay Biomass Power Project	25.00	2011	Panay Island
GBPC Coal-Fired Plant (2x50 MW)	164.00	2012	Iloilo, Panay Island
Dauin Geothermal	40.00	2012	Dauin, Negros Oriental
Aklan Hydropower Project	41.00	2013	Libacao, Aklan
Villasiga HEP	8.00		Sibalom, Antique
Mindanao	**745.50**	2010	
Cabulig Hydro	8.00	2010	Plaridel, Jasaan Misamis Oriental
Tamugan AB, Panigan and Suawan Hydroelectric Power	34.50	2010	Hedcor Tamugan , Inc.
Cagayan de Oro Biomass Power Project	10.00	2011	Cagayan de Oro
Agus 3 Hydroelectric Plant	225.00	2011	Lanao del Norte
SM 200 MW CFBB CFPP	200.00	2012	Southern Mindanao
Suldan Kudarat Coal	200.00	2012	Sultan Kudarat
Tagoloan Hydropower	68.00		Bukidnon
Total	**4,472.50**		

Table 4.1-1b: Indicative System Capacity Retirement (2007-2014)

(In Megawatts, MW)		
	Capacity	Year
Hopewell GT	210	2009
Malaya 1	300	2010
Malaya 2	350	2010
Total	860	

Source: Department of Energy

Table 4.1-2: RE Potential, Installed Capacity, and Indicative Additions

RE Potential	Resource Potential	2007 On-grid Installed capacity	Baseline - Indicative Additions (2007-2014)	Identified Indicative Capacity (2007-2014)	Available Potential to 2030	Targets (Medium Scenario)	Targets (Low-Carbon Scenario)	Targets (DOE RE Scenario)
Hydro (+Mini, micro)	10,500	3,289	381	1,784	6,830	1,419	2,299	3,400
Geothermal	4,537	1,958	210	650	2,369	1,150	1,346	1,070
Wind	76,600	25	86	557	76,489	227	4,587	515
Solar	4-6 kWh/m2/day	1				0	2,000	30
ocean	170,000				170,000			
Biomass	2,136		9	674	2,127	179	2,127	2,000
Sugar cane cogen	*540*				540			
Ricehull	*1,256*				1,256			
Coconut residues	*20*				20			
Bagasse	*235*				235			
MSW/Landfill gas	*85*		9		76			
Totals (MW)	**263,773**	**5,274**	**686**	**3,665**	**257,815**	**2,975**	**12,359**	**7,015**

Source: Department of Energy except for Landfill Gas estimates and targets made by Study team

In its draft PEP for 2008-2030, the DOE presented a roadmap for accelerated development of RE in the Philippines. While this new PEP being developed foresees the demonstration of ocean energy technology, this was not included in this Study due to insufficient data and uncertainties as to its commercialization. The doubling of RE capacity was also assumed as part of the medium-carbon scenario, but up to 2030, and not 2020. The DOE is also considering adding nuclear energy into the mix in 2025, but this has not been incorporated in the plan and in this Study. *[The 2009 DOE RE and EE targets, drawn as a result of Study workshops, are now incorporated in this Study. Results are shown as part of the concluding section in this Final Report. In essence, the new DOE RE targets fall halfway between this Study's medium and low carbon scenarios. This less intensive RE is compensated by an intensive EE campaign of 10-30% reduction in the industrial and residential sectors, and 20-50% in the municipal/public sector. A midpoint 30% reduction in electricity consumption across all sectors is assumed for the DOE scenario in this Study considering the existence of barriers to EE implementation that hamper the full achievement of its potential.]*

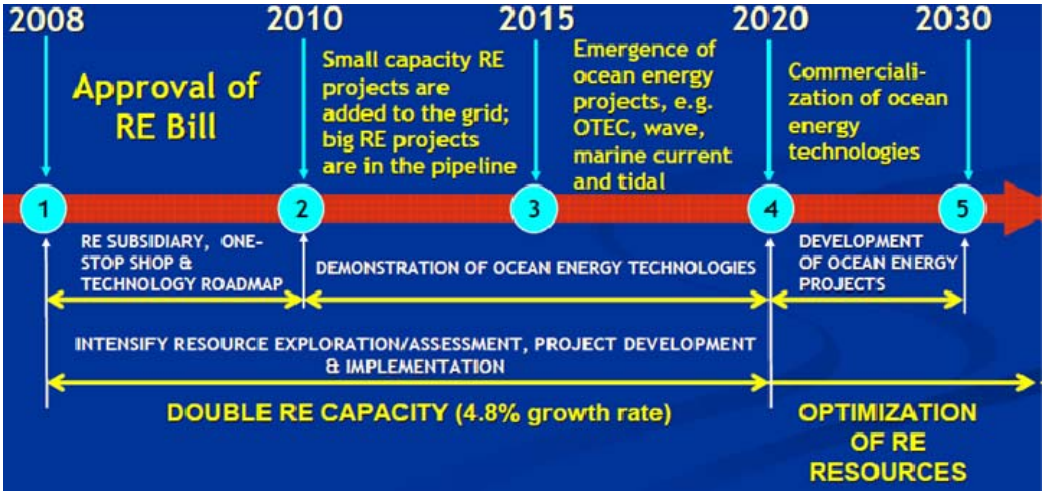

Figure 4.1-3: DOE Roadmap for Accelerated RE Development

As part of the DOE's RE program until 2007, photovoltaic battery charging stations were able to energize six barangays in Visayas and 86 barangays in Mindanao. The capacity of Sunpower Solar Wafer Fabrication Plant was increased to 108 MW and is planned to be increased to 400 MW by 2010.

The first phase of the North Wind project in Bangui, Ilocos Norte consists of 15 wind turbines, each capable of producing electricity up to a maximum capacity of 1.65MW, for a total of 24.75MW. This accounts for 40% of the power requirements of the province of Ilocos Norte. The recently completed second phase will provide additional 8 MW to the Luzon grid. Wind power is gaining interest from private investors although the high investment cost and low capacity factors are persistent barriers. It is expected that the ongoing activities would lead to the development and implementation of wind projects in the country.

Biomass is expected to contribute 122 MW in 2010. Private sector initiative is quite evident in biomass energy development. An example of which is the 12 MW Cogeneration Plant of JG Summit Holdings, Inc. in Negros Oriental. This plant will use the bagasse generated from the sugar milling operations in Negros Oriental and Negros Occidental. Other bagasse powered plants are being planned throughout the country. Rice hull powered cogeneration plants are also being put up. These plants are planned to provide not only the energy requirements of the proponents but also to be distributed through the grid. The proposed biomass fueled power plants in PEP 2007 total to 183.9 MW, with the big ticket projects in Central Philippines.

National Energy Efficiency and Conservation Program (NEECP)

The Study looked closely on the identified demand side management strategies under the SWITCH Program launched in October 2008 covering five key areas. Details of the NEECP are found in **Appendix 4**.

The energy efficiency initiative of the Department of Energy is expected to result in a cumulative target potential energy savings (2008-2030) of 332.1 MMBFOE (47.95 Million TOE). This is equivalent to 7,866 MWe (342 MW per year) of deferred power capacity addition and result in 54.3 $MtCO_2$ avoidance according to DOE. The targets in the EE initiative are not included in the baseline scenario for this study but are taken into account in the medium carbon scenario. Results show agreement with the DOE's projections.

4.2 Baseline Analysis

4.2.1 Base Year Power Supply and Demand Profile[59]

In the scenario development, the year 2007 was taken as the reference year. As of December 2007, the country's total installed generating capacity was 15,937 MW, with a dependable capacity[60] of 13,205 MW or 83%. Coal-fired power plants, majority of which are located in Luzon, had the largest share followed by oil-based power plants. Hydroelectric power plants, which is the main source of electricity in Mindanao grid accounted for 20%. Natural gas fired power plants in Luzon contributed, while geothermal power plants, with large plants located in the Visayas accounted for 12% of the mix. Wind power with 25 MW and solar at 1 MW accounted for only 0.16 percent of the capacity mix. This excludes a total of 30 MW solar and biomass installed capacity not connected to the grid. **Figure 4.2-1** shows the 2007

[59] DOE, 2007

[60] *Dependable capacity refers to the maximum capacity a power plant can sustain over a specified period modified for seasonal limitation less the capacity required for station service and auxiliaries. It changes due to various factors affecting the actual operational conditions of the power plants like allowances for the planned/scheduled outage rate, forced outage rate, de-rating and water inflow of hydro plants. The dependable capacity of hydro plants were high during rainy months and low during dry months*

installed capacity mix of the Philippines. Over 64% of installed capacity was from indigenous resources.

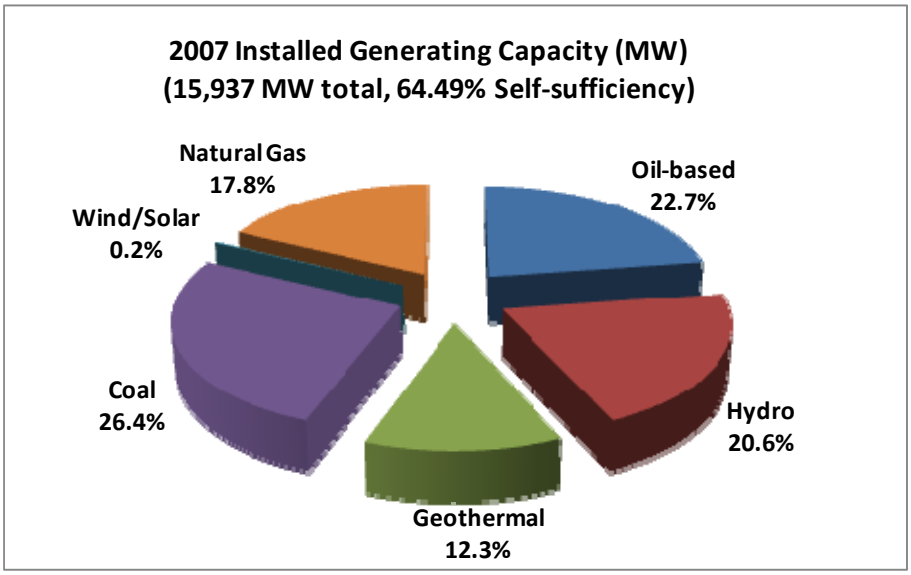

Figure 4.2-1: Installed Generating Capacity, 2007

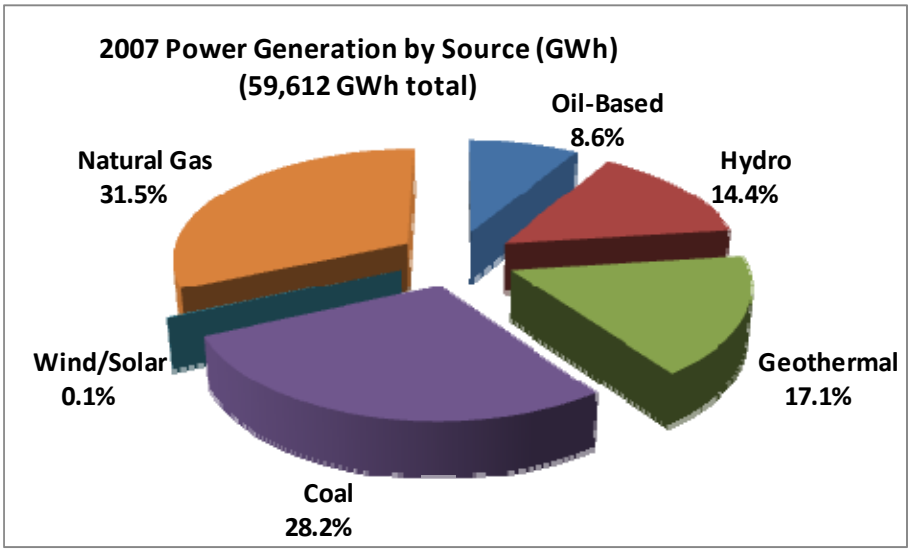

Figure 4.2-2: Power Generation by Source, 2007

Gross power generation reached 59,612 Giga Watt-hours (GWh) in 2007. Natural gas fired power plants replaced coal-fired power plants in 2005 and its share in the mix is consistently increasing from 18.1 percent in 2002 to 31.52 percent (18,789 GWh) in 2007, the highest contribution. This is followed by coal at 28 percent. Meanwhile generation from hydro electric power plants fell by almost 14 percent, from 9,939 GWh in 2006 to 8,563 GWH in 2007 when rainfall and water levels in the dams fell below critical levels. Likewise, generation from geothermal power plants decreased by over 2 percent from 10,465 in 2006 to 10,215 in 2007 due to outages experienced by Macban, Bacman and Tiwi geothermal plants in Luzon. Its share in the mix was also lower from 18.4 percent in 2006 to 17.1 percent in 2007. Most occurrences of outages from geothermal power plants were due to deactivated

shutdown which resulted from steam deficiency as well as isolation due to transmission network related problems. Generation from oil-based power plants increased by over 10 percent in 2007, from 4,665 GWh in 2006 to 5,148 GWh in 2007 since oil-based power plants were in full operation in Luzon grid for the entire month of July during the time that Pagbilao and Sual coal-fired power plants were on outages due to fuel constraints. Other renewable energy such as wind and solar, grew by 8.31 percent contributing a meager share of gross generation in 2007. **Figure 4.2-2** shows the 2007 Power Generation Mix.

