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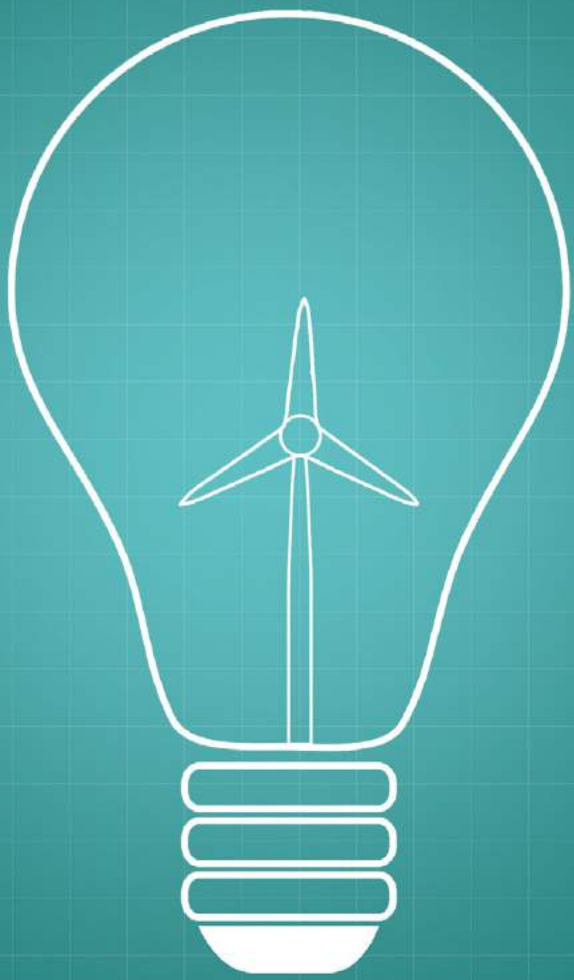

BUILDING MOMENTUM FOR LOW CARBON DEVELOPMENT IN THE PHILIPPINES

WWF

WWF is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption

Building Momentum for Low Carbon Development is a project undertaken by WWF-Philippines in partnership with the Philippine Climate Change Commission (CCC) and WWF-Germany.

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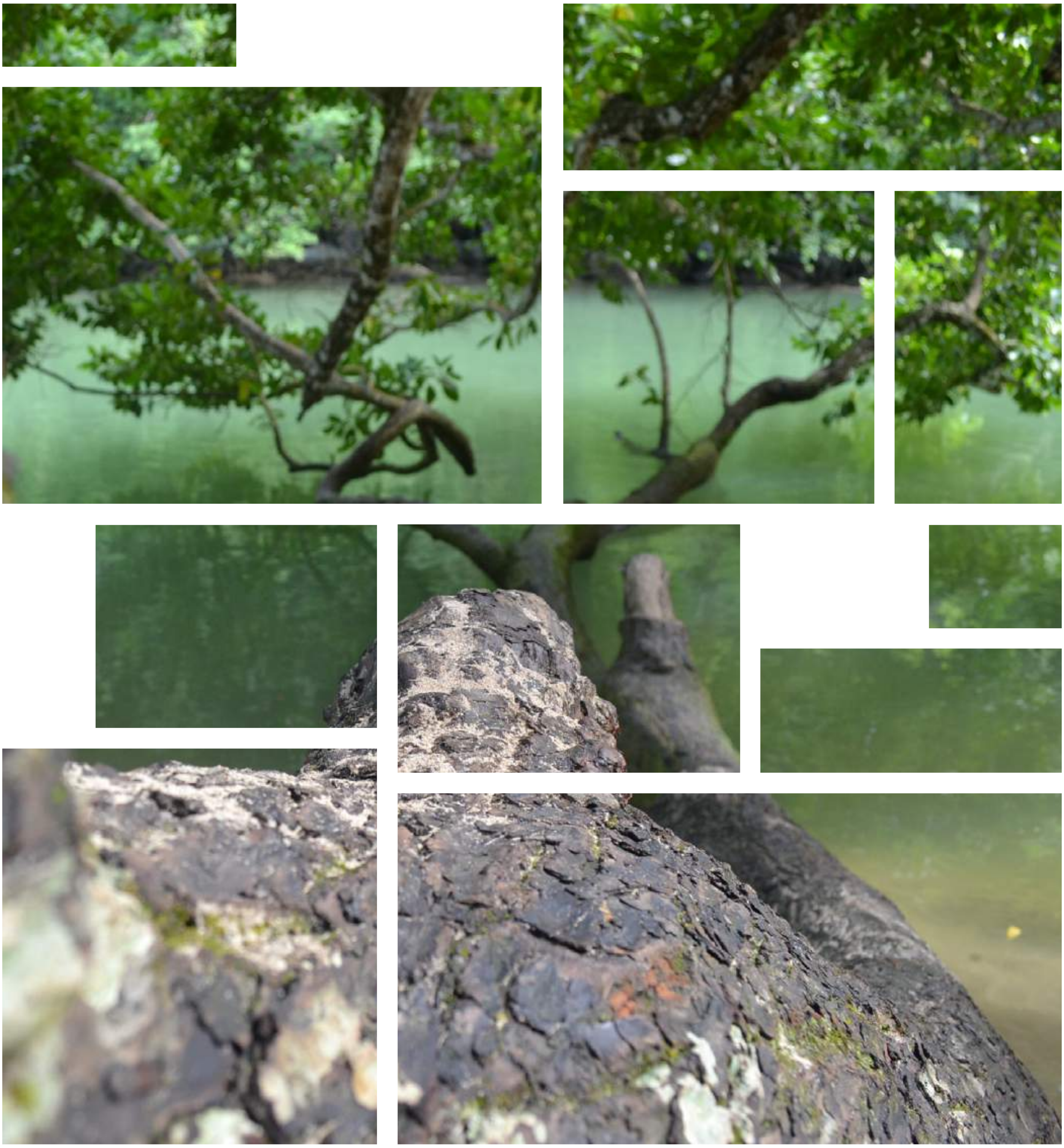


EXECUTIVE SUMMARY

MAINTAINING THE ALLOWABLE GLOBAL CARBON BUDGET

The accumulation of greenhouse gases (GHGs) from fossil fuels into the atmosphere has contributed significantly to global warming. Scientific bodies have determined that the global average temperature should not exceed 2°C relative to pre-industrial levels.

However, initiatives of developed countries have not brought down global emissions substantially. Further, under present business as usual (BAU) development of global emissions, the share of emerging countries is already higher than 50%. If left unabated, this is expected to increase to more than 80% in 2050[1]. Nations of the world are expected to breach the allowable cumulative carbon budget by 2023 and even if developed countries reduce their emissions to zero, it is not sufficient to prevent dangerous and irreversible climate change impacts. In short, all countries must implement drastic measures to avert catastrophic and irreversible damage from climate change.

SOCIO-ECONOMIC COST OF CLIMATE CHANGE

The Philippines' socio-economic losses due to adverse effects of air pollution and climate change are substantial. To illustrate, a DENR-WB report states that in 2002, public health concerns caused by air pollution cost the economy USD2.28 billion[2]. About USD605 million worth of public health costs could be attributed to air pollution from fossil-fueled power plants.

On top of this, climate change is also felt in the Philippines, perhaps more than most, being ranked 3rd[3] among countries worst hit by extreme weather events in 2013. Every year, the country averages 20 typhoons with 8 to 11 of these making landfall according to the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). This results in loss of lives and property, thereby affecting the economy. For example, Super Typhoon *Yolanda* (international name: *Haiyan*) hit the country in November 2013, and was widely reported as the deadliest typhoon to make landfall. It claimed more than 6,000 lives, dislocated 4.1 million people, and damaged more than1.1 million homes. The country's GDP growth slowed down in 2013, with its effects continuing through 2014.

LOW CARBON DEVELOPMENT PATHWAY

Given this, it is imperative for the Philippines to pursue a low-carbon development strategy. It should work to promote inclusive economic growth within a sustainable and green economy framework and to prevent the acceleration of GHG emissions. This calls for increasing energy efficiency and making a shift from fossil fuel use to renewable energy (RE), transitioning to a low carbon development (LCD) pathway.

1 see Figure E 1.0, JLBTC 2011
2 PEM 2002, Air Quality, a DENR WB publication
3 http://www.adb.org/themes/climate-change/facts-figures

LCD pathway may be defined in terms of the following processes and goals:

- the setting and abiding by the global and national carbon budget;
- reducing fossil energy demand and CO_2 emissions in electricity generation, transport and the other energy end use sectors;
- developing, enlarging and integrating the different RE sources and increasing their share in the energy mix such that there is compliance with the carbon budget.

There must be a paradigm shift and a solution-oriented transition into an LCD policy and pathway.

SCENARIOS

The energy sector is the biggest source of GHG emissions of the country and is, therefore, the focus in determining the strategy for LCD in the Philippines. LCD strategies include energy efficiency and conservation measures, replacement of GHG emitting fossil sources with RE, and improving the carbon sink potential.

Six scenarios covering the Energy Sector, particularly electricity generation, are presented in this study. Model calculations are based on simplified energy mix models which can be projected to 2050 time horizon with the application of different speeds in transition and RE options to be employed.

The first two scenarios, (Business as usual) **BAU 1** and **BAU 2** consider coal and natural gas as fuel sources in the energy mix. **BAU 1** presents a larger share for coal, while **BAU 2** provides a larger share for natural gas (NatGas). Calculations were undertaken, particularly because of impact on carbon emissions of the two fuels, with emissions from coal double to those of natural gas.

The third scenario, or **Innovative 1**, is premised on electricity generated from purely RE sources, providing a roadmap for transitioning to 100% RE, while, the fourth, **Innovative 2** considers electricity production from almost an equal share between natural gas and RE sources. RE options included are geothermal, hydro, wind and solar. Biomass and ocean energy are excluded. In all these scenarios, considerations include availability of RE sources, technical feasibility of plants in the given mixes, in terms of capacities, efficiencies, dependability and utilization.

These first four scenarios focus on determining cost of electricity. Two additional scenarios, **BAU 3** and **Innovative 3** were formulated to determine the impact on the country's carbon emissions for the given forty-year study period. The RE sources, biomass and ocean, which were not considered in the first four scenarios are included in the energy mix for these last two scenarios.

In the context of the global budget, the calculated budget share of the Philippines is about a cumulative 2,105 Tg-CO_2e for the study period (2010-2050). Thus, knowing this, the country can begin its journey to LCD by first detailing and assessing its reference-baseline condition. To formulate the BAU scenario, the study profiles the energy sector's dependence on fossil fuel, its centralized power generating capacity, separated (rather than combined) energy usage system, the use of high quality energy for low value uses (such as heating and cooling), and the growth of fossil-based electricity generation, and its high carbon growth consequences.

Energy

The transitional pathway to LCD envisions developments in the Energy Sector, such as enabling the development of solar, wind and biomass energy generation plants; the establishment of a decentralized grid; reform of the centralized energy generation and distribution system to allow for the synchronization of natgas and RE supply to the grid; and the generation of surplus energy to augment the operations of wind and solar power plants to meet peak power generation requirements. Additionally, surplus RE electrical power can be converted to hydrogen and to storable RE-methane (RE-CH_4) used as filler energy.

The recommendations for the key pathways for the Energy Sector are as follows[4]:

- Energy saving & efficiency increase, employing:
  - a) reduction of specific energy use in application;
  - b) distributed power generation;
  - c) combined power generation; and
  - d) energy recovery through recycling.
- Replacement of fossil energy with RE based energy for electricity production by calling for a moratorium and phase out of coal- and oil-fired plants, and a shift to natgas plants for lower emissions, allowing for more variable and reduced static base load along with hydro and geothermal, with natgas only as back up and bridge power generator during the transition process towards 100% RE based economy.
- Installation of liquefied natgas (LNG)/compressed natgas (CNG) supply and distribution system in land map. Importantly, operation of the system should prioritize utilization of electricity generated from RE based plants, with production by LNG/CNG based plants as filler.
- Set up systems and policies to prioritize combined heating, and cooling power (CHCP) systems to improve prime energy efficiency conversion levels of LNG/CNG and RE-CH_4, and to reduce peak power requirement. Decentralized distribution system is recommended to reduce system losses from transmission and distribution, parallel to undertaking full blown development of RE sourced plants.
- Increase RE based system coverage through energy storage & buffering systems, including:
  - a) hydro storage;
  - b) battery storage;
  - c) physical phase change storage systems;

4 JLBTC 2012

d) conversion of surplus RE energy from wind and Photovoltaic (PV) to hydrogen and further into RE-CH_4 ; and
e) thermal and cooling energy storage systems.

The implementation of the following policies may reduce or diminish the production share of coal and oil:

- the application of standards on prime energy efficiency and environmental norms;
- setting a ceiling on the allowable CO_2 emissions for electricity generation, transport and other final energy users;
- the application of reduction factors on fossil energy demand in transport and other sectors either through direct command-control measures or the imposition of CO_2 emission taxes;
- the provision of incentives to natgas for the use of absorption-cooling systems such as CHCPs;
- fossil fuel switch to biofuel in transport and the availability of RE-fueled vehicles *(E-vehicles)*.

Renewable Energy

In order to promote strategic RE development, and specifically increase the share of wind, solar, and biomass, the following actions must be undertaken:

- Launch a massive information and education campaign (IEC) to reach the general public, government and potential investors to obtain their support for extensive RE development, and invite new investments;
- Remove restrictive RE policies that impose a limit on the generation capacity of wind, solar and other RE resources and that require the prior establishment of RE plant facilities before the granting of feed-in tariff (FIT) eligibility; and implement priority application and use of RE;
- Specify "green energy options" that should be provided to end-users as mandated by the Renewable Energy Act of 2008 (Republic Act 9513);
- Develop the appropriate differentiated approach in promoting the development of wind and solar energy, and locally-based biofuel production and energy production from organic wastes, with their respective lead agencies;
- Democratize the entry of local RE generating units into the grid and reform the centralized power generating and distribution system.

Electricity Generation

The recommended innovative LCD pathway for electricity generation, along with stronger policies on RE and energy efficiency and conservation, calls for the following initiatives: non-renewal of contracts, phase-out and replacement of fossil sources (i.e. coal and oil) and to initially use natural gas (natgas) as a bridge energy source on the road to attaining 100% RE economy. It likewise proposes augmenting the current power distribution system with decentralized systems for the entry of decentralized RE, natgas and trigeneration systems (e.g. CHCP). These would provide combined power, heat, and cooling close to demand location and direct service users; integrate service for power supply to the transport sector; and operate complementary power generation facilities. Decentralizing power generation and distribution systems would also help reduce transmission losses which now stand at 11%.

Transport

For transport, currently dependent on fossil fuel, the overlaying principle is to increase efficiency levels of the drive systems and infrastructure. The LCD strategy for Transport calls for:

- Implementation of sustainable urban development with improved mass transit, road network and telecommunications services, and closed, narrow loop production systems.
- Consideration for improved pedestrian walkways and use of non-motorized modes of transport.
- Elimination of less efficient drive systems and application of mandatory transition to highly efficient system transport units such as transport units with reduced weight, increased fuel efficiency, and with higher person- or load-efficiency per km. To catalyze this, policies on their implementation are needed, as follows:
    A. application of fossil fuel tax for lower efficient drive systems;
    B. replacement of luxury import tax with CO_2 based taxation for transport vehicles;
    C. provision of incentives for imported and locally produced, highly efficient drive systems; and making available soft loan rates to finance the transition[5].
- Shifting from mono fuel vehicles to hybrid drives (i.e. shift from gasoline to diesel/natgas) and shifting from liquid fuel to electricity provided by RE sources, requiring the implementation of LNG/CNG supply and distribution system in land maps, and implementing energy switch and integration of combined and RE power use as well as shift towards the use of electric vehicles.
- Further use of alternative fuels in combination with improved transport technologies.
- New direction of land and urban planning towards self-sustaining communities with infrastructure for multi-modal systems with high connectivity and access despite weather related disturbances.

Land Use Change and Forestry

For the Land Use Change and Forestry (LUCF) Sector, the proposed innovative LCD pathway aims to increase its carbon sink potential by launching an intensive reforestation program (Marshall Plan for Reforestation) covering 650,000 hectares in the next 15 years for a total of about 33% of the country's land area[6]. The proposed Marshall Plan for Reforestation provides for a public-private partnership scheme with professional management and consistent public-based check and balance safeguards. It also aims to achieve inclusive growth through the integration of upland farmers and indigenous groups by providing them with a continuous and sustainable income base free from equity, to create real ownership and long term commitment. Long term funding from small scale local and international investors will ensure the project's sustainability over the next 20 to 25 years. Professional management secures an appropriate return on investment to private funders, along with income sharing and sustained livelihood from sustainable forest extraction towards ending illegal logging and slash and burn farming for indigenous people (IP) and upland dwellers[7].

Waste

For the Waste Sector, the LCD strategy calls for a shift from landfill disposal to maximized waste recovery and recycling with the operation of fully integrated waste management systems. The focus must be replacing the existing approach of building sanitary landfills by setting up professionally designed and operated waste recycling plants. This will maximize waste recycling; allow power generation from organic, biodegradable bio-waste that produces RE-CH_4 and organic fertilizer; and

5 *Soft loans provided by donor countries and financial institutions are lent to takers at commercial rates and loan terms by Philippine government financial institutions such as the Development Bank of the Philippines (DBP) and Land bank of the Philippines which make financing unaffordable to bus operators, taxi operators, jeepney operators and tricycle operators to transition. The Philippine government economic advisers have to rethink this policy to afford operators financially viable transition.*
6 *Key results of the model calculation are shown in Figure 12.3, 12.7 and Table 12.6*
7 *JLBTC 2010*

produce Refuse Derived Fuel (RDF) from dry, non toxic residuals for thermal conversion and power generation. This approach could recycle up to 95% of the current waste generation and would limit residual storage requirement to a minimum[8]. Long-term behavioural campaigns to instill proper waste management, reduce waste generation at source, and create necessary awareness is still needed.

Agriculture

Although emissions from Agriculture (CH_4 and N_20) and fugitive process emissions are not considered in this study, reduction of GHG emissions in this Sector can be achieved by implementing the following:

- Shift from chemical based production to organic agricultural practices;
- Lower irrigation levels and improve field management in rice cultivation to arrest N_2O emissions;
- Improve farm to market transport and storage systems and integrate food production including farmers and marketing systems to create inclusive growth, to benefit from appropriate share in added value and to avoid losses in perishable products; and
- Promote increased consumption of vegetables in favor of meat products.

A shift to the recycling approach would help create a substantial number of jobs, avoid further pollution of water-bodies, avoid flood risks, and help cut methane and resulting GHG emissions within the next 5 to 10 years.

PROJECTING CO_2 EMISSIONS UNDER BAU AND LCD

The country's population is expected to increase from around 92 million in 2010 to around 140 million in 2050. In 2014, the Philippine population has already reached 100M. This will necessarily impact its energy consumption.

BASELINE (YEAR 2010) AND PROJECTED CO_2 EMISSIONS TO YEAR 2050

Year 2010 CO_2-baseline emissions were established for electricity generation, transport, heat, solid waste and forestry at 32.57 Tg, 26.69 Tg, 13.72 Tg, 14.60 Tg and 78.38 Tg respectively, for a total of 166 Tg. **Under the BAU development scenario**, these will escalate to about 452 Tg CO_2e in the year 2050, with cumulative emissions from 2010 to 2050 reaching 10,142 Tg, or by more than 480%. The assumed cumulative allowable emissions budget for the Philippines by 2050 is calculated at 2,104,572 Gg or 2,105 Tg CO_2e and will be breached as early as Year 2022.

The development of CO_2 emissions under the BAU 3 scenario, with cumulative CO_2 emissions from Year 2010 to 2050, total 10,142 Tg, increasing emissions from 166 Tg[9] per year in 2010 to 452 Tg per year in 2050. This assumes also that the calculated sink capacities from newly grown forest will be accounted for. If this would not be the case, further reductions of fossil energy production share must be implemented to stay below the stated allowable budget level.

8 System was developed for the Philippines under a solicited International BOO project for Metro Manila including surrounding areas and awarded to PEC/Remondis/JLBTC, 2000.
9 1 Tg (teragram) = 1000 Gg (gigagram) = 1,000,000,000 kg

Transportation exceeds all other sectors in total emissions in 2050, and overtakes Electricity Generation emissions in 2035. In 2050, emissions from electricity generation, transport, heat, solid waste and forestry are projected to reach 146.94 Tg, 194.80 Tg, 44.56Tg, 49.67 Tg and 15.68 Tg respectively. Emissions from forestry are reduced from 78.38 Tg in Year 2010 to 15.68 Tg in 2050 due to bottoming out of residual forest degradation and elimination of most remaining forests.

On the other hand, **under the innovative LCD scenario**, cumulative CO_2 emissions peak in 2035 with 2,121 Tg, breaching the allowable cumulative emissions budget of 2,105 Tg CO_2e. However, with the increase in the country's carbon stock due to the implementation of the proposed Reforestation Marshall Plan, total cumulative CO_2 emissions in Year 2050 will be 1,261 Tg. From 166 Tg CO_2 emissions in 2010, a budget of -96 Tg is achieved in 2050, with electricity generation contributing only 9.49 Tg, Transport at 5.48 Tg, Heat and Solid Waste both generating no emissions, and increased forest carbon stock equivalent to -110.93 Tg.

Under the innovative LCD scenario, emissions level decrease continuously through the study period as an effect of the combined energy conservation initiatives. The results clearly point to the necessity of adopting and implementing stronger policies and programs towards LCD to keep resultant CO_2 emissions below the given allowable carbon budget by shifting to an RE based economy.

Projected CO_2 Emissions, Philippines, Reference, BAU and Innovative Scenarios, Years 2010 - 2050

Estimated Philippine CO_2 Emissions							
YEAR	Innovative Total Tg-CO_2/a	Cumulative Innovative Total cum.Tg-CO_2	Reference/ BAU Total Tg-CO_2/a	Cumulative Reference/ BAU Total cum.Tg-CO_2	Cumulative Philippine Budget cum. Tg-CO2-e	Cumulative Philippine Real Emissions Baseline cum. Tg-CO2-e	Relative Philippine Worldwide Budget 600Gt Goal *cum. Tg-CO_2-e*
2010	166	166	166	166	168	135	135
2020	102	1,475	173	1,853	1,637	1,664	1,346
2030	22	2,074	214	3,819	1,994	3,572	1,776
2040	(32)	2,031	301	6,385	2,052	5,956	1,934
2050	(98)	1,261	452	10,142	2,105	8,932	2,105
Total	1,261	1,261	10,142	10,142	2,105	8,932	2,105
Inno/BAU	12.40%	12.44%	804.10%				

CO_2 EMISSIONS FROM ELECTRICITY GENERATION

BAU 3 scenario and Innovative 3 scenario were formulated to determine the impact on the country's carbon emissions for the given forty-year study period. BAU 3 scenario assumes a continued increase in fossil energy share, and a reduction in its projected RE targets to 2030, whereas the Innovative 3 Scenario moves towards continuous reduction of fossil fuelled plants by replacing them with RE-fuelled plants, and maximizing the utilization of RE depending on reasonably set potentials, availability, and deployment patterns.

The calculation model result shows that electricity demand will increase from 67.743 TWh/year in 2010 to 325.29 TWh/year in 2050 based on an AAGR of 4.01%, including use of electricity by the transport sector, which will increase from its present share of 0.16% due to the expansion of the light rail transit system and employment of e-vehicles.

To meet increasing electricity demand, under BAU 3 scenario, the currently installed 16.36 GW[10] capacity is expected to increase to more than 74 GW, while under the Innovative 3 scenario, it is expected to reach 118 GW to supply the demand in 2050. Under the BAU 3 scenario, by 2050 the production share of fossil fueled plants is calculated to reach 78% with its total installed capacity of about 62 GW, while renewables will generate the remaining 22% with its total installed capacity of 12.5 GW. On the other hand, under the Innovative 3 scenario, the production share of RE is calculated to reach 91% with its total installed capacity of 86 GW, while fossil will contribute about 9%, with its total installed capacity of 32 GW.

Under BAU 3 scenario, the fossil production in 2050 rises to 255 TWh-e per year. The RE production share is calculated at 71 TWh-e per year. The Innovative 3 scenario projection shows an almost reverse picture wherein fossil production is reduced to 29 TWh-e per year and RE production rises to 297 TWh-e per year. This result shows that residual fossil energy demand can be limited if we deploy enough capacities from wind and solar and limit fossil use to equalizing and filling short-term gaps occurring due to the variable nature of such sources.

CO_2 EMISSIONS FROM FINAL ENERGY DEMAND FOR HEAT

Insofar as CO_2 emissions for heat demand is concerned, reduction in emissions is through the following: savings in prime energy demand, fuel switch to RE fuel sourcing, waste heat recovery or through efficiency increase, wherein high temperature heat demand is sourced through waste heat use generated during power generation from direct combustion of fossil fuel or preferably from biomass fuel or fossil fuel; and for lower to medium temperature heat demand by process and other heat energy recovery systems or employment of combined heating, cooling and power (CHCP) systems.

Under the Efficiency Increase Scenario, where prime energy demand is reduced due to energy saving measures, an estimated reduction potential for year 2050 of 11,383 MWh-pr/h[11] for High Temperature Energy Demand and 26,760 MWh-pr/h for Low to Medium Temperature Energy Demand is achieved as compared to the Reference *(BAU)* Scenario. This results in a total cumulative saving potential of 34% to 38% for the projected period 2010 to 2050.

After applying all possible energy demand reduction and efficiency increase measures, under the Fuel Switch to RE Scenario, it is envisioned that heat demand will be supplied from RE sources. The remainder biomass is then used under second priority for high temperature applications (i.e. cement industry). Residual demand for medium and low temperature applications is satisfied through waste heat usage from power generation, as applicable.

10 1 GW (Gigawatt) = 1000 MW (megawatt) = 1,000,000 KW (kilowatt)
11 MWh-pr/h - Megawatt hour prime energy per hour

Only after exhausting all above stated measures would conventional fossil prime energy be used. The described priority scheme underlines the importance of combined power generation preferably at sources of high heat and cooling demand.

CO_2 EMISSIONS FROM FINAL ENERGY DEMAND FOR TRANSPORT [12]

Evaluation of CO_2 emissions development from the Transport Sector were undertaken by comparing these scenarios[13]:

- Baseline/Reference *(or BAU3)*;
- Optimized Approach/ Efficiency Increase; and
- Fuel switch to biofuel & RE-fueled E-vehicles (Innovative 3).

Final energy demand for Transport in 2010 totaled 7.92 MTOE (Million Tonnes of Oil Equivalent), of which 6.93 MTOE or 87.50% of the total demand is attributed to Land Transport. Of the energy consumed by the Land Sector, 6.91 MTOE, or almost 100%, comes from fossil fuels.

The Innovative 3 Scenario projections show that the potential supply from local biofuel sources for transport would be sufficient only under the 3rd projection level including substantial RE-Fuel Switch using Biofuel, RE-e and RE-CH_4 which could cover a 100% RE transition. This is not the case for Baseline/ Reference (BAU3 Scenario), even if we would apply all projected energy saving measures.

The calculations reflect a relation of 2:1 energy demand share between Passenger Transport (61,367 GWh-pr/ year) and Cargo Transport (30,780 GWh-pr/ year), and CO_2 emissions share between Passenger Transport (15,802 Gg CO_2e) and Cargo Transport (7,926 Gg CO_2e)[14]. By applying all measures under the efficiency increase scenario, the projected annual CO_2 emissions for Passenger and Cargo transport will still rise between 2010 to 2040 from 23,728 Gg to 65,357 Gg and will then fall to 5,477Gg in 2050.

The Innovative 3 Scenario applies all energy reduction and transition measures described under the earlier two scenarios (reference scenario and efficiency increase scenario). Under the Innovative 3 scenario, fossil energy demand substantially decreases with increasing fuel efficiency level of the drive systems by implementing a combination of:

A. use of light weight yet durable materials in the design of transport vehicles;
B. enhanced design to improve aerodynamics;
C employment of improved motor controls; (Auto start-stop etc.)
D. shifting towards hybrid systems for long haul and mixed distance applications and electrical drives for shorter ranges.

In place of the current use of low capacity mass transit, a fast, comfortable higher capacity mass transit system will increase specific transport efficiencies. Efficiency of mass transit systems must be improved by replacing transport stock with intelligently networked hybrid systems *(CNG+E)*. This

12 In the study only road transport for Passenger and Cargo is evaluated, the other transport modes (Air and Shipping) are excluded. A case study is also presented, comparing different fossil fuel based drive systems and alternative electrical powered and evaluates the effect on energy efficiency- and cost relations in use of fuel type.
13 see Table 9.1 in Chapter 9
14 Ibid

can be achieved with the integration of energy production and usage through distributed energy generation and combined use of energy. Automated interdependently communicating and operating individual and mass transit systems could further boost the energy efficiency in this sector.

To reduce energy losses in the transport sector, it is also necessary to remove existing blockages caused by:

A. insufficient infrastructure,
B. missing or inefficiently working traffic management systems; and
C. roadside blockages through encroachment of buildings and parked vehicles in drive-zones.

The transition to LCD calls for integrating the present separate, disjointed transport sector into a combined and distributed energy transformation system based on RE sourced energy and a power network. This can be supported intermediately by RE-power that is transformed into H_2 and reformed into RE-CH_4 which can be stored and conveyed to the distributed power generation network and to the transport sector at any deferred time.

The Fuel Switch Scenario indicates biomass fuel coverage of more than 100% from 2030 onwards. However, this assumes a sharp transition towards E-vehicle and hybrid drives which have to be covered from complementary RE based energy sources and cannot be covered by biomass alone as indicated under the Energy Efficiency Scenario. Consequently a substantial build up of RE capacities from Wind, Solar and Ocean must cover the RE potential gap in order to stay below the GHG emission cap.

Under the three assumptions for fossil energy demand development scenarios[15], for the Year 2010, prime energy demand from fossil fuels under the Baseline or Reference Scenario is 10,519 MWh-pr/h. For the Year 2050, this is projected at 67,448 MWh-pr/h. Under the Optimized Approach/ Efficiency Increase Scenario, this will go from 10,519 MWh-pr/h in 2010, and grow to 27,994 MWh-pr/h in 2050. Under the Fuel Switch RE-Based Scenario, prime energy demand is estimated at 10,519 MWh-pr/h in 2010, and would go down to 3,472 MWh-pr/h in 2050.

In 2050, under the Reference *(BAU)* Scenario, annual CO_2 emissions from Road will exceed 150,000 Gg. Under the Optimized Approach/Efficiency Increase, this will reach over 63,000 Gg, while this will fall below 8,000 Gg under the Fuel Switch Scenario[16].

In considering application of energy potential from biomass fuel sources estimated to produce 5,178 MWh-pr/h in the year 2010, and 21,536 MWh-pr/h in 2050, the results of the calculation model show partial biofuel coverage potential under the Energy Efficiency Scenario ranging from around 43% in 2010 to 84% in 2030. It then declines to 77% in 2050. For the Reference or BAU Scenario, a 100% coverage cannot be achieved in any projection period.

15 see Table 9.3
16 see Table 9.13

A comparative cost analysis between a high efficient diesel drive (Direct Injection or DI-Diesel) and an electrical drive system e-Car was undertaken. Results of the analysis show that the diesel system has the highest fuel cost, close to fuel cost from electricity supplied by centralized power generation systems but shows reasonable values in terms of GHG emissions. The non-beneficial results for e-Cars fueled by electricity from centralized coal fired plants prove that a switch strategy to electric drive systems fueled by coal fired plants is not an option with regard to GHG emission reduction nor with regard to cost reduction.

This underlines the over-all recommended strategy for a distributed and individualized, RE based power generation structure due to cost considerations. It shows a viable, low cost pathway option through wider RE application, integrated with the RE-fueled electrical-and/or RE-hybrid drive systems and localized electrical power supply for Residential, Commercial and Industrial use. This also indicates the need to reform the current inflexible and costly power supply and distribution sector in the Philippines, to be replaced with a real functioning open market structure supporting unrestricted and priority access for distributed, individual power generation systems and giving full priority for RE based power generation systems.

COST OF ELECTRICITY GENERATION AND IMPACT OF RENEWABLE ENERGY SOURCES

While the country has the highest electrical power rates in the Southeast Asian region and among the highest in the world, it still experiences inadequate, unstable supply, and system losses stood at 11% in 2011.

High electricity cost in the Philippines is attributed to dependence on increasing cost of fuel imports; and a policy requiring 60% local ownership of utilities. Both situations—exacerbated by poor infrastructure, the weak regulatory capacity of the state and supposedly independent assigned regulating agencies—impose high power rates on consumers and discourage investors from investing.

The government's current thrust is to continue strong dependence on fossil fuel for electricity generation with the installation of more coal fired plants for base load demand.

In August 2013, the Philippine Department of Energy (DOE) reported that committed coal-fired plants will increase by 1,504 MW. In the pipeline is an additional 6,950 MW. Committed RE sourced plants total 193 MW, or about 13% compared to the total committed capacities of coal-fired plants. RE sourced plants in the pipeline total 1,005.10 MW, or only about 15% of the coal-fired plants in the pipeline. Total capacity for the committed coal fired plants and those in the pipeline total 8,454 MW, while that of RE sources is 1,198.10 MW, or a total of 9,652.10 MW, with RE having an 18% share of the total additional capacity[17].

Determination of the impact on the cost of electricity of new RE sources, other than hydro and geothermal, such as wind and solar, is therefore critical in pushing forward the transition to a RE

17 *Philippine Power Situationer, DOE, Energy Investment Forum, Marco Polo, Davao City, 25 September 2013 https://www.doe.gov.ph/microsites/ipo%20web/linked%20files/2013/MEIF2013/01_Philippine_Power_Situation.pdf*

economy. Several scenarios were considered in the determination of cost of electricity, including with *(limited to the initial evaluation approach)* and without cost of carbon.

A key constraint in achieving a 100% RE supply structure are the capacity limits and availability of some RE sources. The only highly available and hardly limited capacities today are from wind and solar. However, these capacities are highly variable by their very nature. In order to employ these capacities, there is a need to change the old grid view and the current practice of having a practically static base load with a semi-variable, intermediate and variable base load and reduced short-term peak load. The grid must be able to cope with the necessary flexible base load arising from the variable loads provided by wind and solar.

The model calculation showed that by employing the vast potential from Wind, Solar and at a later stage, Ocean based RE energy combined with a conversion of RE-energy to RE-CH_4, a 100% RE based economy is possible in the Philippines. The model calculations show that option *100% RE* entails a marginal higher cost compared to a fossil dominated approach at today's cost level and without employing externality cost. All calculated direct costs for an RE based approach resulted in lower mixed power cost rates than presently charged to consumers. This outcome indicates that a decisive paradigm shift towards a RE based transition today is commercially and economically viable.

Under the Innovative 1 Scenario, a 100% RE mix is generated. Natgas used in Innovative 2 is replaced by increased RE generation capacity from wind and solar; and converting surplus energy generated through electrolysis into H_2 and further into RE-CH_4 for storage. The stored RE-CH_4 can be combusted in generator sets or natgas turbines for dispatch to the grid at any desired time, providing an essential filler and/or peak load supply function.

Part of the focus of this study is on determining direct cost relationships based on today's cost for RE and Fossil based plants and projected plant mix. Model results are targeted to ascertain the cost effectiveness of implementation of a 100% RE today. Results of the cost calculations for electricity generation based on given scenarios are as follows:

Project Cost Evaluation – Electricity Production, 2010 Innovative Scenario and BAU[18]

RESULTS		COAL	NGas	Ngas CHCP	RE-Gas (RE-e-H2-CH_4)+CHCP	Geothermal	Hydro	Wind	Solar
Plant Factor *(100% RE incl. USD30 carbon)*	%	30.00%	30.00%	30.00%	30.00%	90.00%	50.00%	35.00%	17.00%
Ranking *(100% RE incl. USD30 carbon)*		8	6	5	3	2	4	1	7
Total Cost A: Innovative	**PhP/ kWh-e**	**5.79**	**4.77**	**3.70**	**3.31**	**2.99**	**3.68**	**2.76**	**5.37**
Plant Factors for *(Max-Fossil & Coal)*	%	80.00%	80.00%	80.00%	30.00%	90.00%	50.00%	35.00%	17.00%
Ranking *(Max-Fossil & Coal)*		6	7	2	4	3	5	1	8
TOTAL Cost B: BAU	**PhP/ kWh-e**	**3.93**	**4.02**	**2.83**	**3.31**	**2.99**	**3.68**	**2.76**	**5.37**

18 *PowerGenerationModel-BAU-InnovativeV3.xlsx// Summary*

Even without inclusion of the carbon cost, the cost of RE is already competitive to that of fossil sourced electricity. With the spiraling cost of fossil fuels, and decreasing costs of RE technologies in the horizon, it is likely that electricity generated from fossil fuel plants will be more expensive than that from RE. Interestingly, the Innovative 3 scenario under two conditions—without ocean power, and under a 0.7%p.a. cost increase assumption for fossil energy production share—are cheaper than the fossil dominated BAU 3 options under stated assumptions.

The model calculations demonstrate the viability of the Innovative RE transition approach.

DEVELOPMENT OF GHG EMISSIONS IN THE PHILIPPINES

The study focus aims to capture main GHG emissions from Power, Heat, Transport, Solid Waste and Forest excluding fugitive emissions from Agriculture. It is estimated that present emissions cover 80% to 85% of the total GHG emissions.

The results illustrate the entirely different development pathways under the conservative BAU 3 and the progressive, problem solving oriented, Innovative 3 approach.

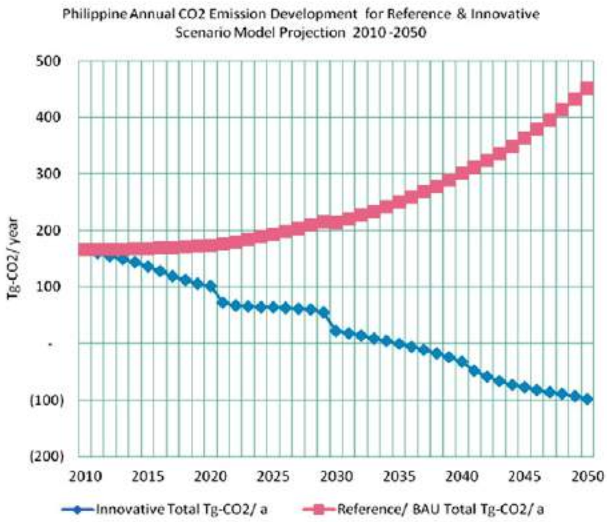
Applying goal settings according to BAU will not resolve pending and upcoming threats caused by fossil emissions. Instead the developed Innovative approach will keep the cumulative emissions within the allowable limits. By applying the recommended Marshall Plan for reforestation, goal limits could be further reduced.

As shown earlier, under the BAU scenario, the combined CO_2 emissions for the stated sources will escalate to about 452 Tg CO_2e at the end of the study period. On the other hand, under the Innovative Low Carbon Scenario, a negative carbon budget is achieved.

Most importantly, the *described innovative pathway can and must be implemented now* by keeping overall cumulative cost well within or below total cost incurred under a BAU scenario which would still bank massively on fossil fuel.

The results of the calculations under the Innovative Scenario show that the allocated carbon budget for the Philippines relative to the worldwide carbon budget can not only be achieved, but can be surpassed. However, implementation of recommended low carbon development pathways or similar low carbon strategies must be implemented as soon as possible. Decisive action now is needed in shifting to RE.

Development of Cumulative Carbon Emission from Selected Energy Sector Sources, Waste and Forestry, Philippines, Year 2010 - 2050[6]



WAY FORWARD

The Philippines' growing population and economic growth will increase demand for electricity, with supply continuing to be dominated by fossil fuels. Harnessing and utilizing the country's huge RE resources is key to reducing its carbon emissions and to addressing energy security.

As cost of RE technologies (i.e. Solar and Wind) are at a downtrend, Government of the Philippines (GOP) must aggressively pursue the shift to RE. Initially, the DOE has increased the installation targets under the National Renewable Energy Plan (NREP) for solar energy, but it still remains to be seen if the other NREP targets will be achieved due to current investment barriers. GOP must revisit current policies limiting deployment of RE caused by issues pertaining to cost, dispatch, and grid system operational load limitations.

The RE transition strategy is financially and technically viable and can be adapted in an emerging country like the Philippines. Both a central and decentralized scheme is recommended to optimize energy efficiency and minimize system losses. Utilization of intermittent RE sources such as solar and wind can be maximized with implementation of decentralized-centralized, smart grid system. To ensure maximum output from hydro sources, the respective watershed areas for water sources must be protected from denudation. In terms of cost impact, calculations indicate total cost for a mainly RE based power generation and decentralized power distribution structure is competitive, if not lower than presently charged power generation rates.

In case cost assumptions applied in the calculations do not capture other project costs such as pre-development, land cost and connection to grid costs, differential costs are estimated not to exceed PhP1 per kWh-e based on constant cost base. Under the assumption of a slight cost increase for natgas of less than 1% p.a., the RE transition strategy presented under the Innovative 3 scenario yields a lower cumulative cost for the projected period and is therefore recommended.

It is in the self-interest of developing countries, like the Philippines, to urgently demand for all nations to meet the given stabilization target in 2050. In doing so, the country can likewise set its carbon reduction goals much higher, take stronger action than already planned, and transit to a solution oriented, problem solving policy rather than remaining in a window-dressing stalemate.

The Philippines' ability to take the transitional pathway to LCD and attain the immediate and strategic goals of LCD would depend on the perceived importance and acceptability of the intervention measures among various stakeholders and the implementation capacity of various government administrations in the coming decades. In this regard, the Philippines should take a leading role in forging international alliances for a concerted action towards a full RE based economical transition. This would also finally eliminate potential short-term windfall advantages for countries remaining in polluting and GHG maximizing production status.