Total sales all over the country posted an accelerated growth for 2007 at 5.0 percent from 45,672 GWh in 2006 to 48,009 GWh in 2007. Significant increases were observed in the commercial sector as sales went up by 6.0 percent from 12,679 GWh in 2006 to 13,470 GWh in 2007. This can be attributed to the increasing number of small-scale businesses and call centers. Rapid increase was also seen in "others" which includes street lightings, public buildings and others not elsewhere classified.

After accounting for losses, electricity used by the power plants and distribution utilities, the Philippines consumed 59,612 GWh in 2007. Total sales accounted for 48,009 GWh or 80 percent of total consumption. Own-used from power plants and distribution utilities consumed 3,994 GWh (7%). Losses from generation, transmission and distribution loss accounted for 7,608 GWh (13%). **Figure 4.2-3** shows the 2007 electricity consumption by sector.

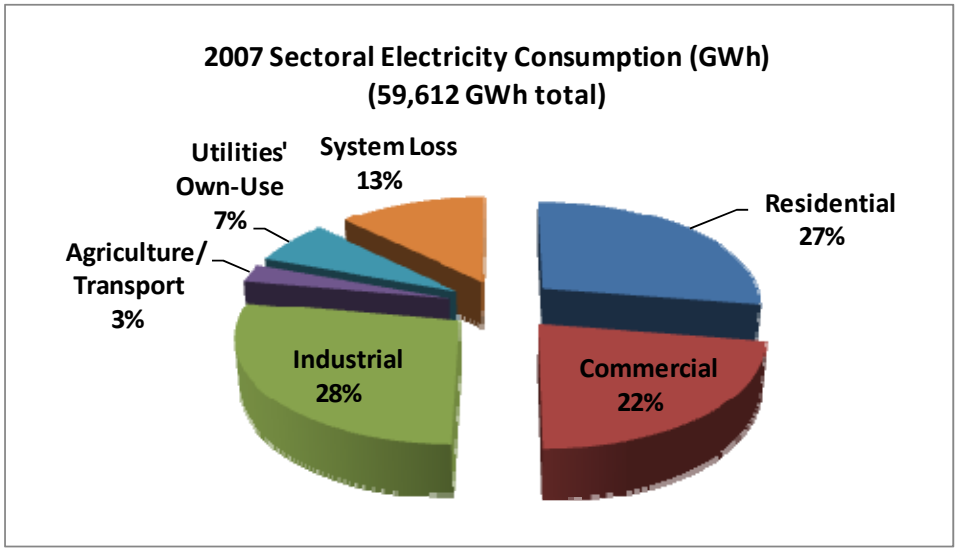

Figure 4.2-3: Electricity Consumption by Sector, 2007

The aggregate peak demand in the country's main grid expanded by almost 3%, from a total non-coincident demand of 8,763 MW in 2006 to a total of 8,993 MW in 2007. The Luzon peak demand occurred during summer due to high cooling demand. Demand in the Visayas and Mindanao peaked at the same period in December.

4.2.2 Power Sector Baseline Scenario

The next decades will see a high growth in energy consumption in the Philippines with a sustained demand for electricity to fuel economic development and population growth. **Table 4.2-1** shows the major economic parameters used in the projections. Over the planning horizon to 2030, the DOE assumes a 3.5% GDP growth to 2010 and a 4 to 6% growth rate to 2030. For the baseline scenario, a mid GDP annual

growth rate of 5% from 2011-2030 was assumed in the Study. To fuel this growth rate, electricity demand is expected to increase at an average annual growth rate of 5.2%. By 2030, electricity consumption will comprise 22% of total energy demand, second only to the transport sector, and is expected to increase at an average annual growth rate of 5.2% from 2007. **Table 4.2-2** shows the share and growth rate of total energy demand per sector and per fuel type by 2030 based on DOE forecasts

Table 4.2-1: Major Economic Assumptions Used by DOE

Major Economic Parameters	2008-2010	2011-2015	2016-2030
High GDP Growth	3.50%	6.00%	6.00%
Mid GDP Growth		5.00%	5.00%
Low GDP Growth		4.00%	4.00%
Crude Oil Price (US$)	70	120	160
Population Growth	2.00%	2.00%	1.00%

Source: DOE PEP 2008-2030

Table 4.2-2 Total Energy Demand by Sector and by Fuel Type

Total Energy Demand by Sector			Total Energy Demand by Fuel		
Sector	**Share**	**AAGR**	**Fuel Type**	**Share**	**AAGR**
Transport	41.58	3.80%	Oil	54.12	3.60%
Industry	24.46	3.80%	Coal	5.66	4.20%
Residential	23.4	2.60%	Natural Gas	0.23	2.90%
Commercial	9.54	3.90%	Electricity	22.12	5.20%
Agriculture	1.01	2.40%	Biomass	17.86	1.30%

Source: DOE PEP 2008-2030

Despite intensifying renewable energy resources exploration and development, increasing use of alternative fuels, and enhancing energy efficiency and conservation, the country will increasingly rely on imported fossil fuels, i.e., coal for power and oil for transport. This is accompanied by an unavoidable increase in GHG emissions and the inevitable decline in energy self-sufficiency as the country continues to exploit its limited indigenous resources.

An important component of electricity consumption is the system loss which can be attributed to technical losses and non-technical losses, which includes pilferage. System loss reduction is the focus of an energy efficiency intervention program of the Department of Energy. The 2007 power losses amounted to 12.8% of electricity sales/consumption, but the historical 20-year average prior to 2007 is 14.78%. The baseline total sectoral electricity consumption uses this average system loss, as well as the average of 5.77% for own-use consumption from 1986-2007, to project the total electricity demand, and these percentages are assumed constant throughout the planning period.

While the Energy Regulatory Commission imposes caps on transmission losses, all under 5% for the Luzon, Visayas and Mindanao grids, the distribution losses, particularly of electric cooperatives, are still in the two-digit percentage range. The guidelines providing for the segregation of technical and non-technical losses and the setting of system loss caps was issued by the ERC in 2004 but the distribution utilities encountered difficulties in complying. The ERC Resolution 19, Series of 2007, deferred its implementation to June 2010. While a new Draft Resolution Adopting a New System Loss Cap for Distribution Utilities (DU) is being set, the existing system loss caps of 9.5% for public utilities and 14% for rural electric cooperatives (ECs) have not been adjusted since 1999.[61]

[61] 13th EPIRA Implementation Status Report, DOE 2008

Using the above assumptions, it is projected that by 2030, electricity consumption will grow to 189 TWh, with the commercial sector posting the highest increase, 3.6 times the 2007 base year, and comprising 26% of total electricity consumption. The residential sector will grow 3.4 times, and the industrial sector, 3.1 times the 2007 figures, taking 29% and 27% of total electricity consumption by 2030, respectively. The power consumption of the agriculture/ transport sector will remain modest at 1% of the total demand. System loss is 12% of the total, and own-use consumption is 5% of the 2030 total. The historical and baseline electricity consumption is shown in **Figure. 4.2-4.** From this baseline scenario, the required power generation mix and sources were selected to meet the load curve, taking into account capacity factors, and least cost options.

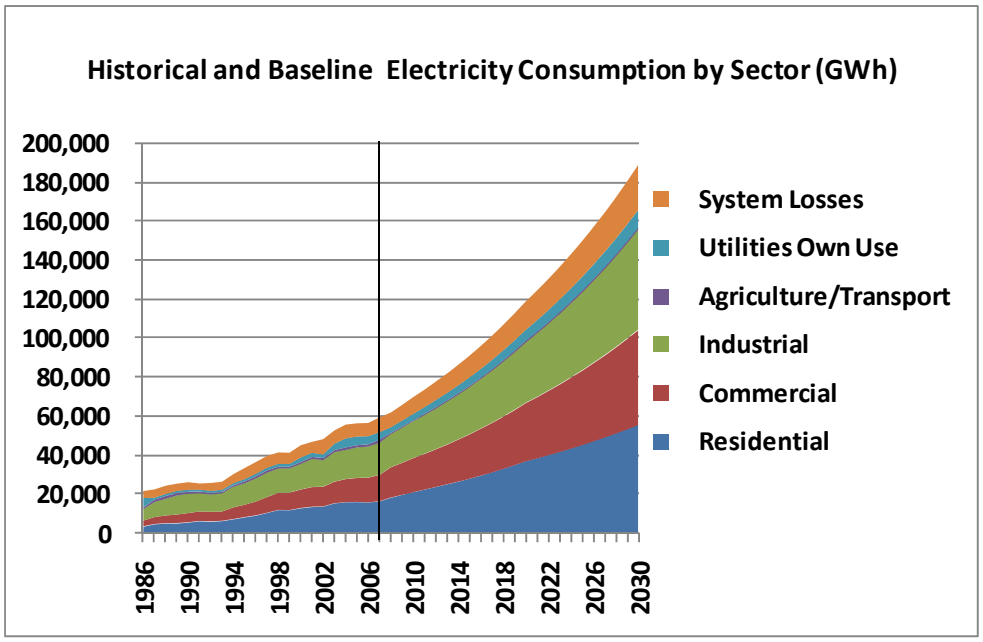

Figure 4.2-4: Historical and Baseline Electricity Consumption by Sector

To supply the above demand, power supply capacity is expected to grow 3.5% AAGR after a slow growth in 2008 (based on actual). **Figure 4.2-5** shows the historical installed capacity mix and the additional capacity requirement 2008-2030. Given the thrust of the government to explore and develop indigenous renewable energy sources for power generation, the country has a considerable percentage of RE power in its mix, notably hydro and geothermal. The discovery of natural gas fields in Malampaya also saw the replacement of coal-fired power plants with gas-fired plants. However, most of the economically viable hydropower and geothermal power plants have already been developed. Moreover, while these RE resources are indigenous, these are not least cost-technologies for power generation. The country's natural gas reserves are also very limited. Hence, despite the relatively higher cost of imported coal (most coal-fired power plants in the Philippines use imported coal and less than 10% local coal), coal is still the fuel of choice for power generation; it is the most abundant fossil fuel resource in the world (the Philippines has 2.3 billion metric tons of potential reserve), is relatively cheap, and coal-fired power plants are quick to install. This, however, comes with the high price of global warming from increased GHG emissions.

For the baseline scenario, the electricity demand is expected to be supplied by the current mix and additional generation will come mostly from coal, with a limited

increase in geothermal, hydro and biomass plants as the country attempts to develop its own resources. The capacity additions and power plant retirements lined up in the latest Philippine Energy Plan for 2007-2014 were also used in the supply assumption.

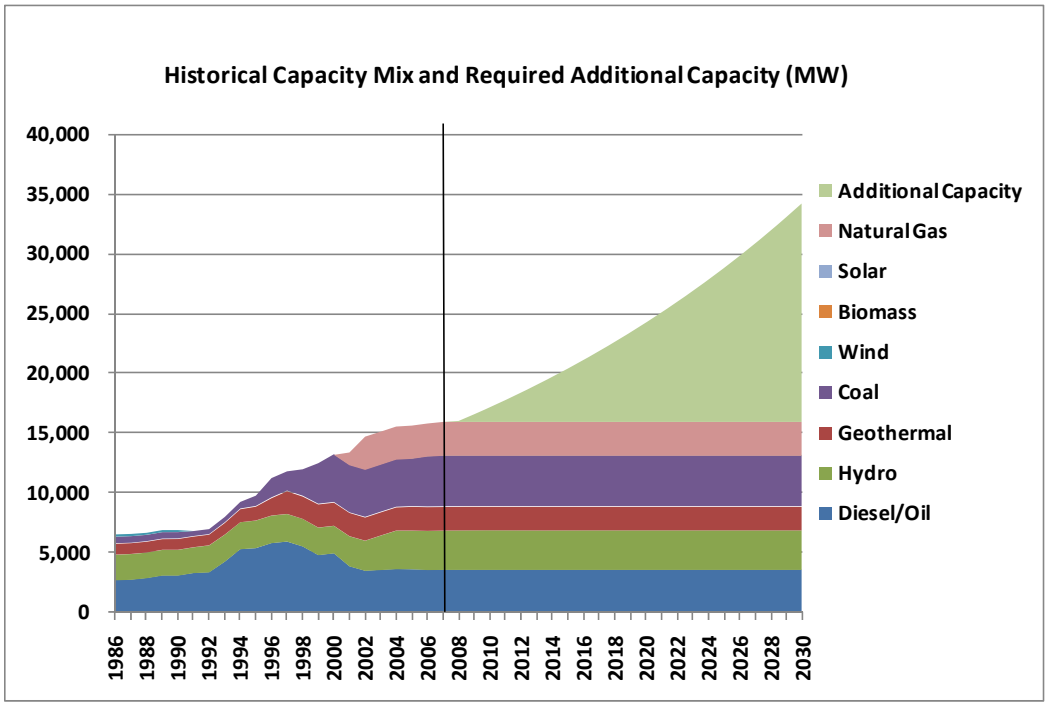

Figure 4.2-5: Historical and Projected Required Additional Capacity Mix (MW)