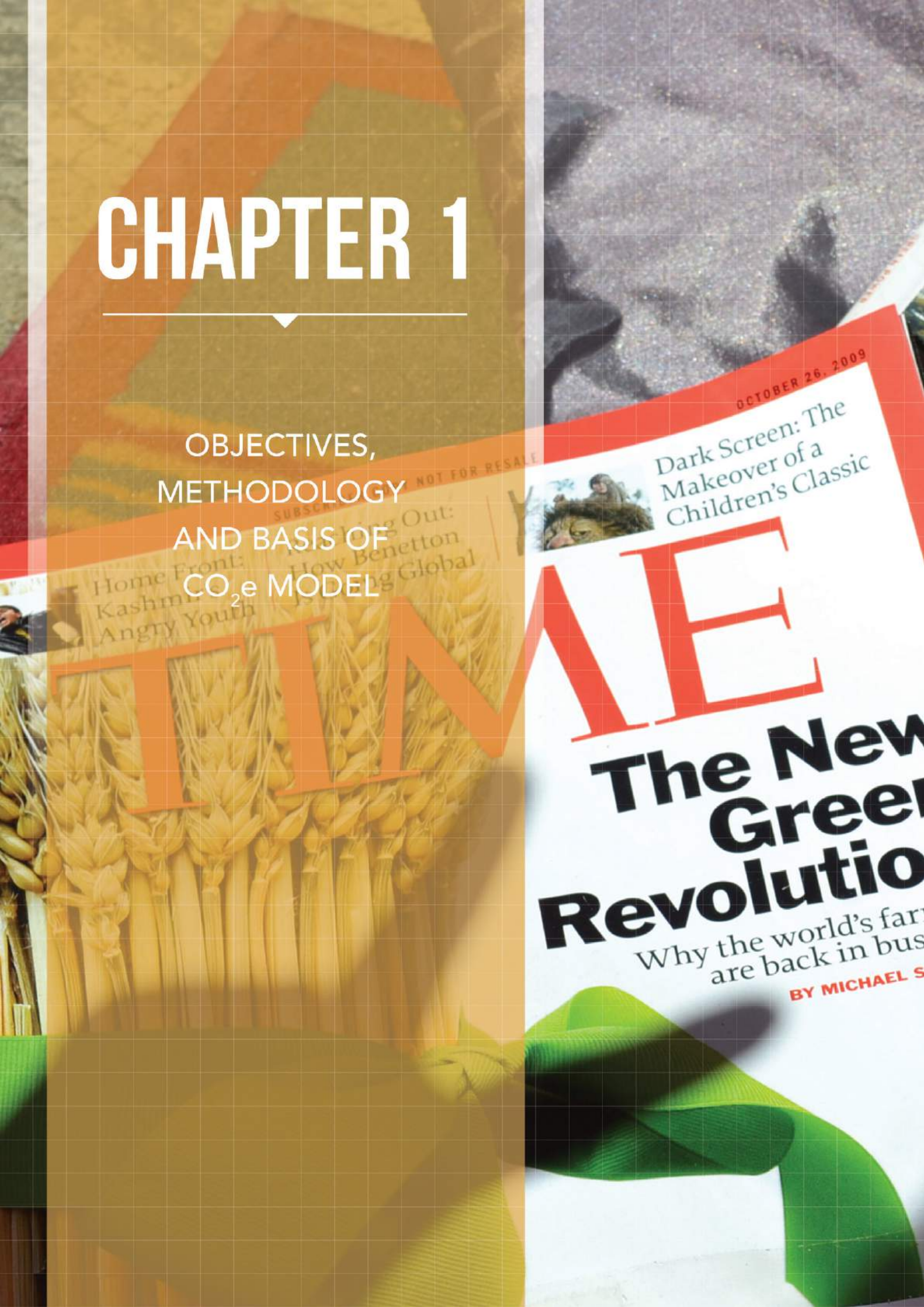
In order to accomplish these objectives under the recommended LCD pathway, it is imperative that existing lead government agencies including, but not limited to the Department of Environment and Natural Resources (DENR), Department of Energy (DOE), Department of Transportation and Communication (DOTC), the National Renewable Energy Board (NREB) and the Climate Change Commission (CCC) plan, monitor, and assess the outcomes of interventions. These agencies, moreover, must anticipate the resistance of vested interest groups and find ways to mitigate and resolve the conflict.

The various interventions proposed in this report presuppose a critical core of environmental advocates, planners and implementers in government, the private sector and civil society groups. There must be a transformative and future-oriented national leadership working with adherents at the highest levels of these sectors, as well as at the local levels.

"We believe that the transition to a renewable energy-based economy in the Philippines may be difficult but it is certainly not impossible. **We are at the frontline of climate change. NOW IS THE TIME TO ACT."**

CHAPTER 1

OBJECTIVES, METHODOLOGY AND BASIS OF CO_2e MODEL




GREEN POWER
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Michael Howard Bill Ford
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By Fareed Zakaria

1.1 INTRODUCTION

Global warming and its dire consequences for life is a common challenge confronting all nations. Unless all nations take responsibility and act with urgency to mitigate the impact of climate change, the threats of more intense natural hazards will result in destruction and human suffering, especially for the most vulnerable countries.

The diverse conditions prevailing in different parts of the world as a function of geological characteristics, geographic location, and levels of economic development call for differentiated actions for reduction of carbon emissions to prevent global temperatures from rising beyond 2°C. It is imperative for developed economies to downscale their unsustainable production and consumption growth pattern, and pursue a low-carbon development strategy. It is estimated, for instance, that the European Union must reduce its GHG emissions by 80-90% before 2050 to contribute to the overall goal of keeping global temperatures from rising.

On the other hand, developing nations have the responsibility of promoting inclusive economic growth within a sustainable, green economy framework.

Therefore for both the developed and the developing world, saving the planet means an imperative shift from fossil fuel to RE sources and increasing energy efficiency in order to avert a global catastrophe. Among the developing countries, the Philippines is the 3rd most vulnerable to climate change. Thus, considering the country's energy situation and its energy requirements for development, it is a major challenge evolving into a low carbon society to help mitigate the country's vulnerability, while pursuing sustainable economic development, and democratization of its oligarchic structure. This means the provision not only of affordable power but also equitable access to power from sources that will not exacerbate climate change.

At present, the Philippines has the highest electrical power rate in the Southeast Asian region. In 2007, the ASEAN Power Utilities Authorities reported that the cost of electricity in the Philippines was about USD17.5 cents per kilowatt hour, with the Department of Energy (DOE) reporting that the Philippines has the 6th highest industrial power rate and 7th highest residential rate in the world. Contributing to this cost are distribution and transmission losses reported at 11% in 2011.

High electricity cost reflects the country's inadequate, unstable supply, and centralized generation and distribution system, and that results in system losses and limits its accessibility. At the same time, the country largely depends on fuel imports, the prices of which can be volatile. Oligopolistic oil refineries and local private power plants set the price in the local markets with very minimal intervention from the government that opens opportunities for collusion. Exacerbated by poor infrastructure and the weak regulatory capacity of the state, this results in high power rates on consumers and discourages investors from investing in the development of alternative energy sources.

Evidently, investments in energy-efficient technologies and infrastructure development are crucial to address the increasing demand for affordable, sufficient, reliable, and sustainable energy. But to facilitate such investments, it is necessary for government agencies and various sectors to expend concerted effort in charting future directions of the country, as far as mitigating climate change and its consequences by moving away from reliance on fossil fuel and moving towards a low carbon regime.

Delaying implementation of mitigation strategies and continuing on a business-as-usual path will only result in a more emissions-intensive future, greatly increasing the risk of more severe and irreversible impacts of climate change.

1.2 OBJECTIVES OF THE STUDY

The agenda of this study is first, to establish the country's allowable carbon budget or ceiling based on a global carbon budget determination model; second, to frame the country's current GHG emissions focused on the Energy Sector based on energy mix, electricity production, energy demand in transport, and the other energy transformation areas under business-as-usual *(BAU)* conditions. Then, to present pathways to LCD to reach the ambitious target of a climate safe 2050 or to enable successful transition from a coal-oil dependent economy to a more RE-based one that meets the country's allowable carbon ceiling. And finally, to compare the net benefits of the LCD pathways and GHG emissions with the established baseline and innovative carbon budgets. Correspondingly, the LCD pathway targets are presented in increments of 10 years up to 2050.

GHG emissions from the non-energy sectors *(Agriculture, Waste and Land Use Change and Forestry)* are incorporated into the model in order to determine its potential for biofuel and biomass energy production, as well as the necessary interventions in these sectors so that these can contribute towards reduction of GHG emissions.

The study also discusses the costs and identifies the barriers, uncertainties and obstacles that must be hurdled, the required conditions that must be present, and the actions and interventions in order to move forward along a pathway for sustainable, LCD.

In fulfillment of the above objectives, it is initially necessary to determine the baseline-reference conditions of the economy, energy sector, the secondary energy transformation areas, and GHG emission levels, i.e. how the nature, structure and performance level of the economy, energy, transport and other sectors and their interaction account for the level and growth of GHG emission levels. Specifically, the dependence of the economy and population on fossil fuel, the growth of energy demand of all sectors, the relative change or stagnation in energy mix and installed generation capacity, the degree of centralization in energy generation, the level of energy efficiency and the capacity to capture heat/waste energy – all bear implications on the generation of GHGs.

Similarly, the present conditions and history of the non-energy sectors *(forestry, agriculture, land use change and forestry, and waste)*, apart from contributing to GHG emission levels, are also largely untapped sources of RE. Apart from these factors, existing government policies and programs either improve energy efficiency or help reduce, mitigate emission levels on one hand, or contribute to its inefficient use and aggravate emissions on the other.

Characterizing these baseline conditions and projecting them into the coming decades up to 2050 as population and incomes change defines for us the **reference scenario**. When we include into this reference scenario the various government policies and programs to improve energy efficiency and reduce GHG emissions, we have the so-called **business-as-usual *(BAU)* scenario**. Various BAU scenarios may be considered: whether plant costs are optimized, whether a carbon constraint is considered, or whether RE targets are set.

Given the allowable global cumulative CO_2e emissions to be released to the atmosphere to prevent catastrophic consequences of temperatures from rising beyond 2 degrees C, under the BAU scenario, we will be informed whether the country will meet or exceed its allowable carbon budget relative to the global budget. And if we find that we are already moving in a particular trajectory beyond the budget, it is evident that we are living in a high-carbon society, growing at an unsustainable rate, and contributing to global warming, and that whatever current climate mitigation policy measures the government is implementing are insufficient to curb the accumulation of GHGs. In other words, more action and interventions are necessary to decelerate the economic-emission movement and bring the economy and society to a safer pathway. These interventions, together with new RE development, must be expounded in an LCD plan.

Projecting GHG emissions in the coming decades under the BAU scenario and finding them surpassing the carbon budget shows indeed that current government policy measures are not enough to curb the growth in emissions. In other words, an **innovative scenario** in general is imperative for satisfying the carbon budget, and the components and pathway to this development scenario has to be defined.

The extent in which emissions exceed the allowable carbon ceiling depends on emissions from the energy, transport, and other economic and non-energy sectors. From the non-energy sector in particular, the study accounted and projected the related emissions from at least three sources: deforestation, solid wastes produced by residential, commercial and industrial sectors, and the use of agricultural lands, as well as estimate the potential prime biomass energy. How do these non-energy sectors contribute to the GHG emissions from the energy sector? Does the non-energy sector through reforestation, for instance, help reduce emissions by serving as a natural carbon sink? How much potential biomass energy can each supply and thereby shift from prime fossil to RE energy use?

Thus, one of the critical challenges in the innovative scenario is how to reduce GHG emissions in the energy sector, rebalance the disrupted carbon cycle in the non-energy sector, and source and expand the RE sources, since they are all equally important. But if the energy and transport sectors are the larger CO_2 emission culprits, will the challenge to GHG emissions reduction entail a complete shift from fossil fuel to RE, and how will this transition come about?

1.3 DATA AND METHODOLOGY OF MODEL CALCULATION

Primary data are provided by study team members' expert knowledge and information culled from meetings and interviews with relevant government officials.

Secondary data were gathered from relevant government agencies and published national and international reports. A constraint of the research process has been the unavailability and quality of secondary data sources. Further, available secondary data have not been updated. A case in point is the available study on transportation. The only comprehensive and recent study on Metro Manila transportation system has been the 1999 Metro Manila Urban Transport Integrated System *(MMUTIS)*. No alternative comprehensive data base on fuel efficiency, load factor and number of trips per vehicle type, and other information could be obtained.

Up to the time of writing the report, the data on industries and enterprises are sparse because of the absence of regular and systematic data monitoring and collection at the industry level. To partly rectify this situation, an effort was made to get primary data from industry associations such as the Cement Manufacturers' Association of the Philippines, the Manila Electric Company *(MERALCO)*, and the commercial establishments in Makati, but this attempt did not yield any useful research data.

In the absence of data or updated information, the research team had to put more effort in verifying data, completing missing data files from local private sources, and building up data sets through own estimates derived from comparable international data files. Based on the information gathered from mixed sources, a separate set of cost data for the investment and operational expenses of a menu of power plants to be constructed was used in the BAU and the innovative scenarios. Several model calculations[1] in computing the cost effectiveness of the given innovative low carbon interventions were formulated based on a heuristic approach using Excel worksheets. These mainly focus on the Energy Sector, the main GHG emitter, which has the greater influence in the results. Due to lack of availability of input data, to simplify and limit the complexity in estimations, other sectors contributing to about 15 to 20% of the country's current emissions as enumerated in Section 1.4 are not considered.

As the Energy Sector contributes more than 50% of the country's GHG emissions, the task includes determining the direct cost *(investment and operations and maintenance cost)* of fossil and RE energy sources, the country's potential RE sources which could replace fossil sources, and the technical viability in the implementation of RE towards a LCD pathway.

1 *Calculation model used as formulated by Juergen Lorenz, JLBTC Business & Technology Consultancy, Inc.*

In as much as the policy and decision making by the DOE is governed by the least direct cost approach, with seemingly no weight given for cost of externalities, a clear way to influence government decision to fast-track transition to LCD is to compare direct cost approach for BAU and innovative LCD pathways. This is done to prove viability and advantage of a paradigm shift to a flexible energy plan due to variability of RE sources such as wind and solar from the current energy plan of dispatching electricity from power generation plants for base, mid-merit or intermediate and peak load demands.

The BAU model calculations do not reflect the National Renewable Energy Program *(NREP)* targets to Year 2030 with a given renewable *(RE)* capacity of 15,000 MW as the DOE has lowered the given target in 2015, and given information that the achievable DOE target for 2030 is only of an additional 9,600 MW[2]. Dissimilar values provided by DOE and NREP regarding RE targets, availability and potential, likewise vary from RE potential provided in a 2010 World Bank assisted publication of 12,000 MW[3]. Additionally, RE implementation is seen to have a slower start due to challenges currently facing RE investors:

A. Given current cap for RE capacities to enjoy FIT contracts;
B. Approval of applications for FIT eligibility to be granted when the applicant's RE plant is installed and commissioned, resulting in high financial risks to investors and lenders;
C. Current DOE approvals of coal-fired plants to meet increasing power demand would still be operational for the next 25 years, limiting entry of RE; and
D. Current apprehension of government decision makers with regard to the dependability of RE, its high cost and impact to users, particularly of solar energy.

The **BAU Scenario** therefore assumes a continued increase in fossil energy share, and limited RE implementation considering the barriers and development trend and existing policies of GOP, as well as availability and effective utilization rates for each plant type. On the other hand, the recommended **Innovative Scenario** is premised on lifting of caps on RE capacities and pursuing an RE based energy plan aggressively. This envisions giving priority dispatch of variable supply from all RE sources *(including solar and wind)*. In the innovative scenario, RE capacities are calculated based on reasonably set potentials, availability and deployment patterns. This scenario anticipates complete phase out of high emission coal-fired plants by the year 2030 and that baseload demand is satisfied by geothermal, hydro, biomass *(broiler)* sources, supplemented by Natural Gas plants. Due to the variability of supply from wind and solar sources, the Innovative Scenario assumes that Natural Gas plants and biomass *(Gas CH_4)* plants will fill in the supply gaps to meet power demand.

In both BAU and Innovative Scenarios, the same volume of power production would be deployed for baseload and peak demand, given an annual power demand increase factor of 4% to Year 2050, lower than DOE's current projected annual demand growth of between 5.20% to 5.5% for the period 2014 to 2020[4]. The 4% factor used in the model calculation takes into consideration that the high economic growth rate presently enjoyed by the Philippines of 6% to 7% may not be sustained for the

2 *9,600MW RE Capacity in 2030 as provided in REECS LEAP BAU Model*
3 *Winds of Change: East Asia's Sustainable Energy Future, Xlanodong Wang, Noureddine Berrah, Subodh Mathur and Ferdinand Vinuya, June 2010, © 2010 The International Bank for Reconstruction and Development / The World Bank*
4 *DOE Sec. Carlos Jericho L. Petilla, Energy Sector Development Plans & Programs, ECCP Breakfast Forum, 25 February 2014*

entire duration of the 40 year study period. However, it takes into consideration the effects of GOP's energy efficiency program and the entry of more energy efficient electrical lighting, appliances and equipment, a green building program, and improvements in mass transit and entry of fuel efficient, hybrid e-vehicles.

The model calculations consider that energy sources have different characteristics with regard to over-all availability and feasible capacity and time availability. RE sources depend on several factors such as time of day, season, tide and weather conditions, and locality. Principal choices for energy transformation, whether central or distributed, with some energy conversion systems limited to either central and/or distributed application, depending on their type, size and source of fuel or source of energy, are also evaluated.

In calculating the carbon budget for the Philippines in relation to the worldwide carbon reduction goal, the International Energy Agency *(IEA)* projection for the Philippine population was used showing a total population of 140 million in Year 2050. Further, population growth rate considers National Statistics Office census of the country's urban and rural population from 1980 to 2010, projected to grow at 1.05% annually which likewise results in a total population of 140 million in 2050.

1.3.1 Philippine GHG Inventory Data

As reference, the study team reviewed data for GHG emissions of the country for Year 1994 as presented in its Initial National Communications (INC) submitted to the United Nations Framework Convention on Climate Change *(UNFCCC)* in May 2000, as well as data contained in the Second National Communications (SNC), which as of writing of the report has yet to be officially submitted.[5]

As stated earlier, in the data gathering phase of the study, difficulty in accessing data was a particular challenge. Further, data was often fragmented and general in nature and lacked specific data for each source category. Gaps are also noted, such as that for Heat in the Energy Sector.

The country's insufficient carbon emission database is revealed in a 2013 Philippine Senate Economic Planning report, GHG Emissions at a Glance, which states that the government needs to strengthen its database and research efforts to develop country specific emission factors to improve future estimates of GHG inventory in the various source categories.

5 *http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php The SNC was submitted to the UNFCCC on 29 December 2014*

The Senate report also provides that so far, most GHG inventories in the country were conducted by foreign research institutions; and that the latest available data generated by the Philippines through the Climate Change Commission *(CCC)* and the Department of Environment and Natural Resources *(DENR)* were in Year 2000. The Senate report also states that the CCC is currently implementing two foreign assisted projects from 2012 to 2014 with project component on GHG emissions inventory, as follows:

- *"Low Emission Capacity Building Project (LECB Philippines Project)"*, funded by the European Union, Germany and Australia through the United Nations Development Programme (UNDP) which aims to conduct GHG emissions inventory on the transport, agriculture, waste and industry sectors; and
- "*Enhancing Capacities for Low Emissions Development Strategies: Philippine Experience*", funded by the United States Agency for International Development (USAID). It aims to conduct GHG emissions inventory on the forestry and energy sectors.

Meanwhile, the Third National Communication is still currently being prepared with assistance from USAID.

It is important for the Philippines, like all UNFCCC Party countries, to diligently maintain complete, accurate, consistent and internationally comparable data on GHG emissions in order to take the most appropriate action to mitigate climate change, and to achieve the objective of the Convention towards global sustainable development.

1.4 LIMITATIONS OF MODEL CALCULATIONS

The model calculations have limitations for lack of available and verifiable source data. Particularly in estimations for GHG emissions, only CO_2 and CH_4 emissions were considered in calculations for 1) Energy Sector - including Prime Energy, Energy Transformation, Use of Energy by Industry, Commercial, Residential and Agriculture; Auto-generation and Process Heat and Transport; 2) Land Use Change and Forestry Sector; and 3) Waste Sector for Municipal Solid Waste (MSW). Other GHG emissions (NOx, CO, NMVOC and SO_2) are excluded.

GHG emissions from Agriculture *(CH_4 and N_20)* and CH_4 and fugitive emissions from processes are also excluded. For the Waste Sector, only CH_4 emissions for municipal solid waste *(MSW)* have been calculated and wastewater is not taken into account.