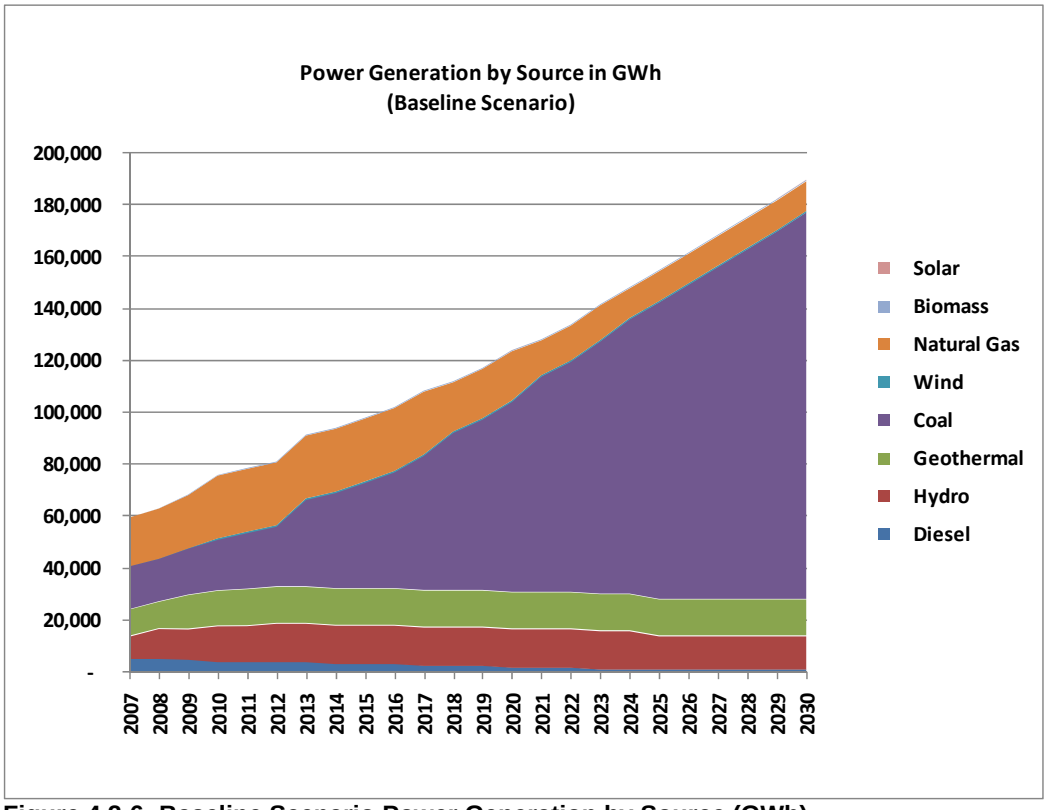

Figure 4.2-6: Baseline Scenario Power Generation by Source (GWh)

Figure 4.2-6 shows the baseline power generation by source. The installed capacity mix will reach 34 GW, 76.6% of which, or over 26 GW will be coal-fired power plants. Geothermal plants will increase slightly to but will comprise only 6% of the total. Hydropower will take 9%, and natural gas, 5%. The few remaining oil-based power plants will take a modest 2% of the capacity mix. Some biomass power plants will be added to the grid in the near term but these, in addition to the current wind and solar capacity, will comprise a minute 0.47% of the total installed capacity in 2030.

The additional capacity will require over USD50 Billion in capital investments to 2030, or an average of USD2.2 Billion per year based on conservative estimates. Importation of coal for power generation could reach over 60 MMMT, over 6 times the 2007 coal imports for power generation.

Under this scenario, the total CO_2 emissions from power generation increase by 538% from 26 $MtCO_2e$ in 2007 to 140 $MtCO_2e$ in 2030 (**Figure 4.2-7**). The expansion of coal fired generation dominates the CO_2 emissions, accounting for over 96% of the total, as natural-gas based and oil-based based power plants are retired and will contribute only 3% and 0.5% of total emissions in 2030, respectively. This high share of coal power generation increases the overall carbon intensity of electricity production by 170% from 436 tCO_2 per GWh in 2007 to 740 tCO_2 per GWh in 2030.

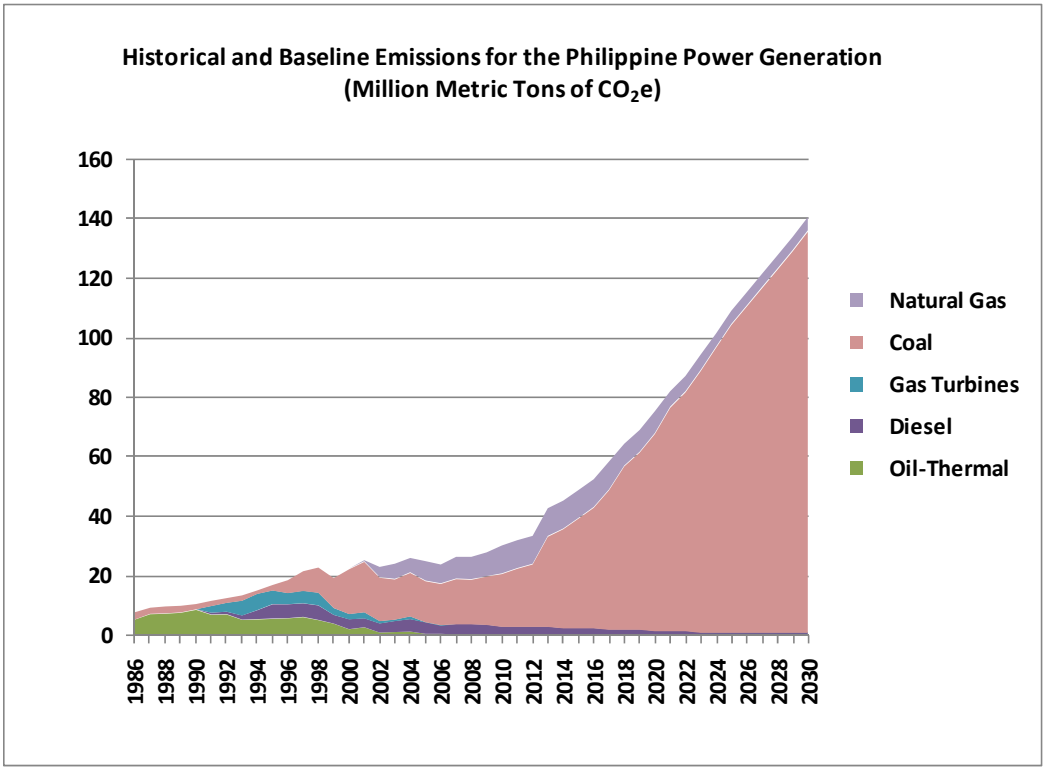

Figure 4.2-7: Historical and Baseline CO_2e Emissions from Power Generation

4.3 Low-Carbon Scenarios

Under the Study scenarios, GHG emissions reduction is introduced as an explicit goal of power capacity expansion. The Study did not attempt to re-optimize the power expansion plan of the Baseline scenario by imposing an arbitrary GHG mitigation constraint. Instead, a range of power supply options and technologies are

evaluated for their GHG emission reduction potential and their cost-effectiveness. The energy efficiency target for each scenario is first applied to the baseline, with the projected annual demand reduced by the percentage reduction assumed as a result of energy efficiency measures. Then, coal-fired power plants in the baseline are replaced with suitable lower-carbon options and generation technologies matching the reduced demand. For the medium carbon scenario, a 10% reduction in consumption from the baseline across all sectors was assumed as a result of energy efficiency interventions. Least-cost power generation options were then introduced coupled with an intensive development of renewable energy, doubling RE capacity by 2030. This scenario doubled the hydro and geothermal generation, while additional wind power and solar PV options were not considered. Some coal power plants in the baseline are replaced by natural gas plants, but coal will still dominate the power supply.

Under the low carbon scenario, a more intensive EE program, plus low-carbon power generation technologies were introduced in the mix. Several EE interventions in the commercial and industrial sectors can achieve reductions of 30% or more. Taking into account persistent barriers to implementation, a 15% reduction in sectoral demand consumption, across all sectors, is assumed for the low carbon scenario. The RE potential of the country was maximized and wind power and solar PV were included, considering the vast availability of these resources in the Philippines. The low-carbon scenario is ambitious considering the huge investment requirements for wind power and solar. Inasmuch as some coal power plants are already included in the indicative capacity addition of the 2007-2014 PEP, these were incorporated in the low carbon scenario and staggered across the twenty-two year horizon. Coal plants also provide much needed base load capacity.

Compared to the low-carbon scenario, the DOE scenario places greater reliance on hydropower and assumes modest wind and solar targets. This is counterbalanced by an ambitious demand side management/energy efficiency program, spawned by the Study team's recommendations. The DOE is embarking on an intensive EE campaign of 10-30% reduction in the industrial and residential sectors, and 20-50% in the municipal/public sector. A midpoint 30% reduction in electricity consumption across all sectors is assumed for the DOE scenario in this Study considering the existence of barriers to DSM/EE implementation that hamper the full achievement of its potential. It must also be remembered that EE/DSM interventions vary in cost and incremental improvement in mitigation will cost more per ton CO_2 reduction for interventions outside of the least-cost options or low hanging fruit interventions.

Table 4.3-1 shows the comparative installed capacity mix for the three scenarios at the end of the study period.

Table 4.3-1: Comparative 2030 Power Capacity Mix for the three Scenarios plus New DOE EE and RE Targets

	Baseline		Medium		Low Carbon		DOE EE RE	
	Capacity (MW)	% share	Capacity (MW)	% share	Capacity (MW)	% share	Capacity (MW)	% share
Coal	26,218	76.64%	17,291	56.60%	6,173	21.22%	6,213	26.11%
Diesel/Oil	756	2.21%	756	2.47%	1,256	4.32%	1,256	5.28%
Natural Gas	1,734	5.07%	4,754	15.56%	4,034	13.86%	4,034	16.95%
Hydro	3,170	9.27%	4,209	13.78%	5,589	19.21%	6,690	28.12%
Geothermal	2,168	6.34%	3,108	10.17%	3,304	11.36%	3,028	12.73%
Wind	111	0.32%	252	0.82%	4,612	15.85%	540	2.27%
Biomass	50	0.15%	179	0.59%	2,127	7.31%	2,001	8.41%
Solar	1	0.00%	1	0.00%	2,001	6.88%	31	0.13%
Total	**34,208**	**100%**	**30,550**	**100%**	**29,095**	**100%**	**23,793**	**100%**

Figures 4.3.1, 4.3.2, and 4.3.3, respectively shows the Power Capacity Mix, Power Generation and CO_2 emissions by source for the baseline, medium-, low-carbon and DOE scenarios.