CH_4 and fugitive emissions from processes in the Industry Sector *(minerals, chemicals, metals, pulp and paper, food and beverages)* and the use of halocarbons are likewise excluded for lack of available and verifiable source data on the amount of materials produced or consumed. The emissions for power generation activities associated with the Industry Sector are accounted for in the Energy Sector. Insofar as emissions from the Industry Sector are concerned, in 1994, Government reported that the Industry accounted for 10.603 $MtCO_2e$ or 10.51% of the country's total emissions of 100,738 ktons of CO_2 into the atmosphere.[6] In 2000, government reported a lower emission level of only 8.609 $MtCO_2e$ or 8.79% of emission that year. This was attributed to the closure of the country's biggest steelmaker, the National Steel Corp *(NSC)* in November 1999.[7]

In terms of cost analysis, focus is given in estimation of the direct cost *(investment and operations and maintenance cost)* of fossil and RE energy sources. Current government policy and decision making prioritizes providing energy at least cost, with exclusion of cost of externalities. The study considers the cost of carbon, showing both resulting electricity cost with and without cost of carbon.

It should be noted, however, that recommendations such as maximizing utilization of RE towards LCD already prove economically and technically viable; as well as cost effective in comparison to fossil energy sources. The resultant reduction in cost of externalities would be added benefit into the equation.

Given the negative impact of rising global GHG emissions on temperature and the accompanying adverse consequences of global warming, a more stringent carbon budget is required. The annual and cumulative allowable range of CO_2 emissions for the coming decades therefore has to be recast to prevent global temperatures from rising beyond the maximum 2°C and moving towards 4°C. The proposed world cumulative emissions budget is set at 600 $GtCO_2e$ by 2050 and its annual emissions ceiling 2,388 $GtCO_2e$ (Table 1.1). This determination is based on a revisit of the work of Meinshausen et. al. (April 2009) and the UNEP Emission Gap Report (December 2009).

Table 1.1 Projected Worldwide Carbon Budgets and BAU Carbon Emissions to 2050

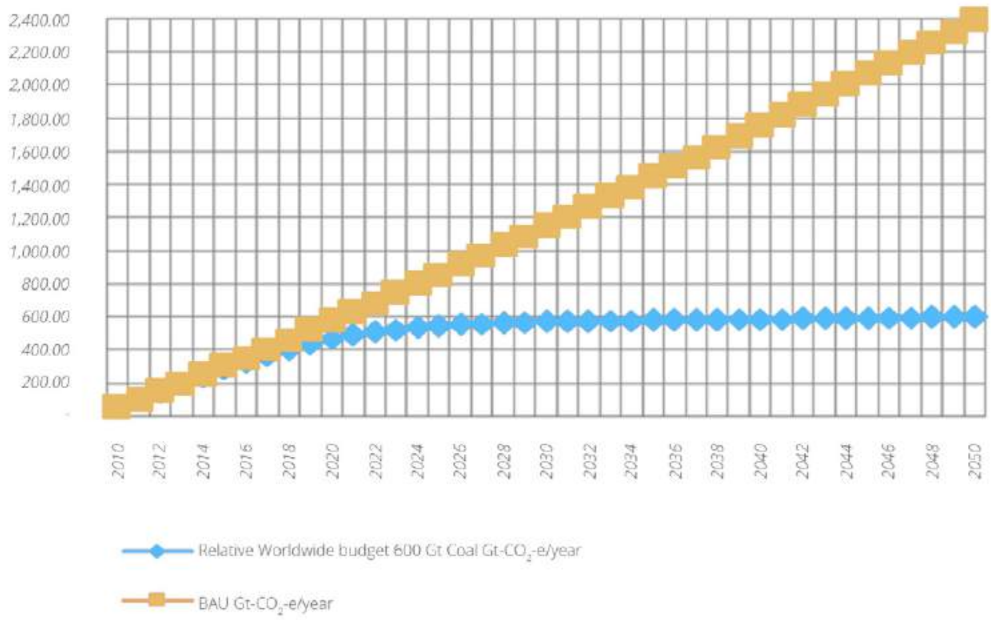
YEAR	Relative Worldwide Budget (600Gt Goal)					World/BAU			
	$Gt\text{-}CO_2\text{-}e$/ year	% of 2010 Emission Level	Annual Reduction Change %	% Reduction Goal p.a.	Cum. $Gt\text{-}CO_2\text{-}e$	$Gt\text{-}CO_2\text{-}e$/ year	% of 2010 Emission Level	% Reduction p.a.	Cum. $Gt\text{-}CO_2\text{-}e$
2010	48.00	100.0%	0.00%	0.00%	48	48.00	100%	0.00%	48
2020	28.81	60.0%	15.87%	20.55%	467	56.00	117%	1.55%	571
2030	3.15	6.6%	-1.59%	18.06%	569	58.86	123%	0.50%	1,147
2040	1.17	2.4%	-1.59%	2.13%	585	61.87	129%	0.50%	1,752
2050	**2.20**	**4.6%**	**-1.59%**	**-13.80%**	**600**	**65.04**	**135%**	**0.50%**	**2,388**

JLBTC, 2013, 4-EvaluationReport.xlsx

6 *Greenhouse Gas Mitigation Strategies: The Philippine Experience, Ma. Gerarda Asuncion D. Merillo, DENR-EMB, 2001*
7 *Tracking Greenhouse Gases: An Inventory Manual, Philippines: Enabling Activities for the Preparation of the Second National Communication on Climate Change to the UNFCCC 2011*

If present and future projected population growth rates from UNDP are given at 0.46% for the developing world and 0.99% per annum for the emerging world, the cumulative world emissions is projected to reach 571 $GtCO_2e$ by 2020, and 2,388 $GtCO_2e$ by 2050. Figure 1.1 illustrates this trajectory. Thus, GHG emission levels would have already exceeded the global carbon budget by 2020. This prospect suggests that global mitigation efforts must already be made even before 2020 to reduce GHG emissions.

Figure 1.1 Projected Worldwide GHG Emissions, BAU Scenario and Cumulative Budget Goal of 600 Gt $C0_2$-e, Years 2010 - 2050



JLBTC Model Calculations, 4-EvaluationReport.xlsx

1.5 THE PHILIPPINE CARBON BUDGET IN THE GLOBAL CONTEXT

A country's carbon emissions budget cannot be determined arbitrarily. Nor can it be based solely on its past and current GHG emission levels.

As previously determined, the maximum allowable threshold of global cumulative emission ceiling of 600 $GtCO_2e$ until 2050 bears implications for the Philippines' own emissions ceiling. Translating this worldwide projected carbon to the Philippines and under the given assumptions of the country in terms of population trends, the country's average allowable emissions budget share is 0.35% of worldwide emission levels.

Table 1.2 shows both the annual and cumulative allowable emissions budget over the decades for the Philippines together with the projected real CO_2 emissions. If in 2010 the real annual emissions *(135,000 Gg CO_2e)* were less than the allowable emissions budget, we can expect that as annual real emissions increase after 2010 while the annual budget decreases, an emissions gap will possibly emerge before 2020.

Table 1.2 Projected Philippine Carbon Budgets, Emission Baseline and Goal

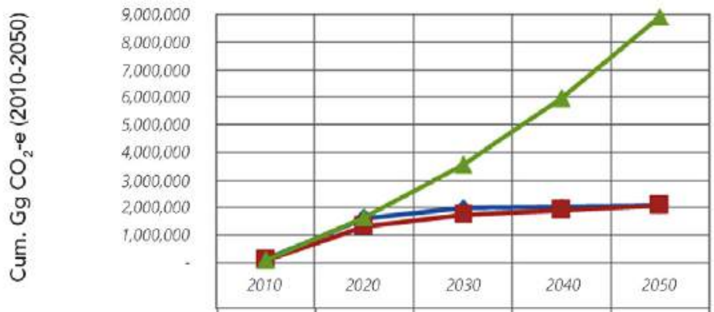
YEAR	Allowable Philippine cum. budget		Philippine Real Emissions Baseline			Philippine worldwide relative budget (600 Gt Goal)				Popula-tion	Budget	Baseline	Goal
	Gg-CO_2-e/year	Cum. Gg-CO_2-e	Ave. Annual Increase	Gg-CO_2-e/year	Cum. Gg-CO_2-e	% Re-duction Change p.a.	% Reduc-tion Goal p.a.	Gg-CO_2-e/year	Cum. Gg-CO_2-e	Million Pax	Mg/pax,a	Mg/pax,a	Mg/pax,a
2010	168,339	168,339	0.0%	135,000	135,000	0.0%	0.0%	135,000	135,000	92.00	1.83	1.47	1.47
2020	101,029	1,637,406	2.2%	168,580	1,663,542	2.5%	13.5%	84,545	1,345,772	103.96	0.97	1.62	0.81
2030	11,043	1,994,434	2.2%	210,513	3,572,297	-1.0%	10.7%	22,706	1,775,808	117.47	0.09	1.79	0.19
2040	4,107	2,051,952	2.2%	262,877	5,955,840	-1.0%	0.2%	13,626	1,933,955	132.74	0.03	1.98	0.10
2050	**7,731**	**2,104,572**	**2.2%**	**238,265**	**8,932,270**	**-1.0%**	**-10.2%**	**23,145**	**2,104,145**	**150.00**	**0.05**	**2.19**	**0.15**

JLBTC Model Calculations, 4-EvaluationReport.xlsx

In the context of the global budget, the calculated budget share of the Philippines is about a cumulative 2,105 Tg CO_2e for the study period. The cumulative growth of Philippine Carbon Emission Budget until 2050 is shown in Figure 1.2. Thus, with this overall strategy, the country can begin its journey to LCD by first detailing and assessing its reference-baseline condition.

To formulate the **BAU scenario**, in the energy sector, the study profiles the sector's dependence on fossil fuel, its centralized power generating capacity, separated *(rather than combined)* energy usage system, the use of high quality energy for low value uses *(such as heating and cooling)*, and the growth of fossil-based electricity generation, and its high carbon growth consequences. Available government given targets to Year 2030 are used as a basis, with an annual projected GNP growth rate of 4% per annum from 2031 to 2050. This reflects the expected general trends and present policies and programs in particular sectors, like the residential, industry, and transportation to determine the projected growth of GHG over the coming decades and the respective contribution of particular sectors.

Figure 1.2 Development of Cumulative Philippine Carbon Emission Budget to 2050



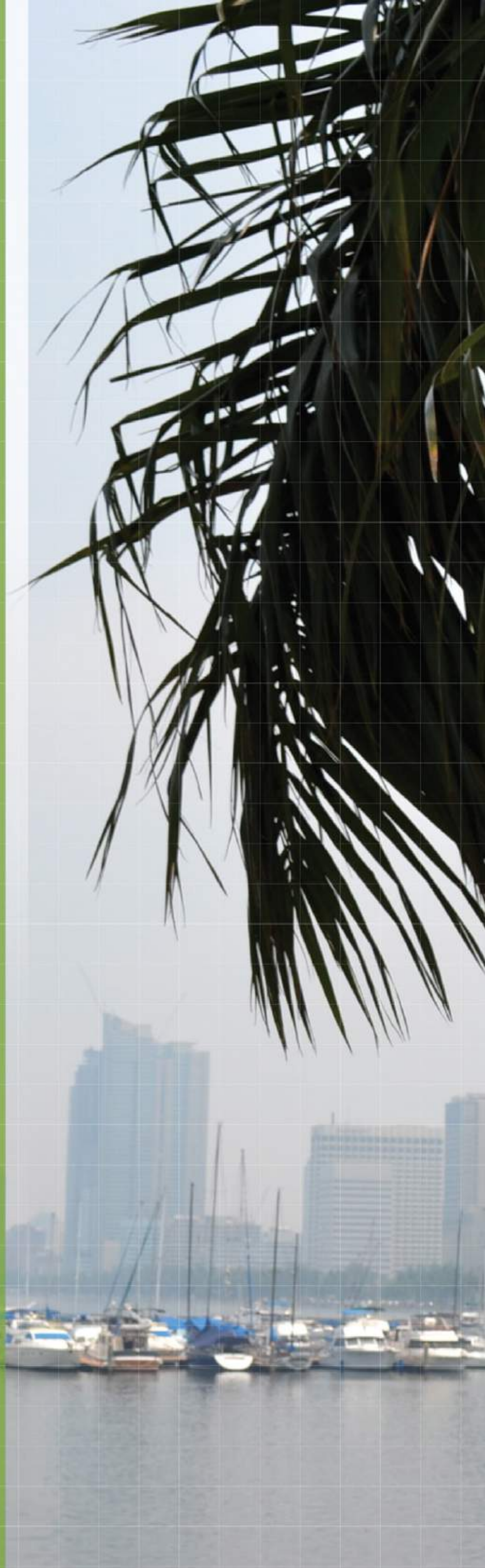
	2010	2020	2030	2040	2050
Allowable Philippine Cum. Budget	168,339	1,637,406	1,994,434	2,051,952	2,104, 572
Philippine Worldwide Relative Budget (600Gt Goal)	135,000	1,345,772	1,775,808	1,933,955	2,104, 572
Philippine Real Emissions Baseline	135,000	1,663,542	3,572,297	5,955,840	8,932, 270

JLBTC Model Calculations, 4-EvaluationReport.xlsx

Moreover, in order to fully account for current prospective GHG emissions, the role of the non-energy sectors, like forest land conversion over the past decades and the accumulation of waste, must be considered. It must specifically account the effect of existing policies, like the government's reforestation program and sanitary landfill programs at the local government level in order to project their BAU scenario to 2050 and respective impact on GHG emissions.

CHAPTER 2

CURRENT CONDITIONS IN THE PHILIPPINES



2.1 INTRODUCTION

In the last five years, the Philippine economy has grown continuously. In 2010, investment commitments from both foreigners and Filipinos increased to PhP542.6 billion compared to PhP314.1 billion in 2009. The top two sectors, i.e. manufacturing and electricity, accounted for more than half of investments.

Under the Philippine Development Plan *(PDP)* 2011-2016, the government is prioritizing the development of areas with the highest growth potential and which generate the most jobs. These include: *tourism; business process outsourcing (BPO); mining; agri-business* and *forest-based industries; logistics; shipbuilding; housing; electronics; infrastructure;* and *other industries with high growth potential.*

Despite its growth, the Philippine economy has seen a reduced share of the manufacturing sector in the country's GDP and declining gross domestic investment rate. The country continues to lag behind its neighbors in terms of foreign direct investments, due to *inadequate and poor quality of infrastructure; inefficient transport and communication networks; the high cost of power;* and *the cumbersome business procedures.*

The country has the highest urbanization rates in the developing world, with 5.1% annual urban population growth from 1965 to 1995. By 2030, it is projected that urban areas will account for 75% of its total population[1]. In 2050, it is projected that about 117 million or 84% of its population will be residing in urban areas[2].

High population growth increases demand for food, products and services thus resulting in increased demand for energy and pressures on the environment. If further urbanization and increased industrialization takes place, increased CO_2 emissions are inevitable.

2.2 PHILIPPINE GHG INVENTORY

The country submitted its Initial National Communications (INC) to the United Nations Framework Convention on Climate Change (UNFCCC) in May 2000, providing results of its 1994 GHG Emissions Inventory. The INC placed total GHG emissions of 100,738 kilo tons or 100.738 million tons (Mt) of CO_2e.

The Climate Change Commission[3] (CCC) reported the country's GHG emissions in Year 2000 at 127 Mt of CO_2e, up by 25% from 101 MtCO_2e in Year 1994 (with the exclusion of LUCF.) Considering Year 2000 carbon sink value of Philippine forests of about 100 Million tons of CO_2e, net CO_2e emissions of the country would only be 27 Mt, but because of discrepancies between 1994 and 2000 values, forestry is often not included.[4]

1 *UN World Urbanization Prospects, 2001 Revisions (2002), Meeting Urban Development Challenges, http://siteresources.worldbank.org/INTPHILIPPINES/Resources/ DB13-UrbanBriefing-June22.pdf*
2 *Towards a Strategic Urban Development and Housing Policy for the Philippines by Benjamin Carino and Arturo Corpuz, National Urban Development and Housing Framework*
3 *CCC is the lead policy-making body of the government tasked to formulate and review every 3 years, the Framework Strategy on Climate Change and to ensure that the National Climate Change Action Plan is in line with the framework and to coordinate, monitor and evaluate the programs and action plans of the government relating to climate change.*
4 *Commissioner Naderev Saño as reported at the Climate Change Adaptation workshop convened by the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) and the Department of Agriculture's Bureau of Agricultural Research (DA-BAR), 2012*

Considering the given net sequestration capacity in Year 2000, CO_2e emissions of the country is reduced by 81%. The LUCF sequestration capacity and its emissions should be ascertained and discrepancies in values reconciled, first to determine the country's contribution towards REDD+; and second, to formulate a proper reforestation program towards attaining effective and long terms carbon storage in Philippine forests.

With the exclusion of Land Use Change and Forestry, for Year 2000, the highest emitter of GHG in the Philippines is the Energy Sector at 54.91%, followed by Agriculture at 29.16%, Waste at 9.14%, and Industry at 6.79%. A comparative summary of GHG emissions for Year 1994 and Year 2000 is shown in Table 2.1 below, while Table 2.2 shows CO_2e emissions presented in a 2010 report sourced from the World Resources Institute (WRI).

Table 2.1 Comparative Summary of Carbon Emissions in the Philippines for the Years 1994 and 2000 (in $MtCO_2e$)

SECTOR	Year 1994 INC	% to Total	Year 2000 SNC	% to Total
Energy	50.038	**49.61%**	69.667	**54.91%**
Agriculture	33.130	**32.85%**	37.002	**29.16%**
Industry	10.603	**10.51%**	8.609	**6.79%**
Waste	7.094	**7.03%**	11.599	**9.14%**
Land use Change and Forestry	*	**0.00%**	**	**0.00%**
TOTAL	**100.865**	**100.00%**	**126.877**	**100.00%**

** Initial National Communication (INC) GHG Emissions Inventory shows a net sequestration from biomass growth of 126 kilo tons CO_2e or 0.000126 million tons of CO_2e resulting from biomass growth uptake and emissions from Round wood/ Fuel wood Harvests; Land Use Conversion; On and Off Site Burning and Decay.*
*** Second National Communication (SNC) GHG Emissions Inventory (not officially submitted to UNFCCC) shows a net sequestration of 107,387.67 gigagrams or 107.387 million tons of CO_2e.*

Table 2.2 Philippine GHG emissions, 1990, 2000 and 2004, WRI[5]

SECTOR	1990		2000		2004*		% Change	
	$MtCO_2$	%	$MtCO_2$	%	$MtCO_2$	%	1990-2000	2000-2004
Land Use Change and 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	58.9	36.5	89%	7.84%
Manufacturing and 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.

A comparative table (Table 2.3) shows different values from the three *(3)* data sources for CO_2 emissions for the Year 2000.

5 *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, prepared by Transport and Traffic Planners Inc. in association with CPI Energy Phils., Inc., 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.*

Table 2.3 Comparative Values for Emissions in the Philippines for the Year 2000, SNC, WRI, OECD/IEA/Index Mundi

In $MtCO_2e$			
2000	SNC	WRI *2009*	OECD/IEA *Index Mundi*
Energy			
Electricity and Heat	21.220	26.80	25.16
Manufacturing and Construction	9.143	9.20	11.56
Other Fuel Combustion		9.40	
Residential	7.029		5.59
Commercial	1.924		Inc. in Res.
Agricultural / Other Sectors	0.887		0.88
Sub-TOTAL	**40.203**	**45.40**	**43.19**
Transportation	25.940	23.50	24.34
Sub-TOTAL	**66.143**	**68.90**	**67.53**
Agriculture	37.002	NI	NI
Industry	8.609	6.00	NI
Waste	11.599	NI	NI
Fugitive Emissions	3.530	NI	NI
LUCF(*)	Excluded	94.90	NI
TOTAL	**126.877**	**169.800**	**67.530**

Among Southeast Asian countries, the Philippines' GHG emissions only contributes an average global share of 0.31% as show in Table 2.4.

2.2.1 Improving Database for Philippine GHG Inventory

The government needs to strengthen its database for activity data, and research efforts to develop country specific emission factors to improve its future estimates of GHG inventory in the various source categories.

Under the Philippine Clean Air Act, the DENR is tasked to prepare and implement plans in accordance with the UNFCCC on reducing GHG emissions. The Environment Management Bureau (EMB) of the DENR serves as a repository of statistical data necessary for determining levels of sectoral emissions and carbon sequestration capacity of Philippine forests. The EMB largely relies on government agencies in collating necessary data. It also relies on data provided by the private sector for its quarterly self-monitoring reports pursuant to the Environmental Impact Statement *(EIS)* System. Accuracy of these reports may not be ensured for lack of monitoring personnel and equipment due to budgetary constraints.

As mentioned in Chapter One, most of the country's GHG inventories are conducted by foreign research institutions, with the latest foreign-assisted projects from USAID and UNDP helping the Climate Change Commission in preparing the Third National Communications.