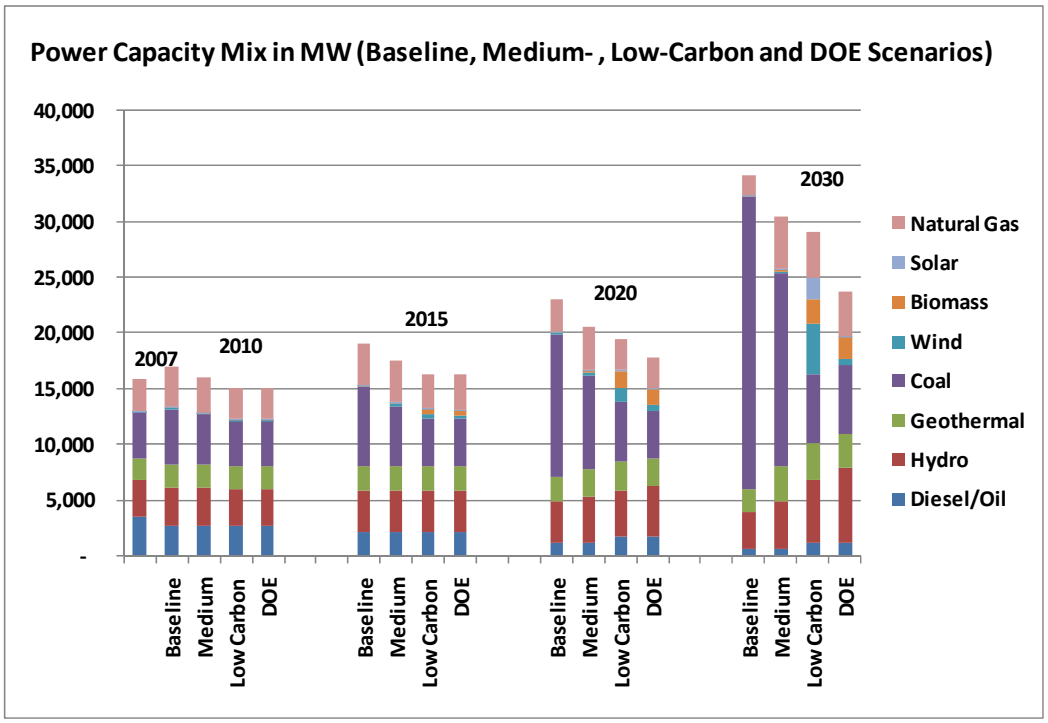

Figure 4.3-1: Power Capacity Mix in all Scenarios

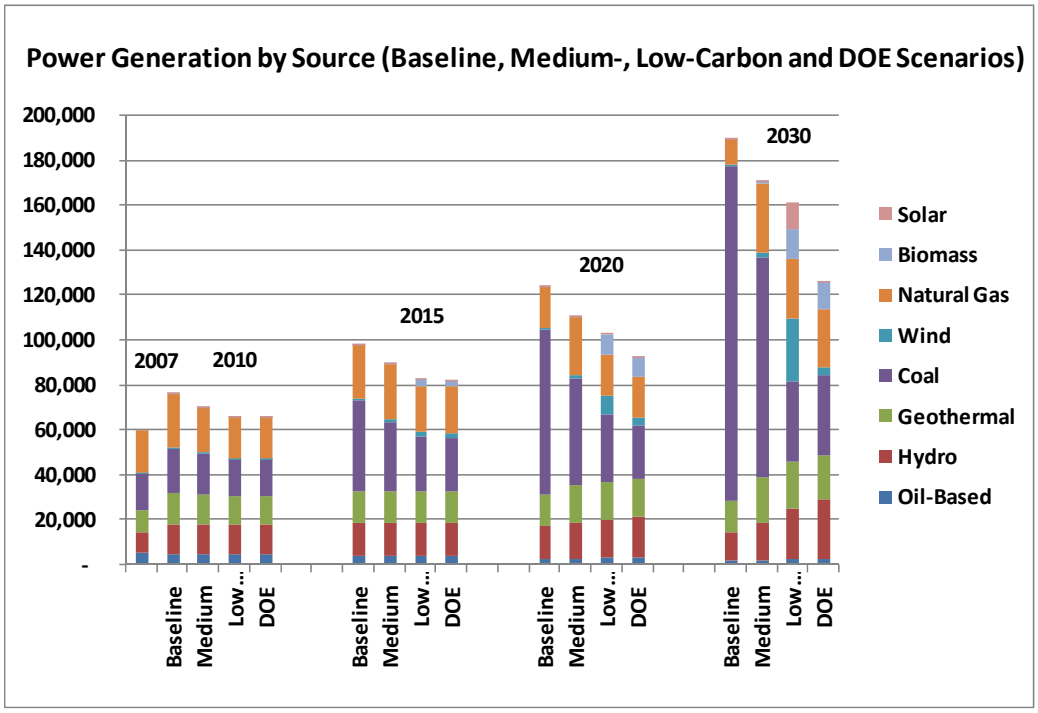

Figure 4.3-2: Power Generation by Source for the Scenarios

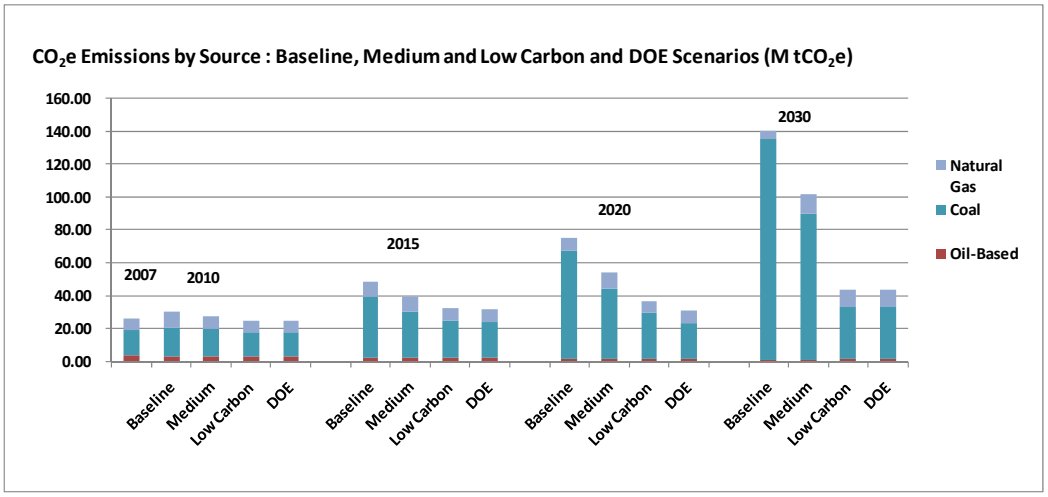

Figure 4.3-3: CO_2e Emissions by Source for the Scenarios

Figure 4.3.4 shows the Comparative CO_2e Emissions of the four scenarios with values for selected years shown in **Table 4.3-2**. Results indicate that the low carbon scenario, which adopts an intensive 15% energy efficiency program coupled with the adoption of wind power and solar PV, produces very similar results with the DOE scenario, which proposes an ambitious 30% energy efficiency program combined with conventional renewable energy and minimal wind and solar. Both scenarios present a huge potential for GHG mitigation, with energy efficiency gains trading off additional and more expensive RE capacity. The cost of incremental energy efficiency gains needs to be compared with the cost of new and emerging power generation technologies. This is particularly relevant in the latter years of the planning period where indigenous geothermal, hydro and biomass resources will have been fully utilized thus calling for the harnessing of new and emerging power generation technologies, at a higher unit cost. An assessment of costs is therefore necessary to determine the investments required to achieve a low-carbon power sector for the Philippines.

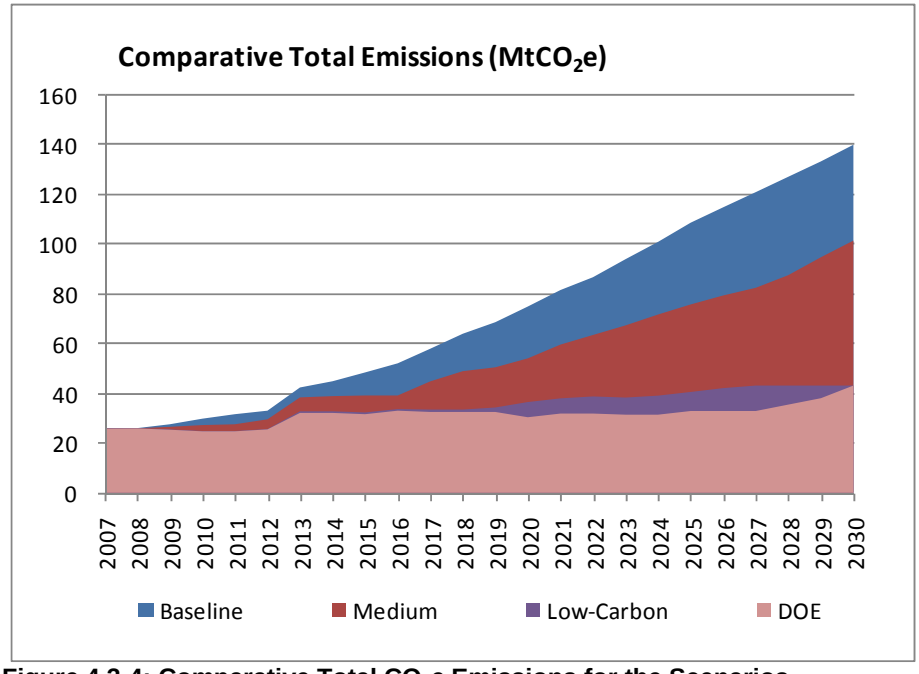

Figure 4.3-4: Comparative Total CO_2e Emissions for the Scenarios

Table 4.3-2: Comparative Annual Power Sector Emissions for Selected Years

Emissions	2007	2010				2015				2020				2030			
	Baseline	Baseline	Medium	Low	DOE	Baseline	Medium	Low	DOE	Baseline	Medium	Low	DOE	Baseline	Medium	Low	DOE
(M tCO2e)	26	30	27	25	25	48	39	32	32	75	54	37	31	140	102	43	43
% Reduction			-8%	-17%	-17%		-19%	-33%	-34%		-28%	-51%	-59%		-27%	-69%	-69%

4.4 Potential Interventions and Their Cost-effectiveness

Costs associated with mitigation options vary greatly. To fairly compare the cost-effectiveness of these technologies, the cost of each technology over its lifetime needs to be determined. Levelized energy cost, (LEC, also called Levelized Cost of energy or LCOE), is a cost of generating energy (usually electricity) for a particular energy generating system and expressed in units of currency per unit of energy generated, e.g. USD/MWh. It is an economic assessment of the cost of the energy-generating system including all the costs over its lifetime: initial investment, operations and maintenance, cost of fuel, cost of capital. A net present value calculation is performed and solved in such a way that for the value of the LEC chosen, the project's net present value becomes zero.[62]

A comprehensive levelized energy costing for the various existing and planned power generation technologies in the Philippines is not available. Levelized energy cost calculations from international organizations were gathered and the most suitable, and complete technology listing, is used in the low-carbon scenario. For a more accurate and nationally appropriate mitigation cost calculations, levelized energy costing needs to be conducted taking into account local conditions and operating costs. Most studies on mitigation potential use software with embedded levelized cost of power generation technologies and energy efficiency interventions.

Table 4.4-1 shows the levelized cost of power generation technologies considered in the three scenarios. The World Bank figures are from a study of Mexico and are considerably higher than the CSIRO figures. The latter is adopted in this study, using the higher end cost.

Table 4.4-1: Levelized Cost of Power Generation Technologies

	2006 USD/MWh*		2005USD/MWh[63]
Technology	Low	High	
Coal	21.56	29.26	57.17
Gas: combined cycle	28.49	41.58	
Small Hydro power		42.35	93.31
Wind power: high capacity factor		42.35	70.18
Nuclear	30.8	53.9	70.94
Solar thermal		65.45	158.33
Biomass		67.76	101.16
Hot fractured rocks/Low Temperature Geothermal		68.53	98.38
Gas: combined cycle + CCS	40.81	71.61	
Coal: IGCC + CCS	40.81	75.46	78.33
Open-cycle Gas Turbine	77.77	77.77	
Coal: supercritical pulverised + CCS	49.28	81.62	
Solar Photovoltaic	92.4	92.4	505.77

*Note: *USD values converted from the Australian Dollar values based on 2006 average exchange rate*
Source: http://en.wikipedia.org/wiki/Levelized_energy_cost[64] accessed on 20 May 2009

[62] Source: http://en.wikipedia.org/wiki/Levelized_energy cost accessed on 20 May 2009.
[63] WB (2008) cited by an unpublished WB study for Mexico

Figure 4.4-1 shows the levelized cost of various power generation technologies from selected sources. These costs have not been adjusted to the same base year, but nonetheless, the variations are glaring. Operating and maintenance costs of power generation are highly site-specific, and renewable energy options are dependent on the available resources in the specific country. Coal power will definitely incur higher operating costs in the Philippines since most of the fuel is imported. Geothermal plays a major role in the power generation mix of the country, but its cost often varies depending on the financing used, as well as sunk costs for exploration and drilling. Most geothermal fields and small and large hydropower potential have been harnessed, and the capital costs per unit output associated with mini- and micro hydro, and low temperature or binary geothermal power generation will be much higher than the existing conventional single- and double- flash cycles for wet geothermal systems, and hydro with 20MW capacity or more. The levelized cost of solar photovoltaics is very low in Australia compared to the US and the Philippines. Current project plans in the country put the installed costs of PV at $6/Watt, almost three times the cost of other RE technologies.