Table 2.4 GHG Emissions of the World, Top Emitters, ASEAN Countries and the Philippines, $MtCO_2e$, 1990-2010

COUNTRY	1990	1995	2000	2005	2008	2009	2010	Average	Average Global Shares (%)
World TOTAL	**38,258**	**39,028**	**40,234**	**47,269**	**48,748**	**49,329**	**50,101**	**44,710**	**100.00**
TOP COUNTRY EMITTERS									
China	3,870	5,013	5,073	7,853	10,060	10,608	11,182	7,666	17.15
USA	6,115	6,342	6,983	7,082	6,923	6,515	6,715	6,668	14.91
Russia	3,582	2,637	2,647	2,585	2,605	2,481	2,510	2,721	6.09
India	1,376	1,637	1,873	2,128	2,434	2,584	2,692	2,103	4.70
Indonesia	1,161	1,312	1,445	2,884	2,015	2,620	1,946	1,912	4.28
SOUTH-EAST ASIAN COUNTRIES									
Myanmar	875	943	562	511	340	344	362	562	1.26
Thailand	208	282	283	349	360	362	413	322	0.72
Malaysia	198	252	254	336	334	356	330	294	0.66
Vietnam	99	121	156	225	258	283	306	207	0.46
Philippines	96	125	140	146	153	154	159	139	0.31
Cambodia	20	21	22	61	172	138	192	89	0.20
Singapore	33	45	48	48	50	47	50	46	0.10
Brunei	18	21	17	23	19	20	20	20	0.04

Source: European Commission JRC/PBL, EDGAR.

2.3 ENERGY SECTOR

Energy is among the main drivers of the economy and is also a major emitter of GHG. The country's emissions from the Energy Sector comprised more than 50% of the country's total emissions in Year 2000 *(with exclusion of LUCF)*, with electricity accounting for about 32% and Transport 20% (Table 2.5).

Table 2.5 Energy Sector Carbon Emissions in the Philippines, in $MtCO_2e$

SECTOR	Year 1994 INC	% to Total	Year 2000 SNC	% to Total
ENERGY (Electricity)				
Energy Industries	16.34	32.66%	21.220	30.46%
Residential	2.69	5.37%	7.029	10.09%
Manufacturing Industries	9.49	18.97%	9.143	13.12%
Agriculture	1.25	2.50%	0.887	1.27%
Commercial	3.56	7.12%	1.924	2.76%
Sub-TOTAL	20.738	41.44%	40.203	57.71%
ENERGY (Transport)				
Road Transport	23.80	47.56%		
Non-Road Transport	5.50	10.99%		
Sub-TOTAL	29.30	58.56%	25.940	37.23%
Fugitive Emissions			3.530	5.07%
Total - Energy	50.038	100.00%	69.667	100.00%
SUMMARY				
Total CO_2e Emissions	100.865	100.00%	126.877	100.00%
Energy (Electricity)	20.738	20.56%	40.203	31.69%
Energy (Transport)	29.300	29.05%	25.940	20.44%
TOTAL - Energy Sector	50.038	49.61%	66.143	52.13%

2.3.1 Prime Energy

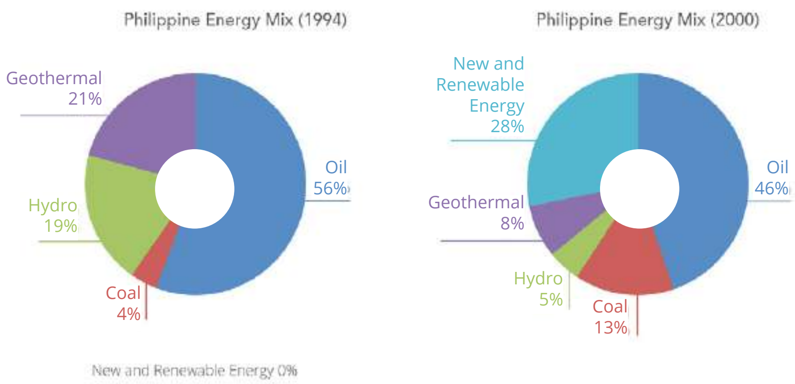
In the Energy Sector, total GHG emissions are projected to increase most rapidly due to higher dependence on imported coal for power generation and petroleum. The composition of the Philippine's energy mix has undergone changes over the years, as shown in Figure 2.1. For the year 2000, largest share of GHG emissions comes from oil *(71.4%)* and coal *(25.5%)* as new renewable energy *(NRE)* systems are assumed to have no net CO_2 emissions.[6]

Analytical work presented in a 2010 ADB and World Bank assisted study[7], reveals

6 *Tracking Greenhouse Gases: An Inventory Manual, Philippines: Enabling Activities for the Preparation of the Second National Communication on Climate Change to the UNFCCC 2011, A Project of the Government of the Philippines and the United Nations Development Programme (UNDP), which serves as the Implementing Agency of the Global Environment Facility*

7 *A Strategic Approach to Climate Change in the Philippines, An Assessment of Low-Carbon Interventions in the Transport and Power Sectors, Final Report prepared by Transport and Traffic Planners Inc. in association with CPI Energy Phils., Inc.*

Figure 2.1 Philippine Energy Mix in Years 1994 and 2000



that in the period 2007-2030, power emissions will likely increase by more than 400%, from less than 30 $MtCO_2e$/year to about 140 $MtCO_2e$/year; and that transport emissions will increase by 133% from 29 $MtCO_2e$/year to over 68 $MtCO_2e$/year.

2.3.2 Energy Transformation

A. Power (Electricity Generation)

The cost of electricity in the Philippines is among the highest in the world. Household consumers in the Philippines pay an average of PhP10 per kilowatt-hour, shouldering the biggest burden of high electric rates. All costs of producing power, from distribution and taxes, are passed on to consumers. Further, the Philippines is the only country in the region that has privatized its electric power sector and has no state subsidy on rates.

The study also noted that domestic natgas coming from the Malampaya gas deposits in offshore Palawan that fuels three of the biggest power plants in Luzon have been priced so high and recommends that the Philippine government renegotiate the Malampaya contract to bring down the cost of natgas.[8] The country's electrification rate is 97% of urban areas and only 65% of rural areas, for an average of 86%. In 2013, the population without electricity is about 12.5 million of its population of about 90 million[9].

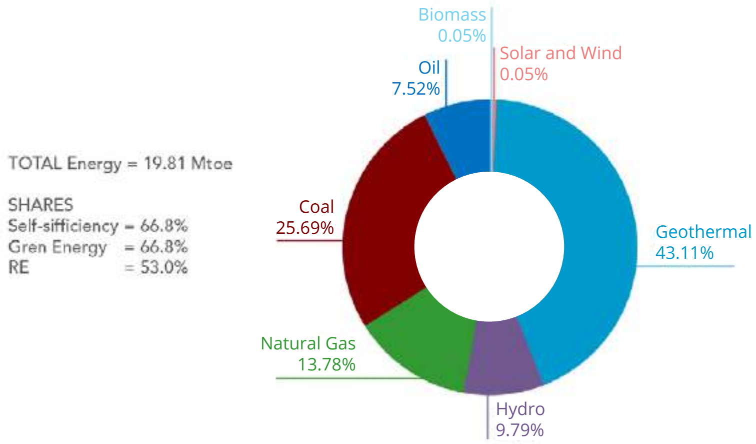
8 *Philippine Chamber of Commerce and Industry (PCCI) power and energy committee meeting, February 3, 2011, http://www.sunstar.com.ph/davao/business/philippines-has-highest-electric-rates-asia*

9 *Source: International Energy Agency Electricity Access Database, Energy Demand and Supply in Southeast Asia presented by Elspeth Thomson, Ph.D., Energy Studies Institute, National University of Singapore, April 10, 2013.*

To provide electricity to all barangays, the government formulated the Missionary Electrification Plan for 2009–2018 which mandates the delivery of electricity to areas that are not connected to the transmission system. In July 2012, the Philippine Government enacted the "National Electrification Administration Reform Act of 2013" *(Republic Act 10531)* which gave the National Electrification Administration *(NEA)* authority over electric cooperatives to ensure the entire population's access to electricity.

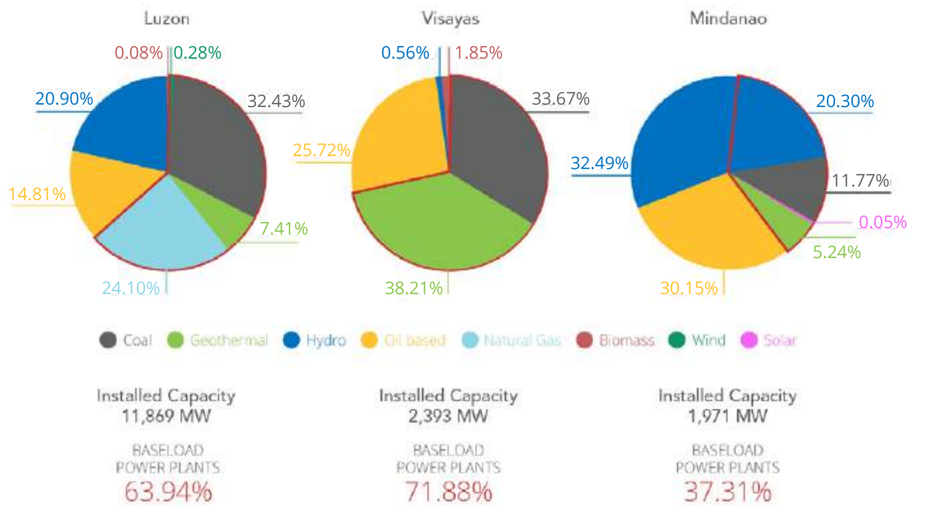
The 2010 power generation profile of the Philippines *(DOE[10])* is shown in Figure 2.2 below, covering the three power grid regions---Luzon, Visayas and Mindanao (Figure 2.3).

Figure 2.2 Power Generation Fuel Mix, DOE, 2010



10 *Presented by Sec. Rene Almendras, Department of Energy, Mainstreaming Renewable Energy Forum, Ateneo de Manila University, October 27, 2011*

Figure 2.3 Capacity Mix for Luzon, Visayas and Mindanao Grids, DOE, 2010



Note: Base-load Power Plants are the facilities used to meet some or all of a given continuous energy demand, and produce energy at a constant rate, usually at low cost relative to each other facilities available to the system.

Table 2.6 shows electricity consumption per sector and power losses for the period 1993 to 2011. Power consumption increased from 47,049 million kWh in 2001 to 69,050 million kWh in 2011.

Table 2.6 Distribution of Electricity Use in Millions kWh, 1999–2011

YEAR	TOTAL	Residential	Commercial	Industrial	Transportation	Others	Utilities/ Own Use	Power Losses
1993	**26,579**	6,368	4,725	9,395	0	721	1,132	4,238
1994	**30,459**	7,282	5865	10684	0	762	1132	4734
1995	**33,554**	8,223	6,353	10,950	0	1,067	1,226	5,735
1996	**36,708**	9,150	7,072	11,851	27	1,140	1,340	6,128
1997	**39,767**	10,477	7,984	12,531	29	1,239	1,471	6,037
1998	**41,577**	11,936	8,725	12,543	29	905	1,590	5,849
1999	**41,431**	11,875	8,901	12,444	30	891	1,536	5,754
2000	**45,289**	12,894	9,512	13,191	55	902	2,390	6,345
2001	**47,049**	13,547	10,098	14,452	55	987	2,196	5,713

YEAR	TOTAL	Residential	Commercial	Industrial	Transportation	Others	Utilities/ Own Use	Power Losses
2002	**48,405**	13,715	10,109	13,628	58	1,052	1,928	7,915
2003	**52,941**	15,357	11,106	15,188	37	1,032	3,410	6,810
2004	**55,957**	15,920	11,785	15,012	67	1,292	4,653	7,227
2005	**56,568**	16,031	12,245	15,705	91	1,086	4,591	6,817
2006	**56,784**	15,830	12,679	15,888	97	1,178	4,227	6,885
2007	**59,612**	16,376	13,470	16,522	107	1,534	3,994	7,608
2008	**60,821**	16,644	14,136	17,031	110	1,283	3,935	7,680
2009	**61,934**	17,504	14,756	17,084	111	1,413	3,524	7,542
2010	**67,743**	18,833	16,261	18,576	109	1,487	4,677	7,800
2011	**69,050**	18,694	16,624	19,334	111	1,335	5,377	7,575

Source: NSCB

DOE's power demand situation for 2012 indicating surplus and given margins are presented in Table 2.7 below, with surplus plus margin for the Luzon grid of 193 MW; for the Visayas at 163 MW; and a deficit of 170 MW for Mindanao. DOE's energy and demand forecasts for 2000–2030 is presented in Table 2.8.

Table 2.7 Power Supply – Demand Situation in MW, DOE, 2012

POWER SUPPLY AND DEMAND	Luzon	Visayas	Mindanao
Available Capacity	9,127	1,843	1,280
Peak Demand*	7,346	1,423	1,300
Surplus/(Deficit)	**1,781**	**420**	**(20)**
Required Reserve Margin	1,588	257	150
Peak Demand + Reserve Margin	8,934	1,680	1,450
Surplus/(Deficit) @ Demand + Reserve Margin	**193**	**163**	**(170)**

Pulangi after repair	100
Embedded Generation	74

NOTES:
Source of data, NGCP Daily Operation Report
** Actual System Peak Demand for the Month of March 2012 for Luson-Visayas Grid*
** Projected System Peak Demand for the Month of March 2012 for Mindanao Grid*

Table 2.8 Philippine Energy Sales and Peak Demand Forecast Average Annual Growth Rate, 2009 – 2030, DOE

GRID AND PERIOD	Luzon		Visayas		Mindanao	
	Sales in GWh	Peak Demand in MW	Sales in GWh	Peak Demand in MW	Sales in GWh	Peak Demand in MW
Base Year 2008 (*)	41,275	6,822	6,565	1,176	7,578	1,228
2009	42,768	7,036	6,857	1,331	7,966	1,359
2018	64,303	10,393	10,601	1,887	11,904	2,031
2030	109,477	17,636	19,121	3,404	20,470	3,493
AGGR (**)						
2009-2018	4.53%	4.30%	4.91%	4.89%	4.62%	5.18%
2019-2030	4.53%	4.51%	5.04%	5.04%	4.62%	4.62%
2009-2030	4.53%	4.41%	4.98%	4.97%	4.62%	4.86%

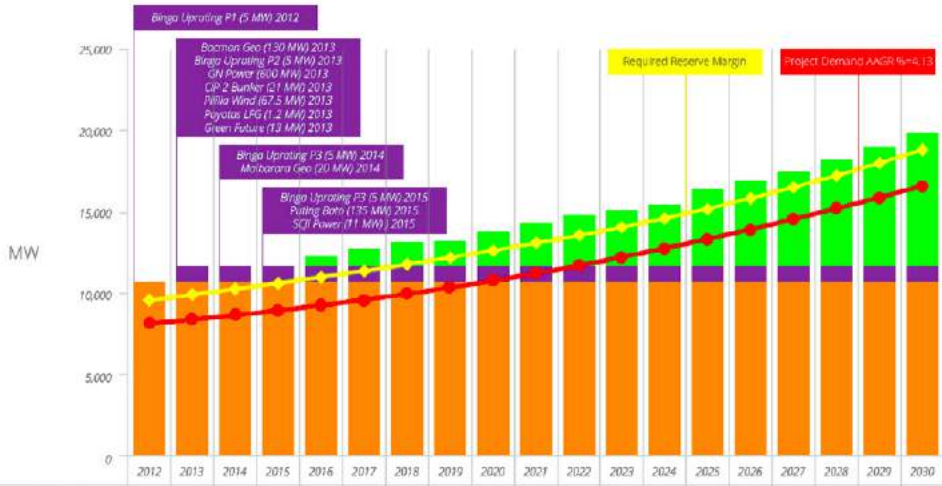
(*) Actual Level; (**) Annual Average Growth Rate
Source: DOE, Power Development Plan 2009 - 2030

Figure 2.4 to Figure 2.6 show DOE's Supply and Demand Outlooks for 2012-2030 for the Luzon, Visayas and Mindanao grids, respectively.

DOE's 2012 Supply and Demand Outlook provides that Luzon and Visayas grid will have enough capacity until 2015. Until 2015, a total of 869 MW committed projects are expected for commissioning; of these, 113 MW will be from RE. Starting 2013, a total of 310 MW committed power projects with 40 MW from RE and 270 MW from fossil based power plants will be online in Visayas.

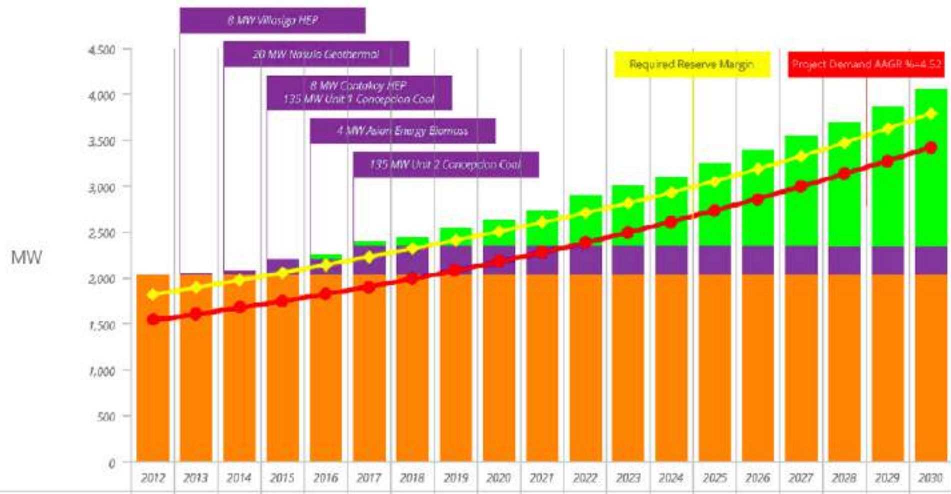
Of the three grids, Mindanao lacks reserve power to provide stability in the grid. Since 2010, Mindanao has been experiencing power outages, due to its hydro-power sources, which currently supply 50% of the demand, being affected by weather conditions.

Figure 2.4 Luzon Grid Supply-Demand Outlook, 2012 - 2030



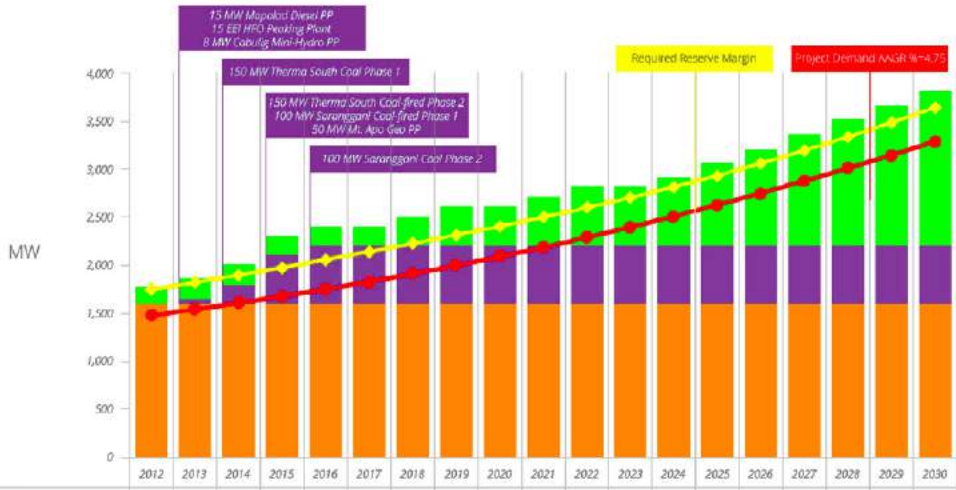
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Required Additional Capacity					500	500	500		500	500	500	300	500	800	500	600	800	800	800
Committed Capacity	5	838	25	151															
Existing/Committed Capacity	10,744	10,749	11,587	11,612	11,763	11,763	11,763	11,763	11,763	11,763	11,763	11,763	11,763	10,744	11,763	11,763	11,763	11,763	11,763
Required Reserve Margin	1,613	1,625	1,637	1,650	1,663	1,677	1,691	1,706	1,722	1,741	1,760	1,781	1,802	1,825	1,848	1,873	1,898	1,925	1,953
Peak Demand Forecast	7,969	8,275	8,575	8,892	9,217	9,567	9,929	10,304	10,693	11,165	11,659	12,174	12,712	13,274	13,860	14,473	15,112	15,780	16,477

Figure 2.5 Visayas Grid Supply-Demand Outlook, 2012 - 2030



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Required Additional Capacity					50		50	100	100	100	150	100	100	150	150	150	150	150	200
Committed Capacity		8	20	143	4	135													
Existing/Committed Capacity	2,037	2,037	2,045	2,065	2,208	2,212	2,347	2,347	2,347	2,347	2,347	2,347	2,347	2,347	2,347	2,347	2,347	2,347	2,347
Required Reserve Margin	263	266	269	272	275	279	282	286	289	293	297	301	306	310	315	320	326	331	337
Peak Demand Forecast	1,568	1,643	1,723	1,799	1,884	1,976	2,060	2,147	2,237	2,331	2,430	2,534	2,644	2,759	2,881	3,008	3,142	3,283	3,431

Figure 2.6 Mindanao Grid Supply-Demand Outlook, 2012 – 2030



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Required Additional Capacity	150	50					200	100		100	100		100	150	150	150	150	150	150
Committed Capacity		38	150	300	100														
Existing/Committed Capacity	1,616	1,616	1,654	1,804	2,104	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204
Required Reserve Margin	266	269	273	276	279	282	286	289	293	297	301	305	309	314	318	324	329	334	340
Peak Demand Forecast	1,407	1,484	1,567	1,657	1,731	1,809	1,891	1,978	2,068	2,164	2,264	2,368	2,478	2,592	2,712	2,838	2,969	3,106	3,250

B. Transport

Roads are over-burdened by tricycles, jeepneys, buses, cars, and delivery vehicles. The existing poor conditions of the country's mass transport system, its limited road network capacities and the annual increasing numbers of individual transport will contribute to increasing CO_2 emission from the transport sub-sector.

In Metro Manila, government implemented public transport inter-modal terminals for buses and jeepneys to de-clog its major thoroughfares. Since bus stops are not properly designed and bus drivers lack discipline, traffic pile-ups are a regular occurrence in all most major crossroads. The expansion of Metro Manila's light rail transit system and rehabilitation of the railway network in Luzon has been slow and insufficient. Pedestrian walkways and bike lanes lack connectivity.

The long delayed skyway connection between North and South Expressways will soon be underway to alleviate heavy traffic within major routes and shorten travel time between the two.

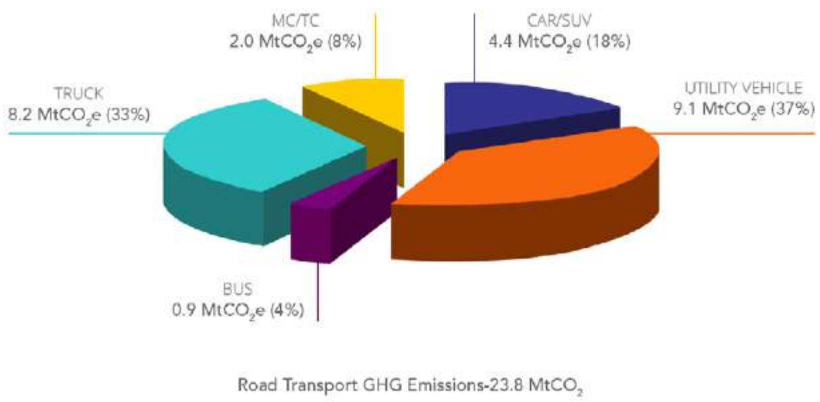
The Philippine Development Plan 2011–2016 reveals that the gaps in the country's transport network facilities is caused by lack of integration between national and local government plans and programs/projects, insufficient capacity of LGUs to finance and manage local projects, particularly roads, and the lack of national government funds to maintain the existing national transport infrastructure base.

To improve the country's infrastructure, the Department of Transportation and Communications *(DOTC)* has announced that it has over 400 billion pesos *(USD9.6 billion)* in projects to upgrade its ports, roads and rails. The government also aims to expand Metro Manila's light rail transit *(LRT)* system and provide an articulated bus service system.

- *Road Transport - Motor Vehicles*

  Philippine GHG emission inventory provides that in 1994, road transport contributed to 29.3Mt CO2e in 1994, (with 23.8 Mt CO2e attributed to the road transport sector and 5.5Mt CO2e to non-road transport) as compared to 25.94Mt CO2e in 2000, down from about 59% to about 37% of the country's total CO2e emissions. A 2010 WB assisted study, *A Strategic Approach to Climate Change in the Philippines, An Assessment of Low-Carbon Interventions in the Transport and Power Sectors,* showed that in Year 2007, total emissions from the road transport sector was 23.5 Mt CO_2e lower than that of Year 2000, with utility vehicles contributing the most (Figure 2.7).[11]

Figure 2.7 CO_2e Emissions from the Road Transport Sector, 2007[11]



11 *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, prepared by Transport and Traffic Planners Inc. in association with CPI Energy Phils., Inc., 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.*

National Statistics Coordination Board *(NSCB)*[12] data show that the number of motor vehicles have continued to increase in 2011 to more than 7.1 million from 4.2 million from 2003 (Table 2.9), with motorcycles and tricycles with the most numbers. As shown in the table below, number of motor vehicles have increased at an average of 4.62% per year.

Table 2.9 Motor Vehicles In the Philippines, 2003 - 2011

	YEAR									
	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average Increase per Year
Cars	739,170	793,353	784,437	788,599	744,830	755,108	776,155	759,683	788,372	0.88%
Utility vehicles	1,685,896	1,788,565	1,791,284	1,788,687	1,788,625	1,790,518	1,865,575	1,707,705	1,764,865	0.66%
Buses	31,347	34,998	30,968	23,155	30,113	29,703	33,006	7,753	8,769	-6.09%
Trucks	255,478	267,930	266,854	291,746	281,128	296,121	311,496	288,427	298,789	2.11%
Motorcycles/ Tricycles	1,552,570	1,847,350	2,157,707	2,157,707	2,409,286	2,647,263	2,982,296	2,841,646	3,206,255	9.76%
Trailers	23,840	23,117	23,917	23,894	24,319	27,104	28,731	26,163	29,373	2.86%
Diplomatic	2,816	4,197	3,284	2,227	2,406	4,884	3,902	3,591	3,597	9.78%
Exempt (*)	1,155	1,083	1,302	3,980	11,368	5,538	607	651	652	34.05%
TOTAL	4,292,272	4,760,593	5,059,753	5,079,995	5,292,075	5,556,239	6,001,768	5,635,619	6,100,672	
Increase per Year		10.91%	6.28%	0.40%	4.17%	4.99%	8.02%	-6.10%	8.25%	4.62%

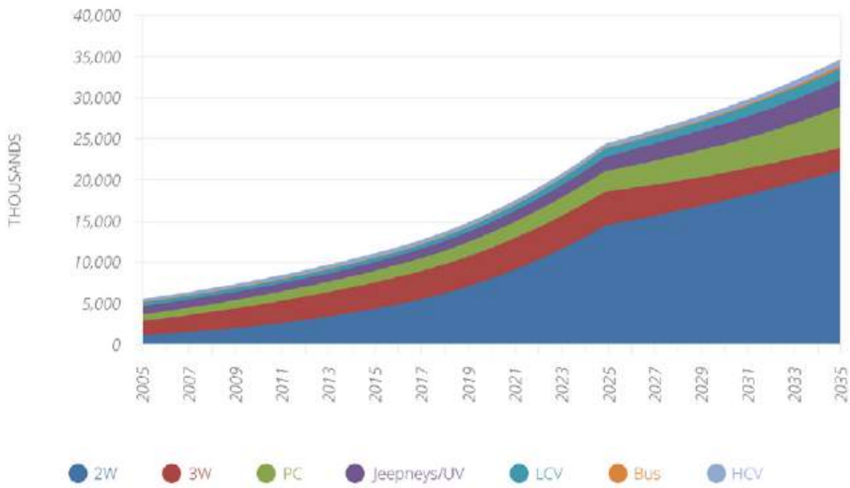
Source: NSCB
(*) Government Motor Vehicles

Growth of motor vehicles is expected to double in Year 2020 and to steadily increase by Year 2035 (Figure 2.8), though not explosively except for motorcycles based on data from the Land Transport Office *(LTO)*[13] and the Chamber of Automotive Manufacturers of the Philippines, Inc. *(Fabian and Gota, 2009)*. Major categories used are: 2W=2-wheelers; 3W = 3-wheelers; PC = personal cars/SUVs, Jeepneys/ utility vehicles, LCV=light commercial vehicles, buses, and HCV=heavy commercial vehicles. The slight decrease in growth rate has been assumed as roads would be saturated with vehicles and high fuel prices would restrict further increase in ownership.

Among the strategies proposed by GOP to improve efficiency in Transport is to implement a bus rapid transit *(BRT)* system.

12 *NSCB is now part of the Philippine Statistic Authority by virtue of Republic Act 10625 (Philippine Statistical Act of 2013)*
13 *About 29% of all total vehicles in the Philippines are registered in Metro Manila and about 56% when adjacent regions, comprising the expanded Greater Capital Region (including Central Luzon and CALABARZON Regions) are included.*

Figure 2.8 Projected Growth of Motor Vehicles in the Philippines from 2005 to 2035 (in number of units)



Source: Fabian and Gota, CAI Asia Center 2009

- *Railroad and Light Rail Systems*

  DOTC data for the country's railway infrastructure (Table 2.10) shows:

Table 2.10 Summary of Rail Transport in the Philippines, 2004-2007

AREA/ITEM	2004	2005	2006	2007
TRAFFIC DATA				
Number of Passenger (million)	244	278	2,969	317
Passenger-kilometers (million)	2,267	2,459	2,637	2,714
Freight (million)	N/A	N/A	N/A	N/A
Freight-km (million)	N/A	N/A	N/A	N/A
RAILWAY INFRASTRUCTURE				
Route Length (km)	523	523	85	85
Double Track Length (km)	76	76	76	76
Electrified Route Length (km)	45	45	45	45
Number of Locomotives (PNR)	14	13	12	11
Number of Passenger Coaches	259	252	300	300
Number of Freight Wagons (PNR)	213	213	151	151
Urban Rail Length (km)	101	101	85	85

Source: Rail Transport Divisio-DOTC

NSCB records likewise show the total number of passengers carried by railways rose by about 10% from 2007 to 2008 from 314.8 million to 346.1 million. Growth in ridership for said years is likewise provided in Table 2.11. For the 5 year period given, the average growth of ridership increased at an average of 9% per year.

Table 2.11 Passengers Carried by Railway Movement, in Millions, 2003 - 2008

YEAR	2003	2004	2005	2006	2007	2008
Passengers Carried	222.3	240.1	273.3	293.5	314.8	346.1
% Growth per Year		8.01%	13.83%	7.39%	7.26%	9.94%

Source: NSCB

A. *Philippine National Railway*

The 120-year old Philippine National Railway (PNR) system in Luzon deteriorated when government priorities shifted and a pan-Philippine highway was built and buses and trucks took over. Past efforts to revitalize this by the Philippine National Railway have been frustrated, among the issues being occupancy of its right-of-way by illegal settlers. The railroad system in Luzon comprises the North and South networks with operations currently limited to the south line and within Metro Manila. The run to the Province of Bicol, or Bicol Express was suspended in 2011 due to typhoon damage. Despite its limited routes, PNR estimated its daily passenger number between 60,000 to 70,000.

Other existing railways in the Island of Cebu and the Island of Panay have been long decommissioned.

In May 2013, PNR announced that the “long-overdue” proposal for a USD2.5 billion public private partnership (PPP) project for further development and upgrade of Luzon’s railway system, and a feasibility study for the proposed PNR Integrated Luzon Railway project is underway. However, PNR’s Charter is due to expire in 2014, but a bill has been filed in the Senate for its extension.

B. *Light Rail Transit System*

The elevated light rail transit, built in 1984 (Line 1), has insufficient capacity to meet commuters' needs. Full implementation of the entire plan is yet to be completed and the system's loop has yet to be closed (Figure 2.9)

Considering that an estimated 5 million commuters travel daily to Metro Manila from surrounding provinces (Cavite, Laguna, Bulacan and Rizal) and that about 22.5 million motorized trips are made every day in Metro Manila, of which about 70% are through public transportation, the need for an efficient mass transportation system is imperative Otherwise, there will be greater vehicle ownership, leading to congestion that will further increase travel times of commuters.[14] Government should hasten the implementation of its proposed plans for Metro Manila's light rail transit *system.*

- *Maritime Transport*

  The Philippines being an archipelago of about 7,100 islands, relies heavily on inter-island shipping. The Philippines has a total of 2,035 ports comprised of: 25 base ports, 214 terminal ports, 1,369 local ports, 4 ports in economic zones, and 423 private ports. Additionally there are 421 fishing ports.

To lessen transport time for passenger and goods between islands, the government implemented a 919 kilometer nautical highway linking roll-on-roll-off (RORO) terminals/ports and roads that connects the three primary regions—Luzon, Visayas, and Mindanao (Figure 2.10). It comprises three major trade routes of the ROROs namely the Western, Central and Eastern Nautical Highways. For shorter distances between islands, sea transport is provided by diesel motor bancas or out-rigger boats. However, during the monsoon season, sea transport is interrupted when rough seas prevail. The maritime sector has been plagued with more than 160 accidents per year over the last decade and is a major concern.[15]

14 *DOTC/LRTA – Manila LRT1 Extension, Operations and Maintenance Project: Preliminary Information Memorandum, Republic of the Philippines, Department of Transportation and Communication, Light Rail Transit Authority, June 2012*

15 *Philippine RORO Ships and Main Trade Routes, Maritime Review Magazine, Vic Viray, March 15, 2013*

Figure 2.9 Plan of Metro Manila's Elevated Light Rail System

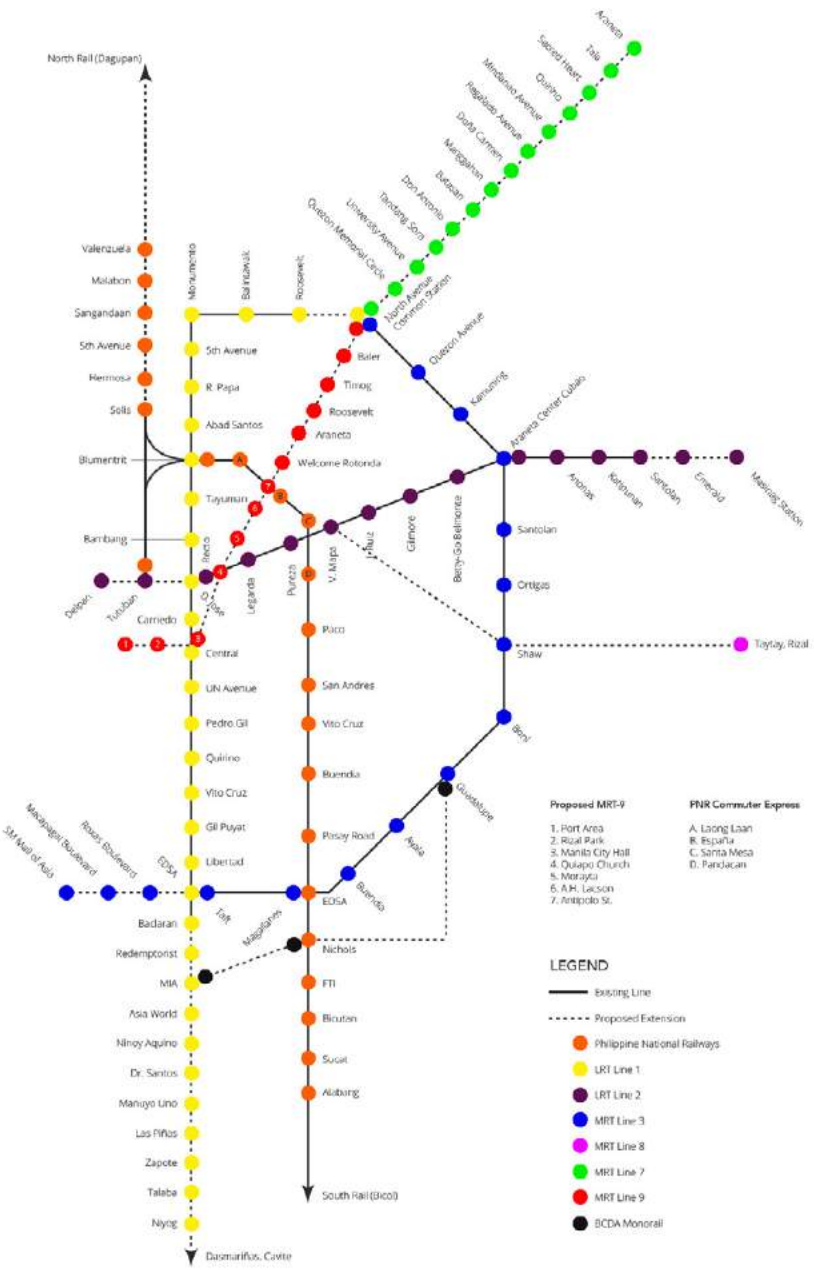


Figure 2.10 Nautical Highway System, Philippines, DPWH[16]

Different types of service vessels registered based on related certificates issued from Domestic Operating Fleet inventory undertaken by the Maritime Industry Authority *(MARINA)* for 2007 to 2010 is shown in Table 2.12.[17]

16 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, prepared by Transport and Traffic Planners Inc. in association with CPI Energy Phils., Inc.
17 BOI

Table 2.12 Registered Sea Vessels, 2007-2010

TYPE OF VESSEL	2007	2008	2009	2010
Passenger/Cargo	853	773	2,230	2,229
General Cargo	551	1,059	1,297	1,293
Container/Special Purpose	4	4	8	8
Liquid/Litherage/Tanker	13	20	174	174
Barging/Miscellaneous	43	49	41	41
TOTAL	**1,464**	**1,905**	**3,750**	**3,745**

Source: BOI, MARINA

BOI data shows that the Philippines shipping business is approximately 2 million TEUs (Twenty-foot equivalent units)[18] in container traffic. Further, the Subic Bay Port Development Project was also completed and was expected to generate significant benefits with the increase in the port's container capacity from 100,000 to 600,000 TEUs.[19]

Data from Philippine Port Authority *(PPA)* shows that total cargo throughput increased from about 150 million in 2006 to 194 million in 2012; and passenger traffic increased from 49.1 million to almost 50 million for the same period (Table 2.13). In terms of passenger traffic, ridership increased by only 2% from 2002 to 2010, or an annual average increase of about 0.18%

The RORO terminal system *(RRTS)* connecting Mindanao, Visayas, and Luzon, has reduced travel time by around 12 hours and transport cost by 37-43% for passengers and 24-34% for cargo.

In the 2013 State of the Nation Address, the President requested Congress to review the Cabotage Law to foster greater competition and to lower the cost of transportation. The Cabotage Law prohibits foreign vessels from directly transporting domestic cargo between two *(2)* ports other than those designated as international ports. In protecting the local shipping industry, higher transports costs are incurred by the local industries and exporters.[20]

18 *TEU is a standard unit for describing a ship's cargo carrying capacity, or a shipping terminal's cargo handling capacity.*
19 *Philippine Development Plan 2011 - 2016*
20 *NEDA Regional Council X Resolution No. IX-013-09*

Table 2.13 Passenger and Cargo Movement in the Philippines, 2002 – 2006 and 2012[21]

YEAR	2002	2003	2004	2005	2006	2007	2008	2012
TOTAL Cargo Throughput (in metric tons)	**149,457,449**	**146,655,873**	**157,437,721**	**141,594,797**	**150,473,286**	**166,395,680**	**177,997,069**	**193,714,306**
Domestic	79,554,834	79,431,913	74,591,279	71,758,150	72,514,651	69,714,085	73,849,537	75,805,477
Foreign	69,520,194	66,854,035	82,846,442	69,836,647	77,958,635	96,579,523	104,106,100	117,908,829
Transit Cargo	382,421	369,925	Not Provided	Not Provided	Not Provided	102,072	41,432	Not Provided
TOTAL Passenger Traffic	**49,116,643**	**51,718,640**	**44,468,927**	**43,870,914**	**43,872,565**	**52,701,645**	**49,815,295**	**49,998,936**
Disembarking	25,186,221	26,582,126	21,943,930	21,516,761	21,723,679	26,851,004	25,384,389	25,441,447
Embarking	49,116,643	51,718,640	22,524,997	22,354,153	22,148,886	25,850,641	24,430,906	24,557,489

Sources:
Years 2002 - 2003 - Philippine Transport Statistics, NCTS, Sheila Flor D. Javier
Years 2004 - 2008 - NSCB
Year 2012 - PPA

- *Air Transport*

  There are 85 airports in the Philippines, 4 of which are regular international and 4 are alternate international airports, with an additional 6 under construction.[22]

The international airport in Metro Manila continues to experience air traffic as it only has one landing strip. In an effort to divert air traffic, the Clark International Airport in Pampanga in the Central Luzon region was opened. However, because of its distance from Metro Manila, the Manila International Airport remains the country's primary gateway.

Table 2.14 shows aircraft, passenger and cargo movement in the Philippines for 2001 to 2010.

The country's aviation industry is benefiting from tourism and trade growth. The Civil Aeronautics Board *(CAB)* reports that the number of passengers carried by domestic airlines rose by 9.6 percent to 20.57 million people in 2012. The expansion in passenger volume came with the increase in the number of available seats on flights with local airlines reporting an average load factor of 72% in 2012.