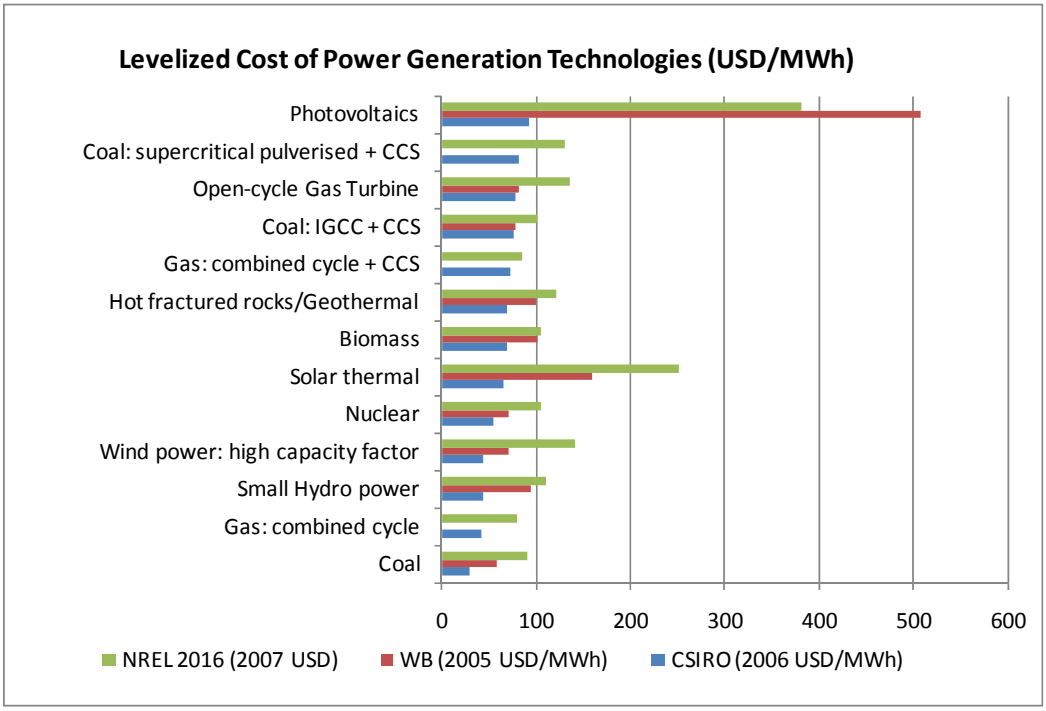

Figure 4.4-1: Levelized Cost of Power Technologies

IPCC (2007) reviewed the existing studies on the potential and costs of various energy sector mitigation options and found that abatement cost estimates vary greatly depending on underlying assumptions regarding emission scenarios, time horizons, cost parameters, and technology specifications, among others. For fuel

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[64] References cited:

1. ^ Nuclear Energy Agency/International Energy Agency/Organisation for Economic Cooperation and Development Projected Costs of Generating Electricity (2005 Update)
2. ^ Graham, P., The heat is on: the future of energy in Australia CSIRO, 2006
3. ^ Switkowski, Z. Uranium Mining, Processing and Nuclear Energy Review UMPNER Taskforce, Australian Government, 2006

switching from coal to gas power plants, the abatement cost is estimated to range from zero to \$11/tCO_2 by 2030 for developing countries. Some mitigation options have much higher abatement costs. For example, it can go up to \$50–100 or even higher per tCO_2e in the case of solar power plants and CCS technologies.

While CCS technologies present a mitigation option with a huge potential for emissions reduction, there is little opportunity for this technology in the Philippines (ADB, 2009). The country has no considerable aquifers for sequestration or option for enhanced oil recovery, oil fields in the country being small, and located off-shore, too far for a pipeline from the CO_2 sources.

Potential low-carbon interventions in the power sector can be broadly grouped into supply side mitigation and demand side mitigation. Fuel switching from coal to natural gas, increasing supply efficiency through system loss reduction and heat rate improvements, use of new and renewable energy sources and demand side management energy efficiency measures are considered. These interventions have been identified by the Intergovernmental Panel for Climate Change (IPCC) in its Fourth Assessment Report (AR4) as key mitigation technologies and options.

The ALGAS report also emphasized that the high growth rate of GHG emissions in the energy sector necessitates the adoption of mitigation options with negative abatement costs such as energy efficiency in the energy supply and demand sides. It was also indicated that institutional capacity building should also be provided to remove barriers and constraints associated with energy efficiency.[65] The costs of the EE program is taken from the DOE's PEP 2007-2014, the values of which are assumed for the medium scenario, or 10% demand reduction. In the absence of a comprehensive cost data from a single source, these costs were assumed to increase in relation to the assumed reduction for the other scenarios, two-fold for the low carbon and five-fold for the DOE scenario to allow for interventions that require huge capital costs yet are cost-effective. The short study period did not allow a comprehensive determination of the abatement cost and mitigation potential of various industrial interventions in the Philippine setting. Interventions such as cogeneration and waste heat recovery have large mitigation potential at negative abatement cost[66].

ADB (2009)[67] also identified mitigation strategies in both the energy supply and demand sectors. On the supply side, major options include efficiency improvements in power generation, fuel switching from coal to natural gas, and the use of renewable energy including biomass, solar, wind, hydro and geothermal resources. On the demand side, the key sources of GHG emissions are the residential and commercial building, industry (steel, cement, pulp and paper, and others), and transport sectors, with several key options. Most of these options are already applied in practice or being considered by the country in its power development planning.

4.5 Conclusions

The cost-effectiveness of each power sector intervention is the net levelized cost of reducing (avoiding) one ton of CO_2-equivalent emissions (US\$/t CO_2e). For the low carbon power generation technologies, each intervention is assumed to replace coal-

[65] ALGAS, 1998
[66] Various studies put the abatement cost of cogeneration in industries and supply side efficiency between -20 to -80 USD/tCO2e avoided
[67] ADB, RRECCS, 2009

fired power plants in the baseline. For the energy efficiency interventions, the assumed percentage reduction is applied to the total sectoral consumption and therefore displaces the GHG emissions of the power capacity mix for each year. To determine the cost-effectiveness of each intervention, the difference in the cumulative levelized cost for the low-carbon intervention and the baseline is divided by the cumulative annual emissions reduction achieved by the low-carbon intervention over the study period. The use of levelized energy cost builds in the economic cost and benefits of each intervention. The methodology is not technically a "cost-benefit" analysis since it does not measure the "benefits" of climate change mitigation in terms of the lower level of climate change impacts, but instead compares the costs of different interventions to reduce greenhouse gas (GHG) emissions.

Results of the study show that energy efficiency interventions present a huge potential for mitigation with negative abatement cost, driving the total cost of mitigation below zero for the medium scenario. On the supply side, hydro and wind present large mitigation potential at a cost of less than USD15/tCO_2e, with wind power providing the highest mitigation potential. While oil provides negative abatement cost, the Philippine government has reserved oil for apposite applications such as transport where there are fewer alternatives. Fuel switching from coal to natural gas also gives considerable emissions reductions at less than USD25/ tCO_2e (Table 4.5-1). Biomass and geothermal power also provide considerable mitigation potential at less than USD45/tCO_2e. Solar is still the most expensive intervention at around USD70/ tCO_2e.

Taking into account levelized costs of power generation technologies, the medium-carbon scenario, which does not include solar PV, provides the most cost-effective mitigation approach at negative USD2.58/tCO_2e, with EE achieving more reductions than supply side interventions (Table 4.5-2). The DOE plan, prodded by a clamor for a more intensive energy efficiency program and the optimization of conventional renewable energy sources, provides the highest mitigation potential at a cost of under USD5 per ton CO_2e avoided. This scenario takes the highest reduction targets of the new DOE energy efficiency program which includes system loss reduction, power plant efficiency improvement, increasing efficiency in manufacturing and industry, and the promotion of Energy Services Companies (ESCOs).

Table 4.5-1: Mitigation Potential and Cost Effectiveness of Low Carbon Interventions

Low Carbon Interventions	**Total Mitigation (Low Carbon) (M tCO_2e)**	**Cost Effectiveness (USD/tCO_2e)**
Energy Efficiency/DSM (15% reduction p.a.)	**372.80**	**-30.26**
5% Heat Rate Improvement in coal power plants	*31.77*	*-97.60*
System Loss Reduction (by 3 %age points)	*86.62*	*-83.03*
Other EE Interventions	*254.41*	*-3.88*
Supply Side Intervention	**530.68**	**31.16**
Oil	*1.69*	*-3.57*
Wind	*137.80*	*14.48*
Hydro	*84.61*	*14.48*
Natural Gas	*42.38*	*23.76*
Biomass	*131.81*	*42.58*
Geothermal	*96.36*	*43.43*
Solar (PV)	*36.04*	*69.83*

Table 4.5-2 Total Mitigation Potential and Cost Effectiveness of the three Scenarios

Scenarios*	Total Mitigation ($MtCO_2e$)	Cost Effectiveness (USD/tCO_2e)
Medium (10% EE + double RE by 2030)	**431.53**	**-2.58**
Low Carbon (15% EE + intensive RE)	**903.49**	**5.82**
DOE (30% EE + double RE by 2020)	**980.58**	**3.40**

**Note: The EE yearly target is first applied to the baseline then the various power generation technologies are entered into the scenarios taking into account the limited indigenous RE resources*

Table 4.5-3 shows that a 25% cumulative emissions reduction from the baseline is achieved for the medium carbon scenario and a total cost of over USD104 Billion to 2030 will be required, just USD4 Billion above the total baseline cost. The low-carbon path and the new DOE trajectory more than halves the cumulative baseline emissions to 2030, with the low carbon scenario requiring a total cost of USD114 Billion up to 2030 for the power sector.

Table 4.5-3: Cumulative Power Sector Emissions and Total Costs of the Scenarios

	Total GHG Emissions, $MtCO_2e$				Total Investments, USD Billion			
	Baseline	Medium	Low	DOE	Baseline	Medium	Low	DOE
	1,711	1,279	807	730	100	104	114	110
% change		-25	-53	-57		4	14	10

This Study has shown that the Philippines can transition into a low-carbon power sector by pushing energy efficiency and demand-side management as much as possible and as widely as possible, mainstreaming energy savings in all sectors. When interventions requiring negative abatement costs are exhausted, the country needs to focus on indigenous, least cost conventional renewable energy, then new and emerging renewable energy technologies to achieve the highest mitigation at an optimum cost per ton CO_2e avoided. The projections show that diverging from a medium carbon pathway to a low-carbon direction doubles the emissions reductions from the power sector but will require at least two-and-half times the additional costs.

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Appendix 1 - STUDY TERMS OF REFERENCE

A Strategic Approach to Climate Change in the Philippines: An Assessment of Low-Carbon Interventions in the Transport and Power Sectors TA-P113939-TAS-BB

Context

Globally, the Philippines is a minor emitter of GHGs, but cost-effective mitigation present opportunities that should be captured. The country accounts for less than 0.3 percent of global GHG emissions. However, emissions are on the rise from both energy-use and land-use changes. Even if the absolute scale will remain small, there is an increasing number of projects under preparation, and this illustrates that cost-effective opportunities exist.

The Government's response to the climate change challenge has been active institutionally, but a clear strategy and action plan is still lacking. The international donor community—including ADB, ISDR, MCC, and UNDP--is actively engaged in addressing climate change in the Philippines. There are several initiatives on capacity building for GHG accounting, monitoring and reporting, for preparation of a second National Communication to the UNFCCC , governance, renewable energy, urban air quality and forest management. There are already several World Bank supported climate change-related activities, with nine active operations. These encompass primarily energy sector operations.

CDM has an active portfolio in the Philippines. There are no less than 23 CDM projects registered with the Clean Development Mechanism (CDM) Board in the Philippines (see annex 2), and three more in the pipeline. Several of them concern management of agricultural waste or wastewater, while others promote renewable alternatives to fossil fuels. The total estimated reduction in CO2e per annum is slightly less than one million tons. This can be compared with a total of some 80 million tons of C02e per annum in total emissions in the Philippines, land-use changes excluded.

The World Bank Group has adopted a new strategic framework: Development and Climate Change: A Strategic Framework for the World Bank Group (October, 2008). It lays down a set of principles for the Bank's work, and outlines an ambitious set of key actions and deliverables for fiscal years 2009-11. There is a need to interpret this agenda from the perspective of the Philippines. Specifically, the advancement in establishing a set of new financial instruments--including Climate Investment Funds (the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF)), and new carbon partnership facilities (Forest Carbon Partnership Facility (FCPF), and Carbon Partnership Facility (CPF)—add further importance to the need for a systematic assessment of how the Philippines might utilize these new opportunities.

From the Bank perspective, the choice of sectors for engagement will be guided by the expected impacts of climate change, opportunities for high net-return interventions in alignment with development objectives, and the need to avoid duplication of efforts. Currently, it appears likely that the focus will be on mitigation through transport and energy sectors. For adaptation, the likely focus will be on natural resources and disaster management, particularly in coastal and other vulnerable areas exposed to typhoons, and longer-term sea level rise and storm surges.

The work is intended to contribute towards the objective of outlining strategic directions for the World Bank's engagement in climate change in the Philippines, integrated with the new CAS, and at the same time to raise awareness of the implications of CC for the economy, and facilitate integration of CC actions into the policies and programs, such as the MTPDP; and to assist the Government to move from general principles of climate change management to an Action Plan with time-bound, well-defined activities with clear accountability and cost estimates.

Scope and Methodology

The objective of the study is to evaluate the potential for GHG reduction in the Philippines over the immediate, medium and long terms, up to 2030. It will evaluate low-carbon interventions in the transport and power sectors using a common methodology based on cost-effectiveness, with the objective of determining the least cost options per ton of CO2e. Specific activities will include:

1. Review developments in the transport and power sectors especially with respect to current policy environment, thrusts and initiatives by concerned line agencies, proposed programs and projects, studies undertaken, and ongoing dialogs among stakeholders as relevant to the climate change agenda. Accomplished and ongoing work will be taken into account and built upon, e.g., Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS) of ADB, GEF, and UNDP (1998), A Regional Review of the Economics of Climate Change in Southeast Asia by ADB expected to be completed by April 2009. Other activities, such as of the Manila Observatory on the Second National Communication to the UNFCCC and its GHG inventory, and the National Economic, Environment and Development Studies (NEEDS) for Climate Change sponsored by UNFCCC study, will be underway for the duration of the study, although their outputs are not expected to become available during the study. Reference documents will include, among others, the latest Philippine Energy Plan prepared by the Department of Energy, and the transport plans and programs of the Department of Transportation and Communications. Constant liaison with the ongoing studies will be undertaken to ensure proper coordination and avoid duplication of activities, including data gathering.