21 *Philippine Transport Statistics, NCTS, Sheila Flor D. Javier*
22 *http://www.caap.gov.ph/web/offices.htm*

Table 2.14 Summary of Aircraft, Passenger and Cargo Movements in the Philippines, 2001 - 2010

YEAR	Number of Aircraft	Number of Passenger	Cargo in kg.
2001	343,039	19,895,475	509,275,627
2002	365,138	20,057,431	596,181,458
2003	374,449	20,601,050	533,305,415
2004	372,491	23,269,284	688,256,805
2005	328,969	24,670,595	570,969,815
2006	326,510	26,682,198	539,229,834
2007	609,419	34,259,543	678,306,757
2008	565,894	36,162,930	537,669,657
2009	625,582	40,934,947	595,804,359
2010	621,870	40,862,311	563,080,822

Includes international, military and private aircrafts
Source: Air Transportation Office (ATO)

In a report by the Department of Tourism *(DOT)*, the number of domestic tourists in 2012 reached 37.5 million, higher than the government's target of 35.5 million. Domestic travel is expected to keep rising due to the current low fare programs of the airline industry. Table 2.15 shows statistics for air travel in the Philippines from 2001 to 2010.

Table 2.15 Summary of Passenger Movements for International Inbound, Outbound and Domestic Passengers, 2001 - 2010[23]

YEAR	Number of Passenger	Foreign Arrivals	Foreign Departures	Domestic Passengers	Increase-Decrease
2001	19,895,475	1,797,000	1,787,000	16,311,475	
2002	20,057,431	1,933,000	1,969,000	16,155,431	-1%
2003	20,601,050	1,907,000	1,803,000	16,891,050	5%
2004	23,269,284	2,291,000	1,920,000	19,058,284	13%
2005	24,670,595	2,623,000	2,144,000	19,903,595	4%
2006	26,682,198	2,843,000	2,745,000	21,094,198	6%
2007	34,259,543	3,092,000	3,066,000	28,101,543	33%
2008	36,162,930	3,139,000	3,355,000	29,668,930	6%
2009	40,934,947	3,017,000	3,188,000	34,729,947	17%
2010	40,862,311	3,520,000	Not Provided	Not Provided	

23 *http://www.indexmundi.com/facts/philippines/international-tourism*

2.3.3 Use of Electricity

Table 2.16 shows electricity consumption per sector and power losses for the period 1993 to 2011. Power consumption increased from 47,049 million kWh in 2001 to 69,050 million kWh in 2011.

Table 2.16 Electricity Consumption Share per Sector in the Philippines, 1993 to 2011

YEAR	Total	Residential	Commercial	Industrial	Transportation	Others	Utilities/ Own Use	Power Losses
1993	100%	24%	18%	35%	0.00%	3%	4%	16%
1994	100%	24%	19%	35%	0.00%	3%	4%	16%
1995	100%	25%	19%	33%	0.00%	3%	4%	17%
1996	100%	25%	19%	32%	0.07%	3%	4%	17%
1997	100%	26%	20%	32%	0.07%	3%	4%	15%
1998	100%	29%	21%	30%	0.07%	2%	4%	14%
1999	100%	29%	21%	30%	0.07%	2%	4%	14%
2000	100%	28%	21%	29%	0.12%	2%	5%	14%
2001	100%	29%	21%	31%	0.12%	2%	5%	12%
2002	100%	28%	21%	28%	0.12%	2%	4%	16%
2003	100%	29%	21%	29%	0.07%	2%	6%	13%
2004	100%	28%	21%	27%	0.12%	2%	8%	13%
2005	100%	28%	22%	28%	0.16%	2%	8%	12%
2006	100%	28%	22%	28%	0.17%	2%	7%	12%
2007	100%	27%	23%	28%	0.18%	3%	7%	13%
2008	100%	27%	23%	28%	0.18%	2%	6%	13%
2009	100%	28%	24%	28%	0.18%	2%	6%	12%
2010	100%	28%	24%	27%	0.16%	2%	7%	12%
2011	100%	27%	24%	28%	0.16%	2%	8%	11%

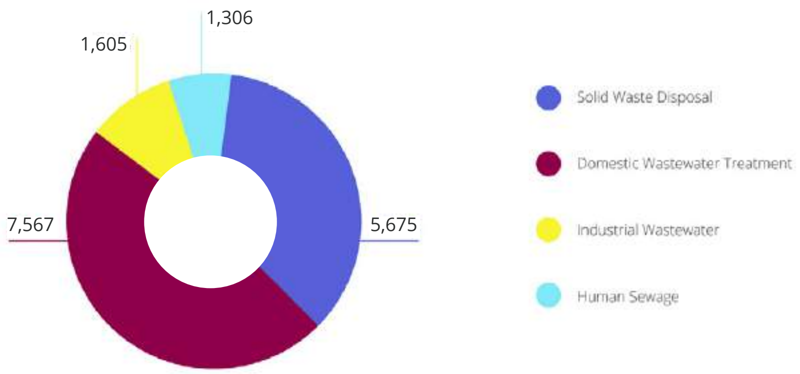
2.4 INDUSTRY SECTOR

In 2000, total emissions from the Industry Sector stood at 8.609 $MtCO_2e$, with a share of about 8% in Year 2000 total emissions *(excluding LUCF)*. This was significantly lower by 23.16% from the 1994 GHG emissions from the Industry Sector, which was at 10.603 $MtCO_2e$. The share of the Industry Sector was about 11%.

2.5 WASTE SECTOR

Rapid urbanization results in increased production and consumption of goods which lead to increase in volume of waste generated by the commercial, domestic, and industrial sectors. Sources of waste in the country are presented in Figure 2.11.

Figure 2.11 Sources of Waste in the Philippines, 2000



GHG emissions from the Waste Sector in 1994 was reported at 7 $MtCO_2e$ as compared to about 11.6 $MtCO_2$ in Year 2000, having the highest increase at 39%. The biomass from livestock waste and agricultural residue is accounted for in the Agriculture sector; while biomass yield for forests is accounted for in LUCF.

2.5.1 Solid Waste

Filipinos generate around 0.3 to 0.7 kg of garbage depending on the economic status, with population in urban areas generating more than those in the rural areas. Households produced 10 million tons of solid waste in Year 2000 *(Philippine Environment Monitor, 2001)*.

MSW is generally disposed in open and controlled dumpsites, with the country having only a limited number of appropriately engineered sanitary landfills, some of which are poorly managed and operated as open dumpsites. Despite the enactment of the Ecological Solid Waste Management Act of 2000 *(Republic Act 9003)* in January 2001, not much changed in waste minimization and recycling/reuse, policies to reduce the amount of waste generated, alternative waste management practices and landfill gas recovery. Landfill gas recovery is undertaken in a minimal scale.

2.5.2 Liquid Waste

In the year 2000, municipal wastewater generation was estimated at 2,481,435,000 cu.m. per day based on a population of 76,500,000 and generating 2,236,750 metric tons. The WB assisted Philippines Environment Monitor 2003, estimates wastewater generation in the Philippines as follows: (Table 2.17)

Table 2.17 Wastewater and BOD Generation, 2000

YEAR / SECTOR	2000	1998	1999	Total
	Total	Residential	Commercial	
WASTEWATER GENERATION IN '000cu.m./year				
Metro Manila (NCR)	430,046	272	0	**430,318**
Other Areas	2,051,389	396	57,869	**2,109,654**
TOTAL	**2,481,435**	**668**	**57,869**	**2,539,972**
% to Total	97.70%	0.03%	2.28%	**100.00%**
BOD Generation (*) in Metric Tons	10,736,040	3,355,013	8,275,698	**22,366,750**
% to Total	48.00%	15.00%	37.00%	**100.00%**

BOD Factor
Entire Country, except Metro Manila 37grams per person per day
Metro Manila 53grams per person per day

2.6 AGRICULTURE SECTOR

The Philippines is traditionally an agricultural based economy. In recent years, however, the population has become less dependent on farming. In 1946, about a third of the economy *(29.7 percent)* was agricultural, but the share of agriculture to the economy has declined over the years to 11.1 percent in 2012.[24] GHG emissions from the Agricultural Sector including those from domestic livestock, rice cultivation, burning of grassland and agricultural residue and agricultural soils, rose by 10.46% from 33.13 $MtCO_2e$ *(32.85% of total emissions, excluding LUCF)* in 1994 to about 37 $MtCO_2e$ in Year 2000 *(29.16% of total)*, as shown in Table 2.18. In the year 2000, domestic livestock contributed to about 30% of total emissions from the agriculture sector, while rice cultivation contributed 44%.

24 http://www.nscb.gov.ph/beyondthenumbers/2013/04122013_jrga_agri.asp

Table 2.18 Comparative GHG Emissions, 1994 and 2000, Agriculture Sector						
PARTICULARS	$MtCO_2e$ *Y1994*	% to Total	$MtCO_2e$ *Y2000*	% to Total	Increase (Decrease)	% Increase (Decrease)
AGRICULTURE SUB-SECTORS						
Domestic Livestock						
Enteric Fermentation			6.605	18%		
Manure Management			4.313	12%		
Sub-Total	**10.602**	**32%**	**10.917**	**30%**	**0.316**	**3%**
Rice Cultivation	13.252	40%	16.437	44%	3.185	24%
Agricultural Soil	8.614	26%	8.931	24%	0.317	4%
Grassland Burning	-	<1%	0.018	0%	0.018	
Agricultural Residue Burning	0.663	2%	0.698	2%	0.035	5%
TOTAL - Agriculture	**33.130**	**100%**	**37.001**	**100%**	**3.871**	**12%**
SHARE IN TOTAL CO_2e EMISSIONS						
Agriculture	33.130	33%	37.001	29%		
Energy	50.038	50%	69.667	55%		
Industry	10.603	11%	8.609	7%		
Waste	7.094	7%	11.599	9%		
Land Use Change & Forestry	Excluded	0%	Excluded	0%		
TOTAL - All Sectors	**100.865**	**100%**	**126.876**	**100%**		

Source: INC / Philippine GHG Inventory Manual, 2011

Future emissions from this sector is expected to decrease as farmers in the Philippines are beginning to engage in organic farming and are becoming more aware of the adverse impact of burning biomass.

2.7 LAND USE CHANGE AND FORESTRY

The Philippines has a total land area of 300,000 km^2 of which 298,170 km^2 is land and the remaining 1,830 km^2 is water.

From the 1900 to 1996, the mean average deforestation rate in the country was at about 148,000 hectares per year *(Lasco and Pulhin, 2000)*. From 1934 to 2010, this dwindled by 97% from 11.1M hectares to 0.29M hectares. Changes in land uses are significant sources of GHG emissions and conversion and denudation of forest land results in losses of biological carbon sinks and biodiversity from the landscape.

The DENR estimates that remaining forest cover has significantly dwindled to 7.17 million hectares or 24 percent in 2003, while other non-government sources argue that only 5.2 million hectares or less than 18 percent of forest cover remained by 2002. The Philippines' deforestation rate is estimated at 1.4 percent annually.[25] The aggressive deforestation rate is blamed on the Forestry Code of 1975 which allowed the wanton extraction of timber and other forest resources through the issuance of various timber permits, such as Timber Licensing Agreements *(TLAs)* and Integrated Forest Management Agreements *(IFMAs)*.[26]

Land area and distribution of land use is presented in Table 2.19.

Table 2.19 Land Area and Distribution of Land Use in the Philippines, 2010

DATA SOURCES	DENR-FMB	DENR-PAWB	DA-BAS
TOTAL Area	**30,000,000**	**30,000,000**	**30,000,000**
Land	29,810,700	29,810,700	29,810,700
Water	183,000	183,000	183,000
DISTRIBUTION OF LAND USE			
Forest			
TOTAL – Forest	**15,800,000**	**7,200,000**	
Dipterocarp/ Lowland Rainforest		3,600,000	
Mossy/Montane/Cloud Forest		1,050,000	
Coastal and mangrove forest.		120,000	
Pine Forest		231,000	
Sub-marginal Forest		480,000	
Unclassified Forestland		1,719,000	
Agricultural Land			
TOTAL - Agricultural Land			**9,671,000**
Arable Land			4,936,000
Permanent Cropland			4,225,000
Permanent Meadows/Pastures			129,000
*Forest Land (Agro-Forest)			74,000
Other Lands			307,000
Reconciliation			
Water	183,000	183,000	183,000
Covered Forest – PAWB		7,200,000	
Other Forest (Net of Covered Forest)		8,526,000	
Forest (Net of Agro-Forest)	15,726,000		15,726,000
Agro-Forest	74,000	74,000	74,000
Agricultural Land	9,597,000	9,597,000	9,597,000
Sub-TOTAL	**25,580,000**	**25,580,000**	**25,580,000**
TOTAL Land Area	**29,810,700**	**29,810,700**	**29,810,700**
Built-Up, Other Use (under Alienable and Disposable Land)	**15,800,000**	**7,200,000**	

25 *Food and Agriculture Organization United Nations (FAO-UN) (2003). State of the World's Forests*
26 *On the Road to Disaster: Gaps in Republic Act 9729 and Philippine Climate Change Policies, Copyright © 2011 by the Center for Environmental Concerns-Philippines*

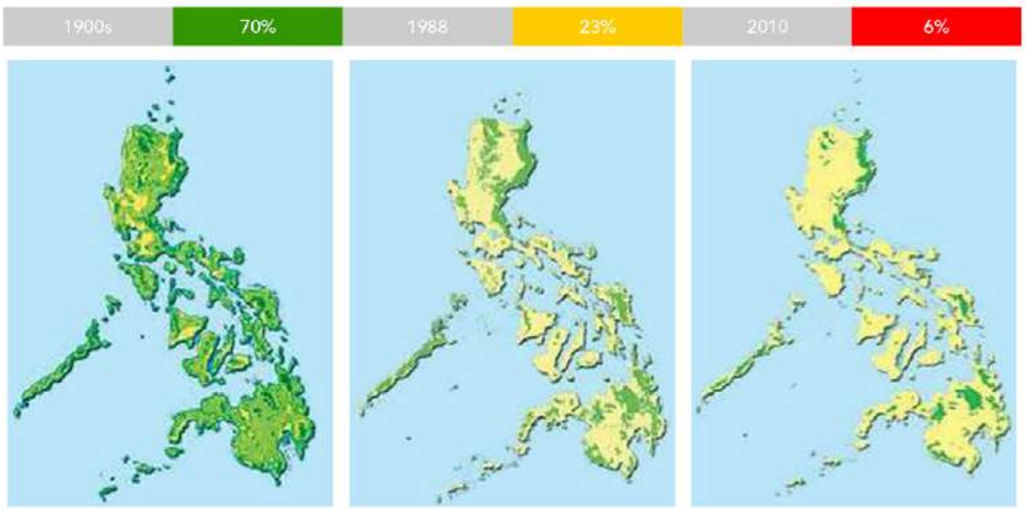
Government reported statistics show dissimilar values for the country's distribution of land which needs to be reconciled. Further reclassification is necessary to reflect actual land use, but most importantly, this should not diminish the area already classified as forestland for ecological reasons that need no explanation.

The Philippine GHG Inventory Manual (2011) also provides that while more than half of the land area has been legally classified as forestlands, not all of the forestland is covered with the original cover of lush tropical rainforest as most of them had been converted into other land uses such as grassland, brushland, upland farms etc.

Aside from illegal logging, a major threat to forest conservation is the aggressive promotion of mineral mining by the Philippine government to boost its economy. Open pit mining is a grave concern, since the proliferation of open pit mining activities throughout the forested areas will result in *bigger carbon sink loss; poor, if not toxic water quality, threatening public health and food security; soil loss; loss in its rich biodiversity;* and *displacement of indigenous people living in the upland areas.*

Figure 2.12 shows Forest Loss in the country in the 20th century with Figure 2.13 showing the forest cover status in 2010.

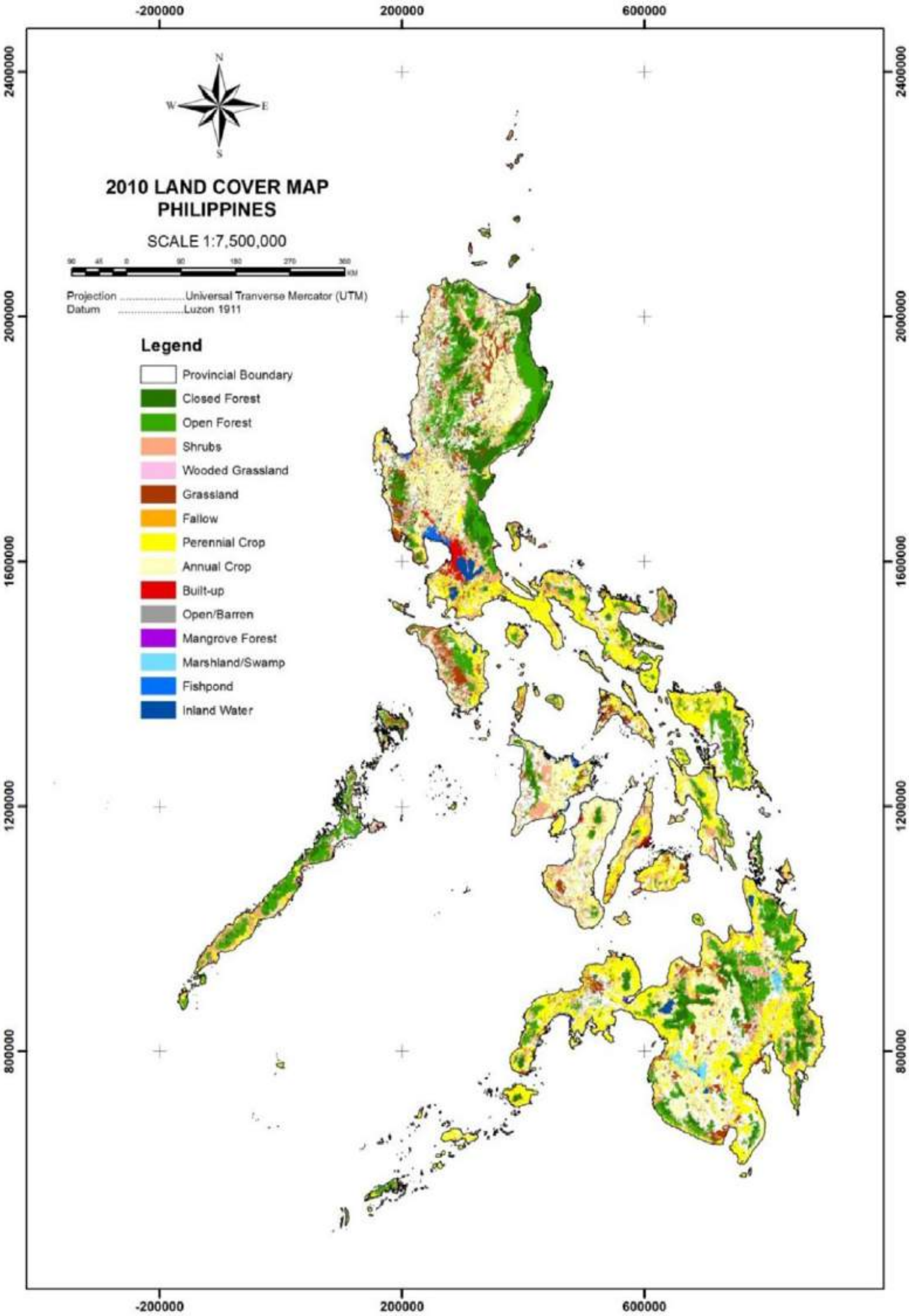
Figure 2.12 Forest Loss in the Philippines in the 20th Century[27]



Source: Key Conservation Sitres in the Philippines (Haribon and Birdlife International, 2011), citing ESSC booklet, "Decline of the Philippine Forest".

27 *ASSESSING PROGRESS TOWARDS THE 2010 BIODIVERSITY TARGET: The 4th National Report to the Convention on Biological Diversity, 2010, DENR-PAWB, UNDP, Asean Center for Biodiversity, Ateneo de Manila University*

Figure 2.13 Philippine Land Cover Map: 2010, DENR



2.7.1 Carbon Sequestration of Philippine Forest

Government statistics show that the contribution of the LUCF sector in the Philippines has resulted in a swing from being a net source in 1990 to a net sink in 1998 as reported in the INC and the SNC. This adjustment is due largely to the changes in activity data used and the availability of country-specific data for the sector. The annual carbon sequestration of all forest lands in the Philippines was estimated to be 30 Tg C/yr (Table 2.20). However, it is also estimated that Philippine forests release 0.3 and 11.1 TgC/yr because of wood harvest and deforestation, respectively *(Lasco 1998)*. This results in a net C sequestration of 19.6 TgC/yr.

Table 2.20 Carbon Storage and Sequestration of Forest Land Use in the Philippines (Lasco and Pulhin, 2000)

LAND USE TYPE	Area (M ha)	Carbon Storage (Mg/ha)	Total C in Biomass (Tg)	C Sequestration Rate ($Mgha^{-1}yr^{-1}$)	Total C Sequestration (Tg/yr)
Protection Forest	2.70	113.70	**306.99**	1.50	**4.05**
Second-growth Forest	3.40	111.10	**377.74**	2.20	**7.48**
Brushlands	2.30	35.00	**80.50**	0.50	**1.15**
Grasslands	1.20	5.00	**6.00**	0.00	**0.00**
Tree Plantations	0.60	55.60	**33.36**	4.00	**2.40**
Agroforestry	5.70	50.30	**286.71**	2.70	**15.39**
TOTAL	**15.90**		**1091.30**		**30.47**

Note: 1 Tg C=1x10^{12} gC= 1 M tC

In the earlier estimates (Table 2.21), CO_2 emissions from forest lands *(decay and harvest)* were calculated to be 120 Tg/yr in the national GHG inventory *(Francisco 1997)* so that forest lands become net emitter of carbon *(-21 Tg/yr)*. Thus, in the more recent estimate, forest lands are a net sink of carbon, as compared to being a net source of carbon in the first national GHG inventory. This difference is significant considering that CO_2e emissions from forest land use was the largest component *(50%)* of total Philippine CO_2e emissions as reported in the INC.