2. Identify emission reduction interventions based on the following: (1) potential for overall emissions reduction, (2) cost-effectiveness of interventions, and (3) feasibility that interventions can be implemented in the immediate, medium and long terms, among other considerations. The consultant will consider studies done in other countries to exemplify options that have been shown to be cost-effective in similar analysis of this nature. The consultant will also discuss with government agencies, private investors, and other stakeholders proposed clean energy and transport programs, as well as possible initiatives in the Philippines that have the potential to reduce carbon emissions that may be considered as part of the analysis. The consultant will provide clear description of the various interventions to be considered.

3. Develop methodology for assessing cost effectiveness of the various low-carbon interventions in the transport and power sectors, with the objective of determining the least cost options per ton of CO_2e. The consultant will review similar studies undertaken in other countries (e.g., Mexico, etc), determine the methodology that can be adopted for the Philippines, and provide the basis for recommending the methodology to be used for the Philippines. Possible funding or credit mechanisms to support the various interventions taken into account in the analysis.

4. Develop baseline and low-carbon scenarios for transport and power sector showing carbon emissions in the immediate to long term, up to 2030. Immediate, medium and long-term interventions up to 2030 will be presented together with the investment requirements and expected impact on GHG emissions under each scenario.

5. Identify barriers--policy, regulatory, institutional market development, etc.--to implementation in the transport and power sectors, in consultation with various stakeholders, including private investors, and recommend action that can be taken by government to overcome these barriers. With respect to the interventions identified, the consultant will describe the various barriers which may affect their implementation. Remedial measures will be recommended for the different barriers and the feasibility of implementing each of them will be assessed.

6. Participate in dissemination of intermittent and final outputs through workshops with the participation of government, private investors, civil society, and other stakeholders, arranged in partnership with government and other interested donors.

7. Consult with the DOTC, DOE, DENR, PTFCC and other concerned agencies, as necessary throughout the study. Other donors, private investors, civil society, and academics will also be engaged in the consultation and dissemination process.

8. The Consultant will make presentations for and consult with the Bank (TTL Jan Bojo and Victor Dato) at every important milestone of the study, especially with respect to Tasks 1 to 5 above, to ensure that the Terms of Reference is met.

9. The Consultant will submit all reports simultaneously in electronic form to TTL Jan Bojo and Victor Dato, and hard copies (1 copy per report) to the World Bank Office Manila (c/o Victor Dato). All reports must be cleared prior to payment by the TTL Jan Bojo.

Deliverables:

Start: April 6, 2009
Inception Report: April 20, 2009
Draft Final Report: May 25, 2009
Conduct of Workshop: May 27, 2009
Final Report: June 15, 2009.

Appendix 2 - ALGAS LIST OF MITIGATION OPTIONS FOR POWER AND TRANSPORT SECTORS

DEMAND SIDE MANAGEMENT

Residential

a. Energy-efficient compact fluorescent lamps (cfl)
b. Energy-efficient longitudinal fluorescent lamps
c. Energy-efficient electronic lamp ballasts
d. Energy-efficient refrigerators
e. Energy-efficient air conditioners
f. High-efficiency electric motors

Commercial

a. Energy-efficient longitudinal fluorescent lamps
b. Energy-efficient electronic lamp ballasts
c. Energy-efficient chillers
d. High-efficiency electric motors
e. Variable frequency motors
f. Intelligent Building Management System

Industrial

a. Overall efficiency improvement in fuel combustion processes and electricity use
    a.1. Increased efficiency of motors
    a.2. Efficient lighting system
    a.3. Combustion control monitoring
b. Promotion of efficiency improvements in production processes
c. Heat recovery and cogeneration
d. Material recycling
e. Good housekeeping

Transport

a. Increased vehicle efficiency
    a.1. Mandatory annual fuel efficiency inspection/checkups
    a.2. Introduction of a vehicle taxation policy to promote efficient vehicle purchases
    a.3. Introduction of a vehicle fuel consumption labeling program
b. Alternative transportation fuels
    b.1. Natural gas (liquefied/compressed)
    b.2. Alcohol (methanol/ethanol)
    b.3. Hydrogen
    b.4. Electricity (from natural gas and non fossil fuels)
c. Improved transport system management
    c.1. More appropriate pricing mechanisms (policy option)
    c.2. Parking and transportation demand management
    c.3. High-occupancy vehicle lanes
    c.4. Availability of mass transit (e.g., Light Rail Transit or LRT)

SUPPLY SIDE MANAGEMENT

Power Generation

a. Power plant efficiency improvement
    a.1. Improve the gross heat rate of local power plants
    a.2. Combined heat and power
b. Fuel switching/substitution to new and renewable and less carbon-intensive energy sources
    b.1. Hydroelectric
    b.2. Geothermal
    b.3. Natural Gas
    b.4. New and Renewables
        i) Wind Power
        ii) Biomass
        iii) Photovoltaic solar home systems (SHS)
        iv) Landfill gas
        v) Methane capture from municipal and industrial wastes
    b.5. Nuclear
c. Clean fossil fuel technology
    c.1. Clean coal technology
    c.2. Fluidized bed

Power Transmission and Distribution

a. Transmission efficiency improvement
    a.1. Reduction of technical losses from the national electricity distribution grid systems to avoid leaks
b. Improved maintenance of oil/coal distribution systems

Appendix 3 - GHG EMISSION ESTIMATION PARAMETERS FOR TRANSPORT SECTOR

A3.1: Emission and Transport Data

Table A3.1-1: IPCC Emission Factors (Default Values)

Fuel Type	NCV (TJ/Gg)	Carbon Content (kg/GJ)	Emission Factor (kg CO2/TJ)	Energy Values (J/liter)
Natural gas liquids	44.20	17.50	64,200.00	38,657,950.00
Liquefied petroleum gas	47.30	17.20	63,100.00	25,700,000.00
Aviation gasoline	44.30	19.10	70,000.00	33,501,698.00
Jet gasoline	44.30	19.10	70,000.00	33,000,000.00
Jet kerosene	44.10	19.50	71,500.00	33,000,000.00
Motor gasoline	44.30	18.90	69,300.00	34,839,537.00
Diesel fuel	43.00	20.20	74,100.00	38,657,950.00
Kerosene	43.80	19.60	71,900.00	33,000,000.00
Lubricants	40.20	20.00	73,300.00	38,800,000.00
Residual Fuel Oil	40.40	21.10	77,400.00	39,700,000.00
Bio-ethanol (E10)	43.54	19.30	69,300.00	33,720,000.00
Bio-ethanol (E85)	27.00	19.30	70,800.00	25,650,000.00
Biodiesel	42.20	20.20	74,100.00	33,000,000.00
Biodiesel (enhanced)	27.00	19.30	70,800.00	25,650,000.00

Source: 2006 IPCC Guidelines

Table A3.1-2: Motor Vehicle Registration, 2000-2008, excluding Trailers

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Car	767948	738650	749553	742665	798160	788408	792373	751092	761919
UV	1388117	1416580	1554619	1570086	1647524	1633856	1618101	1602619	1595162
Bus	33888	31686	33915	31349	35003	30977	29144	30159	29745
Truck	248367	254283	257774	255509	267977	266915	285901	281261	296276
MC/TC	1236241	1337576	1470383	1552579	1847361	2157737	2409363	2647574	2982511
Total	3674561	3778775	4066244	4152188	4596025	4877893	5134882	5312705	5665613

CAGR (2000-2008) = 6.0% p.a.
CAGR (2003-2008) = 6.4% p.a.
CAGR (2005-2008) = 5.1% p.a.

Assumed CAGR, 2008-2030 = 6.0% p.a.

Table A3.1-3: Base Year Motor Vehicle Population, 2007

Vehicle Type	Fuel Type	No. of Vehicles
Private Car+SUV	Diesel	121,924
	Gas	784,455
Taxi+Car rental	Diesel	1,134
	Gas	24,570
	LPG	12,000
Private UV	Diesel	812,933
	Gas	574,157
PUJ+AUV	Diesel	190,277
	Gas	25,252
Private Bus	Diesel	4,767
	Gas	2,250
PUB+SB	Diesel	22,262
	Gas	880

Vehicle Type	Fuel Type	No. of Vehicles
	CNG	20
Truck	Diesel	269,386
	Gas	11,875
Motorcycle	Gas	2,056,320
Tricycle	Gas	591,254
Total		5505696

Table A3.1-4: Annual VKT and Emission Factors by Fuel Type

Vehicle Type	Fuel Type	Km/year	gCO_2e/km	Km/liter
Private Car+SUV	Diesel	15200	319	8.98
	Gas	8000	506	4.77
	LPG	10500	338	4.8
Taxi+Car rental	Diesel	15200	319	8.98
	Gas	8000	506	4.77
	LPG	8000	338	4.8
Private UV	Diesel	15200	415	6.90
	Gas	8000	579	4.17
	LPG	10500	386	4.2
PUJ+AUV	Diesel	15200	415	6.90
	Gas	8000	579	4.17
	LPG	8000	386	4.2
Private Bus	Diesel	26000	1097	2.61
	Gas	12200	1320	1.83
	CNG	14000	143	2.99
PUB+SB	Diesel	26000	1097	2.61
	Gas	12200	1320	1.83
	CNG	25000	166	2.99
Truck	Diesel	26000	1097	2.61
	Gas	12200	1320	1.83
	CNG	26000	166	2.99
Motorcycle	Gas	2800	266	9.08
	LPG	2800	178	9.10
Tricycle	Gas	2800	266	9.08
	LPG	2800	178	9.10

Sources: ADB ALGAS (1998), ADB Vehicle Emission Control Planning in Metro Manila (1992), JICA Survey on Interregional Passenger and Freight Flows (2005), AusAID Truck Overloading Study (2009)

A3.2: Scenario Assumptions and Cost Data

1. Biofuels

	2008	2009	2011	2015	2020	2025	2030
S1 Mix							
Biodiesel	1%	2%	2%	5%	10%	15%	20%
Bioethanol	1%	5%	10%	15%	20%	25%	30%
S2 Mix							
Biodiesel	1%	2%	2%	10%	20%	20%	20%
Bioethanol	1%	5%	10%	35%	60%	85%	85%

Cost data source: IEA (2008), From 1st- to 2nd-Generation Biofuel Technologies

Transport Sector Options	Potential Total Mitigation, $MtCO_2e$ (2008-2030)	Total Investment, USD billion (2008-2030)	Mitigation Cost, $/$tCO_2e$
Biofuels (No co-benefits)	363.3	11.2	30.8

Transport Sector Options	Potential Annual Mitigation, $MtCO_2e$	Mitigation Cost, $/$tCO_2e$
Biofuels	15.8	-9.8

2. Compressed Natural Gas Vehicles

	2008	20010	2015	2020	2025	2030
S1 PEP 2008						
CNG buses	25	200	700	2000	5000	7000
S2						
Heavy Duty Vehicles				10%	25%	50%

Cost data source: Wright and Fulton, 2005, "Climate Change and Transport in Developing Nations", Transport Reviews

Fuel / technology type	**Carbon dioxide reduction (per km)**	**Incremental vehicle purchase cost (thousand US$)**	**Refueling infrastructure investment cost per vehicle (thousand US$)**	**Incremental operating/maintenance costs ($/km)**	**Incremental fuel costs, including amortised refueling infrastructure**	**Estimated cost per tonne CO2**
Compressed natural gas						
Pessimistic	**0%**	**$30**	**$20**	**$0.02**	**equal**	**n/a**
Optimistic	**10%**	**$20**	**$10**	**$0.02**	**equal**	**$442**
Hybrid-electric						
Pessimistic	**5%**	**$100**	**$0**	**$0.02**	**5% lower**	**$1,912**
Optimistic	**25%**	**$65**	**$0**	**$0.02**	**20% lower**	**$148**
Fuel Cell						
Pessimistic	**30%**	**$1,000**	**$50**	**$0.05**	**50% higher**	**$3,570**
Optimistic	**75%**	**$250**	**$20**	**$0.03**	**50% higher**	**$463**

3. LPG Vehicles

	2008	20010	2015	2020	2025	2030
S1						
Gas Taxis	13886	50%	100%	100%	100%	100%
S2						
Gas Cars & Taxis		50%	100%	100%	100%	100%

Cost data: Conversion kit between PhP30,000 - 70,000

4. Road Maintenance

Assumptions:
1% improvement of IRI for national roads yield 4% reduction in VOC
PhP1 invested in road maintenance = PhP1.01 economic returns

Scenario 1: PhP10 billion/year - 2% reduction in VOC
Scenario 2: PhP23 billion/year - 4% reduction in VOC

5. Motor Vehicle Inspection and Maintenance

Scenario 1: MVIS lanes in Metro Manila and Regions 3 and 4
Scenario 2: MVIS lanes nationwide

Cost data source: ADB (2004), Feasibility Study for the Privatization of Metro Manila Airshed MVIS Lanes

6. Vehicle efficiency technologies

Scenario 1: Direct injection systems - 10% fuel efficiency in gasoline cars, SUV and utility vehicles
Scenario 2: Other technologies - 20% fuel efficiency in gasoline cars, SUV and utility vehicles

Cost data:
Marginal cost of technologies - USD1,000/vehicle
Fuel savings - USD500/year (payback period of two years
Environmental benefits - USD100/ton of fuel saved (Source: World Bank, Environmental Cost of Fossil Fuels: A Rapid Assessment Method with Application to Six Cities, 2000)

7. Two-Stroke Tricycle Conversion (DI System)

Scenario 1: Tricycles in Metro Manila and Regions 3 and 4
Scenario 2: Total tricycle population

Cost data:

Marginal cost of conversion - USD300 (source: Envirofit PDD)
Fuel savings - USD384/year (six year period of analysis)
Environmental cost savings - USD100/ton of fuel saved

8. Congestion Pricing (Metro Manila)

Scenario 1: Within C-3 central core
Scenario 2: Within C-4 (EDSA)

Cost data:

Investment cost - USD50 million
O & M cost - USD5 million/year (10% of investment)
Fuel cost savings - USD292/vehicle reduced (experience from London Congestion Pricing Scheme)

9. Metro Manila Public Transport Service Improvement

Scenario 1: EDSA Organized Bus Route Enhancement
Scenario 2: All bus, AUV and jeepney routes in Metro Manila

EDSA OBR cost - USD6.2 million
O & M cost - USD0.62 million/year (10% of investment)
Bus fuel saved - 509 tons/day or 152,700 tons/year
Environmental benefits - USD100/ton of fuel saved (Source: World Bank, Environmental Cost of Fossil Fuels: A Rapid Assessment Method with Application to Six Cities, 2000)

10. Bus Rapid Transit System

Scenario 1: 50 kilometers in Metro Manila and Metro Cebu
Scenario 2: 100 kilometers in Metro Manila and Metro Cebu

Investment cost - USD5 million/km of BRT line
O & M cost - USD0.5 million/year (10% of investment)
Environmental benefits - USD1.25 million/km of BRT line

11. Metro Manila LRT Systems

Scenario 1: LRT 1 North and South Extensions
Scenario 2: LRT 7 and MRT 3/LRT 2 extensions

Investment cost - USD56 million/km of LRT line
O & M cost - 10% of investment
Environmental benefits - USD100/ton of fuel saved (Source: World Bank, Environmental Cost of Fossil Fuels: A Rapid Assessment Method with Application to Six Cities, 2000)
Traffic data source: model runs using TTPI Metro Manila Transport Demand Model

A3.3: GHG Emission Estimates for Baseline and Low-Carbon Scenarios

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline		24.39	25.86	27.40	29.05	30.79	32.64	34.59	36.66	38.86	41.19	43.66	46.28	49.05	51.99	55.11	58.41	61.92	65.63	69.56	73.74	78.16	82.85	87.10
Scenario 1	**Biofuels**	**0.24**	**0.79**	**0.83**	**1.39**	**1.47**	**1.56**	**1.66**	**3.11**	**2.52**	**3.50**	**3.71**	**3.93**	**6.61**	**7.01**	**7.43**	**7.88**	**8.35**	**12.13**	**12.86**	**13.63**	**14.45**	**15.32**	**20.59**
	Veh Eff	**1.16**	**1.29**	**1.37**	**1.45**	**1.54**	**1.63**	**1.73**	**1.83**	**1.94**	**2.06**	**2.18**	**2.32**	**2.45**	**2.60**	**2.76**	**2.92**	**3.10**	**3.28**	**3.48**	**3.69**	**3.91**	**4.14**	**4.37**
	Road	0.49	0.52	0.55	0.58	0.62	0.65	0.69	0.73	0.78	0.82	0.87	0.93	0.98	1.04	1.10	1.17	1.24	1.31	1.39	1.48	1.56	1.66	1.74
	MVIM	0.62	0.66	0.70	0.74	0.78	0.83	0.88	0.93	0.99	1.05	1.11	1.18	1.25	1.32	1.40	1.49	1.58	1.67	1.77	1.88	1.99	2.11	2.23
	Techno		0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.23
	Tricycle	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.17
	Demand	**2.43**	**2.44**	**2.46**	**2.48**	**2.56**	**2.58**	**2.60**	**2.63**	**2.66**	**2.69**	**2.72**	**2.75**	**2.79**	**2.82**	**2.86**	**2.90**	**2.94**	**2.99**	**3.04**	**3.09**	**3.14**	**3.20**	**3.26**
	Pricing	0.29	0.30	0.32	0.34	0.36	0.38	0.41	0.43	0.46	0.48	0.51	0.54	0.57	0.61	0.65	0.68	0.72	0.77	0.81	0.86	0.91	0.97	1.03
	OBR	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	BRT	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11
	LRT					0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09
Scenario 2	**Biofuels**	**0.24**	**0.79**	**0.83**	**1.39**	**2.55**	**3.91**	**4.75**	**6.86**	**7.95**	**9.15**	**11.88**	**13.40**	**16.66**	**18.56**	**20.64**	**22.90**	**25.35**	**28.02**	**29.70**	**31.48**	**33.37**	**35.38**	**37.48**
	Veh Eff	**2.33**	**2.61**	**2.77**	**2.93**	**3.11**	**3.29**	**3.49**	**3.70**	**3.92**	**4.16**	**4.41**	**4.67**	**4.95**	**5.25**	**5.56**	**5.89**	**6.25**	**6.62**	**7.02**	**7.44**	**7.88**	**8.36**	**8.82**
	Road	1.13	1.20	1.28	1.35	1.43	1.52	1.61	1.71	1.81	1.92	2.03	2.15	2.28	2.42	2.57	2.72	2.88	3.05	3.24	3.43	3.64	3.86	4.05
	MVIM	1.11	1.18	1.25	1.32	1.40	1.48	1.57	1.67	1.77	1.87	1.99	2.10	2.23	2.36	2.51	2.66	2.82	2.98	3.16	3.35	3.55	3.77	3.98
	Techno		0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.23	0.24	0.25	0.27	0.28	0.30	0.32	0.34	0.36	0.38	0.40	0.43	0.45
	Tricycle	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.22	0.23	0.24	0.26	0.27	0.29	0.31	0.32
	Demand	**6.10**	**6.14**	**6.17**	**6.21**	**6.39**	**6.44**	**6.49**	**6.54**	**6.60**	**6.66**	**6.72**	**6.79**	**6.86**	**6.93**	**7.01**	**7.09**	**7.18**	**7.27**	**7.37**	**7.48**	**7.59**	**7.70**	**7.82**
	Pricing	0.57	0.61	0.64	0.68	0.72	0.77	0.81	0.86	0.91	0.96	1.02	1.08	1.15	1.22	1.29	1.37	1.45	1.54	1.63	1.73	1.83	1.94	2.05
	OBR	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	BRT	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23
	LRT					0.14	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.18	0.19	0.19	0.20	0.20	0.21	0.22	0.22	0.23	0.24	0.24

A3.4: Current Transport Programs

National EST Strategy

On 30 January 2009, Administrative Order (AO) 254 was issued mandating the DOTC to lead in the formulation of a National Environmentally Sustainable Transport (EST) Strategy for the Philippines. In line with this initiative, the first draft of the National EST Strategy report has been prepared by DOTC in collaboration with DENR and the Department of Health (DOH) with the assistance of the University of the Philippines National Center for Transportation Studies (UPNCTS). Figure A3.4-1 presents the EST project framework.

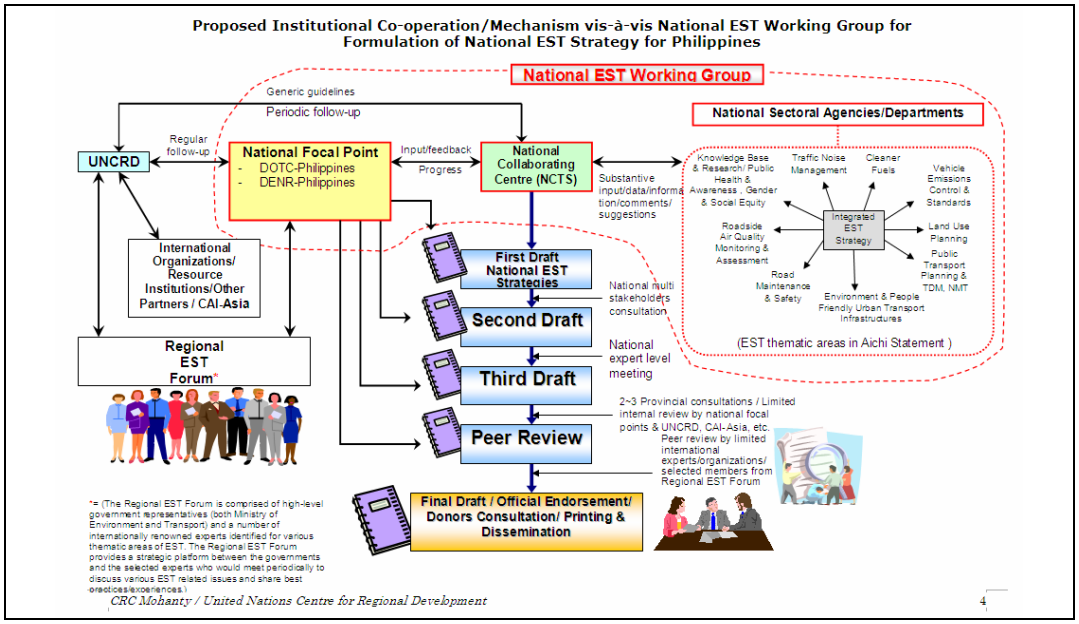

Figure A3.4-1: National EST Framework *Source: UPNCTS*

Motor Vehicle Inspection and Maintenance

Vehicle emission control can best be achieved by both government regulation, i.e., motor vehicle inspection and vehicle owner responsibility, i.e., proper vehicle maintenance. The motor vehicle registration process includes motor vehicle inspection. The objective here is to ensure that a motor vehicle is safe, properly maintained and free from harmful emission before it can be registered. In line with this, the Land Transportation Office (LTO) is set to implement a nationwide Motor Vehicle Inspection System (MVIS) modernization program. This consists of the establishment of MVIS centers in key urban areas. The ADB study on the privatized motor vehicle inspection stations in Metro Manila[68] concluded that strict vehicle inspection during annual registration of vehicles encourage engine tune-up and could result to 2-5% improvement in fuel consumption.

Motor Vehicle Inspection and Emission Testing System (MVIETS) Project involves the construction of an initial 124 MVIETS inspection lanes (29 for motorcycles and 95 for cars, trucks and buses) all over the country, especially for high motor vehicle density areas such as NCR, Metro Cebu, and Metro Davao. This aims to provide a

[68] ADB, Feasibility Study for the Privatization of Metro Manila Airshed MVIS Lanes, TA2835-PHI, 2004.

safe and clean transport environment through a mechanized system of motor vehicle inspection. The inspection stations will be equipped with state-of-the-art equipment and be implemented in three stages.

> Stage I, will undertake the inspection of the vehicles body condition, safety devices, light and light signal systems as well as other exterior body parts plus engine performance analysis. Gasoline and diesel fed vehicles shall be tested for compliance with standard as pre-requisites to registration.
>
> In the second stage, MVIETS will inspect the front and rear wheels of vehicles via a side slip, brake test, speedometer test, headlight and noise level test. It will also test the meters of taxi cabs.
>
> The third stage will cover the inspection of pit undercarriage suspension and steering wheel efficiency of vehicles, including axle play detection.

Optimization of Public Transport Operation

This is a type of intervention which reduces emission per kilometer and per passenger transported. Optimizing road-based public transport operation means reducing public vehicle trips with low passenger occupancy. This can be achieved by efficient fleet operations management through a rationalized dispatching scheme. One example of this intervention is the Organized Bus Route (OBR) program for Metro Manila as implemented by Metropolitan Manila Development Authority (MMDA) along EDSA, the principal bus route. Basically, this program involves bus dispatch system using radio frequency identification (RFID) instead of the current manual system to improve bus fleet operations by being responsive to passenger demand trends. This program is submitted for CDM support through the World Bank.

An electronic bus dispatch system would optimize vehicle-kilometers traveled by reducing the number of roundtrips performed by each vehicle and by preventing driver deviation from specified routes. While there are many other benefits associated with the electronic bus dispatch system, such as reduced dwell time at stations, more predictable headway frequencies, lower air pollutant emissions (e.g., particulate matter and NOx).

The Project Design Document[69] for the EDSA Bus Dispatch System indicated an average annual GHG reduction of 26,463 tCO2e. with system investment cost of USD 802,000.

Introduction of BRT and Urban Rail Systems

Both Bus Rapid Transit (BRT) and urban rail systems, e.g., LRT systems, are high capacity mass transit systems which cater to high passenger demand corridors. Both systems are also environment friendly because the carriers involved have low emissions, i.e., BRT being associated with buses using Compressed Natural Gas (CNG) and LRT being electrically-operated. Taking into consideration that both systems are servicing corridors with high passenger demand thus satisfying public transport efficiency and reliability, their impact on the overall transport system is emission reduction per passenger transported. Both systems therefore satisfy both transport efficiency and emission reduction objectives. They are most suited in highly urbanized areas such as Metropolitan Manila and Metro Cebu.

[69] Version 1, February 2009.

With recent preliminary studies for the introduction of two BRT lines in Metro Manila (total length of about 20 kilometers) and the World Bank and ADB pre-feasibility studies for another two BRT lines for Metro Cebu, it is expected that four lines would be constructed in the near future.

Alternative Fuels

The use of vehicles with low carbon fuels has a big impact on the level of CNG emissions in the transport sector by reducing emission per kilometer and per passenger or cargo transported. Non-fossil based fuels such as CNG and LPG if made available for use by transport carriers can substantially reduce carbon emissions.

At present, about 14,500 taxi units in Metro Manila are using LPG as fuel. About eleven (11) operational CNG buses are running the Metro Manila-Batangas corridor. These may not be significant at the moment as far as the overall emission reduction is concerned, but the expansion of the use of these fuels to the motor vehicle population in the country will make a difference.

LPG Option:
The DOE Alternative Fuel Program included the expansion of coverage of Auto-gas vehicles (LPG-fed), particularly those currently running on gasoline engines. Unlike other countries such as Thailand, Malaysia and India, the rate of taxi conversion even with the incentive package offered by the government[70] has been low with total LPG vehicles just about 20,000 in 2007. Taking only the average conversion cost of USD 850 per vehicle for in-use cars, with no fuel cost savings, the calculated cost of emission reduction is about USD 9.7/tCO2e.

Noting the dramatic increase of motorcycles/tricycles in the Philippines[71], conversion of in-use vehicles should be a new area of focus by DOE and DOTC. However, prevailing technologies, particularly locally available OEM vehicles from China, have not targeted in-use tricycles as in Thailand.

Natural Gas Option:
The DOE launched in 2002 its National Gas Vehicle Program for Public Transport, which to date have only 24 buses as participants. The NGV program lays down the government policies in the downstream natural gas market to encourage active private sector participation and create a healthy competitive environment for all players. Specifically, the program gives a package of incentives to participants which includes income tax holiday for pioneering projects qualifying under the Board of Investment's (BOI) Investment Priorities Plan; zero rate duty on imported NGV industry related equipment, facilities, parts and components; preferential and exclusive franchises from LTFRB for NGVs on newly opened routes; accelerated issuance by the DENR of Environment Compliance Certificate (ECC) for NGV facilities and refueling stations; affordable and commercially tenable financial packages from government financial institutions (GFIs), among others.

The main barrier to the expansion of the program is the high capital cost of NGV infrastructure, particularly the pipelines to Manila and in-city refilling stations. Based on the cost structure of the ADB-assisted Dhaka Clean Fuel Project, the estimated

[70] Concessional loans from government banks and 10-year franchise, renewable for another 10 years from the original franchise period of five years, renewable for another five years.
[71] Above 11% rate of increase per year (2000 to 2008)

infrastructure cost for the planned alternative 420-kilometer pipeline system that will ensure private user access in Metro Manila by 2015 is about USD 2 billion.

Recently, natural gas tricycles were tested in the country with the application of proprietary CNG Lite™ technology of Energtek, Inc., Energtek Inc., a world leader in the development of Adsorbed Natural Gas (ANG) technology. Further review of field tests need to be undertaken by DOE on this technology. As cited earlier, greater focus on motorcycles/tricycles should be a key low-carbon strategy.

Freight Transport and Logistics Coordination

In the area of logistics, i.e., goods movement, the trucking services involved can be a significant contributor to GHG emission reduction interventions by way of reducing vehicle trips through appropriate dispatch operations based on goods demand pattern. This involves careful planning of truck trips taking into consideration the interplay between location and volume of goods supply and location and volume of goods demand. Emission reduction per cargo transported can be optimized by using larger or high capacity vehicles, similar in concept to mass transit operations for passengers.

However, with the absence of robust data on truck loadings and inter-city movements, there is difficulty in estimating the impact of freight transport and logistics improvement. The Study simply relied on emission reduction from fuel switching such as conversion of trucks to LPG in the long run.

Non-Motorized Transport (NMT)

On potential intervention which will also have a substantial impact on GHG emission reduction in the transport sector is the use of NMT, i.e., bicycles, for obvious reasons. This measure, however, has to be promoted extensively, because this involves a behavioral reorientation. Due to the popularity of the motor vehicle as a transport mode, the minds of most people are oriented on its use for their transport needs. This can be seen by the putting up of infrastructure facilities for motor vehicle use and the provision of motor vehicle services. In Metro Manila, the city of Marikina has started putting up bicycle lanes to implement NMT in the said city. This can be replicated in other parts of the metropolis and other urban areas in the country.

Promoting NMT as an alternative mode has very promising results. Reorienting people's attitude in favor of this mode should emphasize its relative advantages in terms of cost-effectiveness, health improvement, reliability and environmental friendliness, meaning no air pollution involved. However, to promote NMT, appropriate infrastructure facilities, such as bicycle lanes, bicycle parking areas have to be put up.

In Metro Manila, the city of Marikina has started putting up bicycle lanes to implement NMT in the said city. This can be replicated in other parts of the metropolis and other urban areas in the country.

Urban Land Use Planning

This is a type of intervention which addresses vehicle trip reduction as a means of GHG emission reduction. This however is more appropriate in areas where there are no existing urban developments. Planning urban land uses in areas still to be developed, should take into consideration vehicle trip reduction to address environmental concerns on air pollution.

Vehicle trip reduction will reduce vehicular traffic along the roads. This in effect will minimize both traffic congestion and air pollution. The role of urban land use planning in this respect is to plan land uses so as to: (i) provide easy access to work areas, schools, shopping centers, etc; (ii) provide transit-oriented development by inducing people to reduce the use of their own cars and switch to high capacity transit services; (iii) provide parking-related schemes, such as park and ride, park and walk, park and pick, etc.

Appendix 4 - GHG EMISSION ESTIMATION PARAMETERS FOR POWER SECTOR

Table A4.1 Calculation of Emissions from Fuel Combustion in Power Plants[72]

	A	B	C	D
Item	2006 Electricity Generation	Heat Rate	Fuel Consumption Impact	
Abbreviation	GEN		FCI	
Data Source	PDOE Powerstat	PDOE	A x B	(C x 1055) / 10 ^ 12
Unit	kwh / yr	BTU /kwh	BTU /yr	TJ / yr
Oil Based				
Combined Cycle		6,550	0	0.00
Diesel	4,152,143,531	8,900	3.69541E+13	38,986.55
Gas Turbine	239,000,000	14,400	3.4416E+12	3,630.89
Oil Thermal	273,593,036	8,600	2.3529E+12	2,482.31
Coal	15,294,066,194	8,900	1.36117E+14	143,603.63
Natural Gas	16,365,959,900	6,550	1.07197E+14	113,092.87
TOTAL	36,324,762,661			

E	F	G	H	I
Carbon Emission Factor	Unadjusted Annual Carbon Emission Impact	Combustion Efficiency	Actual Carbon Emission Impact	Annual Carbon Dioxide Emission Impact
CEF	CEI	COM EFF	Adjusted CEI	
IPCC	D x E	IPCC	F x G	H x (44 / 12)
tC /TJ	tC / TJ	%	tC / yr	tCO2 / yr
20.2	0.00	99.00%	0.00	0.00
20.2	787,528.34	99.00%	779,653.06	2,858,727.89
20.2	73,343.94	99.00%	72,610.50	266,238.49
21.1	52,376.73	99.00%	51,852.97	190,127.54
26.8	3,848,577.41	98.00%	3,771,605.86	13,829,221.48
15.3	1,730,320.98	99.50%	1,721,669.37	6,312,787.70
				23,457,103.10

[72] Meija, A.A. (2006), "CDM Baseline Construction for the Electricity Grids in the Philippines

Table A4.2: Baseline Assumptions

TYPE OF PLANT	BTU/kwh
Combined Cycle	6,550
Diesel	8,900
Gas Turbine	14,400
Oil Thermal	8,600
Coal	8,900
Natural Gas	6,550
Biomass/Rice hulls	

TYPE OF FUEL	CEF (tC/TJ)
Diesel	20.2
Residual Fuel Oil	21.1
Coal	26.8
Natural Gas	15.3
Biomass/Ricehulls	

TYPE OF FUEL	Combustion Efficiency (%)
Coal	98.00%
Oil & Oil Products	99.00%
Gas	99.50%
Biomass/Rice Hulls	

Table A4.3: Economic Parameters

	2007	2008	2020	2030
GDP*	1,368,641.13	1,416,543.57	2,140,494.60	3,019,379.02
GDP Growth rate	7.19%	4%	5%	5%
Population	88,574,614	90,346,106	114,580,707.96	126,568,385.16
Pop Growth rate	2.11%	2%	1%	
GDP per capita	15,451.84	15,679.08	15,909.65	16,143.62

Table A4.4: DOE's NEECP

- Switch from inefficient to efficient energy practices-starting with lighting- in workplaces, buildings, homes and public places;
- Switch from petroleum-based fuels to alternative fuels and cleaner technologies in the transport sector (discussed in Section 2.2.2);
- Switch from kerosene to renewable energy sources for lighting and basic electricity in remote rural areas;
- Switch from fossil fuel-based technologies to renewable energy technologies in power generation, where feasible at the local level; and
- Switch from vestiges of centralized energy planning to more participative, bottom-up energy planning at the local level.

Other projects and activities under NEECP include:

- IEC Campaign - DOE conducts seminar-workshops for target participants in the commercial, residential, industrial and government buildings; fuel economy runs for road transport vehicles; and the use of media to reach wider target sectors.
- Voluntary Agreements Program - The government promotes car-less day, carpooling and anti-idling campaigns
- Energy Efficiency Standards and Labeling Program - This has discouraged the manufacture or importation of inefficient household appliances and lighting products in the market and resulted in improved quality of locally-manufactured products.
- Government Energy Management Program - Government buildings are monitored and subjected to energy audits; seminars on energy efficiency and conservation for government employees.
- Systems Loss Reduction Program - This enables private utilities to decrease their systems losses through redesigning transmission lines, improvement of substation equipment and strict monitoring against electricity pilferers.
- Recognition Programs - The Don Emilio Abello Award is given to private companies that make significant improvements in their energy consumption patterns.
- Energy Audit - DOE offers energy audits to manufacturing plants, commercial buildings and other energy-intensive companies to evaluate the energy efficiencies of equipment, processes and operations, and recommend energy efficiency and conservation measures.
- Philippine Efficient Lighting Market Transformation Project - This addresses the barriers to the widespread use of energy efficient lighting systems in the country. The objective is to generate energy savings from the change-over, and therewith contribute to the reduction of GHG emissions.

Table A4.5: Potential Savings from EE Programs (for 2007-2014)

(In Million Barrel of Fuel Oil Equivalent, MMBFOE)	2007	2008	2009	2010	2011	2012	2013	2014
I. INFORMATION, EDUCATION AND COMMUNICATION CAMPAIGN								
II. VOLUNTARY AGREEEMENT								
I. ENERGY LABELING AND EFFICIENCY STANDARDS								
FOR HOUSEHOLD APPLIANCES	5.41	6.04	6.34	6.67	7	7.34	7.71	8.11
A. Fuel Economy Guide for Vehicles								
B. Energy Standards and Labeling Program for Room Air Conditioners	1.78	1.87	1.96	2.06	2.16	2.27	2.39	2.5
C. Energy Labeling Program for Refrigerators and Freezers	0.63	0.66	0.69	0.73	0.77	0.8	0.84	0.89
D. Labeling for Compact Fluorescent Lamps	2.38	2.5	2.62	2.76	2.89	3.04	3.19	3.35
E. Ballast Loss Standard and Labeling for Fluorescent Lamp Ballast	0.28	0.66	0.69	0.73	0.77	0.8	0.84	0.89
F. Luminaire Installation	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06
G. Household Electric Fans	0.09	0.09	0.1	0.1	0.11	0.11	0.12	0.13
H. Television Stand-by Power Reduction	0.15	0.16	0.17	0.17	0.18	0.19	0.2	0.21
I. Performance Certification of Fans and Blowers	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08
II. GOVERNMENT ENERGY MANAGEMENT PROGRAM	0.2	0.21	0.22	0.23	0.25	0.26	0.27	0.28
A. A. Fuel Conservation	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04
B. B. Electricity Conservation	0.17	0.18	0.19	0.2	0.21	0.22	0.23	0.24
III. ENERGY MANAGEMENT PROGRAM	0.49	0.51	0.54	0.56	0.6	0.62	0.66	0.69
A. Energy Audits	0.09	0.09	0.1	0.1	0.11	0.11	0.12	0.13
B. Heat Rate Improvement of Power Plants								
C. System Loss Reduction Program	0.4	0.42	0.44	0.46	0.49	0.51	0.54	0.56
D. Demand-Side Management (Market Base)								
Total	6.1	6.76	7.1	7.46	7.85	8.22	8.64	9.08
Equivalent MW Deferred Capacity	141.45	157	164.88	173.22	181.8	190.85	200.36	210.56
Avoidance of GHG Emissions, Gg CO2 Equivalent	1,959	2,174	2,284	2,399	2,518	2,644	2,775	2,917