Table 2.21 Total Emissions from Land Use Change and Forestry Sector (LUCF) of the Philippines (Gg CO_2e)

SOURCE	1990 Inventory (1997 US Country Studies)	1990 Inventory (1998 ALGAS)	1994 Inventory (1999 Philippine National Commission)	1998 Inventory (Lasco and Pulhin 2001b)
Change in forests and biomass stocks	-48,654	2,622	-68,323	-190,522
Forest and grassland conversion	120,738	80,069	68,197	46,624
Abandonment of managed lands	-1,331	-1,331	Not determined	Not determined
Net emissions	70,753	81,360	-126	-142,007
TOTAL Philippine Emissions	**128,620**	**164,103**	**100,738**	**100,738**
% of TOTAL Philippine Emissions	**55.01**	**49.58**	**-0.13**	**-142**

References: Franciso 1997; Murdiyarso 1996; ADB 1998; Philippines' Initial National Communication, 1999

In spite of the new information generated in the last few years, there is a great need to quantify carbon stocks and rate of sequestration of the various forest types in the country. A revalidation of government's forest database and sector specific factors is needed in accordance with actual forest conditions to finally determine the carbon sequestration value and emission levels from forest.

2.7.2 Protected Areas

The Philippines has 112 protected areas proclaimed under the NIPAS system covering 3.54 million has. comprising terrestrial and marine areas. A substantial portion of proclaimed protected forest areas pursuant to the NIPAS Law[28] is still without adequate protection.

Republic Act 7586 otherwise known as the National Integrated Protected Areas System *(NIPAS)* Act of 1992 provides the legal framework for the establishment and management of protected areas in the Philippines. The establishment and management of protected areas are part of the international commitments signed by the Philippine Government such as Convention on Biological Diversity, Ramsar Convention, World Heritage Convention, Convention on Migratory Species, and the ASEAN Agreement on the Conservation of Nature and Natural Resources.

The NIPAS Act identified 202 initial components with an approximate area of 2.57 million hectares, covering proclaimed national parks, game refuge and wildlife sanctuaries, nature reserves, wilderness areas, mangrove reserves, watershed

28 *Republic Act 7586 otherwise known as the National Integrated Protected Areas System (NIPAS) Act of 1992*

reservations, fish sanctuaries, protected landscapes and seascapes, among others prior to the NIPAS Act. These areas are maintained as part of the NIPAS until such time that they are finally assessed as to their suitability for inclusion to the System.

2.7.3 Issues Governing LUCF

The following issues have bearing on forest land and its use.

A. Ancestral Domains[29]- *Under Republic Act No. 8371, otherwise known as the Indigenous Peoples Rights Act (IPRA) of 1997, the rights of indigenous peoples or communities (IPs/IPCs) are secured to their ancestral domains, or "comprising lands, inland waters, coastal areas, and natural resources therein" held under a claim of ownership, occupied or possessed by ICCs/IPs. IPs/IPCs with legitimate claims will be issued Cadastral Ancestral Domain Titles (CADTs) over such lands.*

Conflict with preservation of forest land lead to conversion to other uses, as the ICCs/IPs have priority rights in the harvesting, extraction, development or exploitation of any natural resources within the ancestral domains. Further, a non-IP person or entity may be allowed to take part in the development and utilization of the natural resources, provided that a formal and written agreement is entered into with the IPs/IPCs concerned or the community.

These lands are exempt from real property taxes, special levies, and other forms of exaction except such portion of the ancestral domains which are actually used for large-scale agriculture, commercial forest plantation and residential purposes or upon titling by private persons.

B. Conflicting Land Use Issues - *Under Section 18 of the Mining Act of 1995, "x x all mineral resources in public or private lands, including timber or forestlands as defined in existing laws, shall be open to mineral agreements or financial or technical assistance agreement applications." This means that forestland, except proclaimed protected areas, are open to mining, without further act of Congress.*[30]

C. Uncontrolled Urban Development - *Uncontrolled urban development will cause environmental and social stress.*

29 *"Republic Act No. 8371." (n.d.) Official Gazette. http://www.gov.ph/1997/10/29/republic-act-no-8371/*

30 *An In-Depth Review of the NIPAS Law and Related Statutes on the Establishment and Management of Protected Areas in the Philippines Final Report, DENR-Protected Areas and wildlife Bureau, Deutsche Gesellschaft für Internationale Zusammenarbeit (gIZ) GmbH, August 31, 2011*

Agriculture land conversion to housing, industrial and commercial development poses a threat to food security. Already, areas beyond 18° slope deemed not appropriate for agriculture are cultivated for corn and other crops without employing terraced farming methods causing soil erosion and silting of downstream water resources.

2.7.4 Green Initiatives in LUCF

A. National Greening Program - *In 2011, the government embarked on a national greening program (1.5 billion trees covering 1.5 million hectares for a period of six years from 2011 to 2016) to revitalize denuded areas to improve forest conditions as a greenhouse abatement strategy. It likewise imposed a ban on logging, with the exception of plantation forests, but despite this, illegal logging remains rampant.*

FMB reports that in 2012, a total area of 221,763 was covered, for a total of 350,321 hectares. Further, the government's forest management plan provides for strengthening forest management through community based forest management strategies in critical watershed areas.[31]

B. Building for Ecologically Responsive Design Excellence (BERDE) Program - *the Philippine Green Building Council is implementing Building for Ecologically Responsive Design Excellence (BERDE) Program, a local adaptation of the US Green Building Council's Leadership in Energy & Environmental Design (LEED) program. The BERDE Program provides a green building rating system which may be used by architects as a framework in designing greener buildings, and allows them to design in accordance to environmental priorities. The rating program also encourages contractors to implement greener construction practices, and certification also helps the bottomline by helping facility managers communicate the level of sustainability of buildings – enabling them to attract tenants at premium rates.*

31 *State of Philippine Watersheds by Director Ricardo L. Calderon, Director of the Forest Management Bureau, State of the Nature Address, Green Convergence Forum, Miriam College, August 6, 2013.*



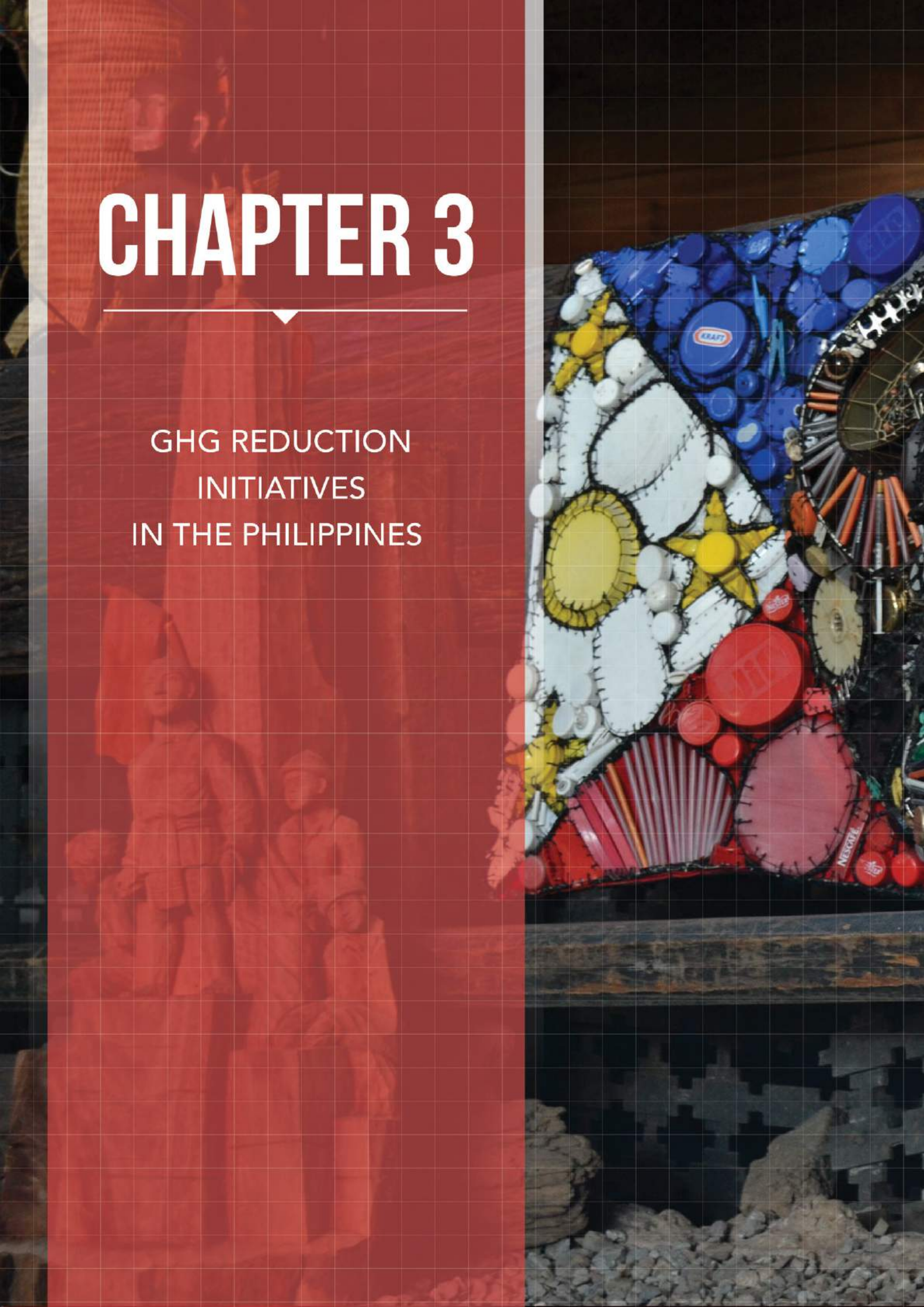






CHAPTER 3

GHG REDUCTION INITIATIVES IN THE PHILIPPINES




HALLS
NESTEA
NESTEA
Coca-Cola

3.1 INTRODUCTION

The Philippines is among those with the lowest carbon emission per capita at 0.9 tons, excluding carbon dioxide emitted or absorbed by its forests, compared to the world's average of 1.2 tons. It ranks among the lowest in the Southeast Asian Region, with its emissions outranking those of Cambodia and Laos. The government likewise estimates that the country's forests are still able to absorb about 100,000 tons each year.

In 1994, the country's GHG emissions totalled 100,738 ktons of CO_2 as reported in its Initial National Communication of the Philippines on Climate Change to the UNFCCC, comprised of mostly CO_2. Energy sector contributed 50,038 ktons or about 31%; and the transport sector contributing to 32% *(Merilo, 2001)*. In 2009, total transport emission was reported at 29.3 $MtCO_2e$, 23.8 $MtCO_2e$ of which was generated by road transport.[1]

Under the UNFCCC[2], developed country parties *(or Annex I countries)* have the primary responsibility to adopt policies and measures to limit their anthropogenic emissions of GHGs. In contrast, developing country parties *(or the Non-Annex I)* parties, like the Philippines, have no binding obligations to do so. Nevertheless, the country is undertaking measures to reduce GHG emissions.[3]

3.2 RESPONSE TO CLIMATE CHANGE

Since 1991, the Philippines has been proactive in responding to the impact of climate change, through initiatives such as the formulation of the Philippine Strategy for Sustainable Development *(PSSD)*. The country likewise adopted Philippine Agenda 21 which serves as the blueprint for the country's sustainable development efforts. That same year, the Philippines signed the Vienna Convention for Protection of Ozone Layer and the ratification of Montreal Protocol on the Protection of the Ozone Layer. Following this, the Inter-Agency Committee on Climate Change *(IACCC)* was created.[4]

In 1997, GOP formulated National Action Plan on Climate Change *(NAP)* which provided the following GHG reduction measures:

- Energy and Transformation
    - A. Shift the energy mix towards RE
    - B. Revise efficiency targets
- Transportation
    - A. Traffic improvement scheme
    - B. Travel demand management
- Industry
    - A. Implementation of energy efficiency measures

1 *CO_2 Emissions from the Land Transport Sector in the Philippines: Estimated and Policy Implications, Proceedings of the 17th Annual Conference of the Transportation Science Society of the Philippines, 2009 by Herbert Fabian and Sudhir Gota, CAI Asia Center.*
2 *United Nations Framework Convention on Climate Change (UNFCCC), the over-all framework for intergovernmental efforts to tackle the challenge posed by climate change.*
3 *Philippine Senate Economic Planning report, GHG Emissions at a Glance, 2013*
4 *IACCC was later on restructured as the Presidential Task Force on Climate Change.IACCC was later on restructured as the Presidential Task Force on Climate Change.*

   B. Promotion of energy conservation
   C. Use of alternative non-CO_2 emitting industrial processes
- Agriculture
   A. Use of tubular polyethylene bio-digesters and urea-molasses mineral block as nutrient supplement in animal production
   B. Use of sulfate fertilizers to reduce methane emissions
   C. Use of rice straw, water management and low-emitting cultivars
   D. Upgrading of food storage and distribution systems
   E. Promotion and implementation of judicious land-use planning

The Philippines was among the first countries to sign the Kyoto Protocol on April 15, 1998 *(ratified November 20, 2003)* which commits developed countries to reduce their collective emissions of GHG by at least 5% compared to 1990 levels for the period 2008–2012. In 2001, it became party to the Stockholm Convention on Persistent Organic Pollutants.

Executive Order 320, Series of 2004 designated the Department of Environment and Natural Resources *(DENR)* as the national authority for the Clean Development Mechanism *(CDM)*, with the DOE taking the lead role in evaluating energy-related projects prior to their endorsement to the DENR and registration with the UNFCCC–CDM Executive Board.

In 2009, after Typhoon Ondoy heavily affected Metro Manila and surrounding areas, Republic Act 9729, or the Climate Change Act of 2009 was enacted creating the Climate Change Commission *(CCC)*. The CCC, attached to the Office of the President, is an autonomous lead policy making body to address the issues concerning climate change.

It is mandated to formulate the National Framework Strategy on Climate Change. To ensure accountability, CCC's advisory body is composed of 23 government agencies, local government units *(LGUs)*, representatives from the academe, the business sector and non-government agencies *(NGOs)*.

3.3 NATIONAL FRAMEWORK STRATEGY ON CLIMATE CHANGE

The National Framework Strategy on Climate Change *(NFSCC)* 2010 – 2022, approved in 2010, was formulated within the context of the country's sustainable development goals and institutional factors that affect the country's ability to respond to climate change. It serves as a program for climate change planning, research and development, extension, and monitoring of activities to protect vulnerable communities from the adverse effects of climate change. It is based on climate change vulnerabilities, specific adaptation needs, mitigation potential and in accordance with international agreements.

Due to the high vulnerability of the Philippines to the adverse effects of climate change, the NFSCC puts greater emphasis on adaptation, rather than measures that reduce greenhouse gas *(GHG)* emissions. The framework strategy provides mechanism to manage risks, adjust economic activity to reduce vulnerability and to improve business certainty.

Mitigation measures provided include:

- Development and enhancement of clean energy sources, uses and other efficiency measures towards a low carbon economy in the energy sector.
- Realization of the full potential of the country's RE capacity so as to further contribute to energy security and promote low-carbon growth in the energy sector.
- Improvement of the efficiency of the transport sector through increased uptake of alternative fuels and expansion of mass transport systems.
- Reduction of carbon footprint through energy-efficient design and materials for public infrastructure and settlements.
- Reduction of emissions from deforestation and forest degradation through the sustainable management of forests and the protection and enhancement of carbon stocks in watersheds, forests and other terrestrial ecosystems.
- Full implementation of proper waste management.

3.4 NATIONAL CLIMATE CHANGE ACTION PLAN (NCCAP)

The NCCAP outlines the agenda for adaptation and mitigation, consistent with the NFSCC for 2011 to 2028, which is to build the adaptive capacities of the citizenry and increase resilience of vulnerable sectors and natural ecosystems to climate change; as well as to optimize mitigation opportunities. The NCCAP has seven strategic priorities:

- Food Security
- Water Sufficiency
- Ecosystems and Environmental Stability
- Human Security
- Climate Smart Industries and Services
- Sustainable Energy
- Knowledge and Capacity Development

The means to implement the strategic priorities are: financing, valuation of natural resources, multi-stakeholder partnership and capacity building. The CCC is mandated to provide assistance to LGUs for the formulation of their respective local climate change action plan.

3.5 GHG REDUCTION INITIATIVES

Presidential Decree 984 entitled Pollution Control Law *(PD 984)* enacted in 1976 provided guidelines for air pollution from industrial sources, set penalties for violations and required all polluters to secure permits from the environmental agency. Due to deteriorating air quality particularly in urbanized areas, in 1999, GOP enacted Republic Act 8749, or the Clean Air Act of 1999. The Clean Air Act recognized the right of the citizens to breathe clean air and adopted the principles to promote and protect the global environment to attain sustainable development. The law called for the formulation of a holistic national program of air pollution management to be implemented by government, consistent with the international agreements on the reduction of GHG emissions in the country.

From 1998 to 2001, GOP implemented the Philippine Climate Change Mitigation Program *(PCCMP)* with funding assistance from the USAID. The project aimed to slow down GHG emissions from the power sector through expanding the use of clean fuels and promoting more efficient generation, distribution, and consumption of electricity.

The 2002 World Bank Environment Monitor reported that air pollution impact on health in four cities alone was estimated at USD430 million. Among the major contributors to air pollution identified are transport, industry and power and waste burning. In 2010, the government presented a target of 30% reduction of the pollution load, 80% of which was attributed to vehicles, through strengthened anti-smoke belching remedial measures and strict implementation of vehicle emission testing prior to annual registration.[5] Until today, the highest cause of morbidity are respiratory illnesses blamed on air pollution.

Apart from Republic Act 9729, or the Climate Change Act of 2009, pending legislation include the proposed Low Carbon Economy Act and the proposed Greenhouse Gas Emission Atmospheric Removal Act which could help in minimizing GHG emissions through the setting up of an emission cap-and-trade system in the industry sector, and in facilitating the development, demonstration and implementation of technology that shall remove GHGs from the atmosphere.

5 *DENR News, The Philippine Clean Air Act: Eleven Years of Partnerships for Cleaner, Healthier Air, Yasmin Roselle Caparas.*

3.5.1 The Energy Sector

In the Energy Sector, emissions from fossil sources was reported at 69.667 Mt in 2000, up from 50.038 Mt in 1994. In 2007, GHG emissions from the transport sector 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 $MtCO_2$. To achieve GHG reduction, GOP adopted three key measures, as follows:

A. Supply and demand side energy efficiency, including power grid optimization and initial investments in smart grid technology, as well as urban energy efficiency;
B. Further development of the country's RE potential, including biomass and solid wastes, geothermal, hydropower, solar, and wind; and
C. Improved transport systems, including Bus Rapid Transit (BRT), advanced vehicle technology, urban rail, motor vehicle inspection and emission systems, and wider use of biofuels.[6]

DOE, the agency tasked to prepare, integrate, coordinate, supervise and control all plans, programs, projects and activities of the government relative to energy exploration, development, utilization, distribution and conservation; and mandated to ensure energy security, self-sufficiency, reliability, sustainability and reasonable pricing of power generation[7] aims to ultimately achieve self-reliance in the country's energy requirements and maximize use of RE, through:

A. the integrated and intensive exploration, production, management, and development of the country's indigenous energy resources;
B. the conservation, renewal and efficient utilization of energy to keep pace with the country's growth and economic development considering the active participation of the private sector investors in the various areas of energy resource development; and
C. the rationalization, integrations and coordination of the various programs of the Government towards self-sufficiency and enhanced productivity in power and energy without sacrificing ecological concerns.

Three *(3)* important government institutions partner with DOE in the implementation of energy management program of the government, are: Department of Science and Technology-Philippine Council for Industry and Energy Research & Development (DOST-PCIERD); Department of Trade and Industry – Bureau of Product Standards (DTI-BPS) and the Department of Environment and Natural Resources (DENR.)

6 *Clean Technology Fund (CTF) Investment Plan for the Philippines, a study undertaken by the Philippine government with Asian Development Bank (ADB), World Bank and International Finance Corporation (IFC)*
7 *DOE was created under Republic Act 7638, also known as the "Department of Energy Act of 1992."*

As early as 1993, a Presidential issuance *(Executive Order 123, Series of 1993)* institutionalized a Committee on Power Conservation and Demand Management *(CPCDM)*.

Further issuances and enacted legislation towards Energy Efficiency, Abatement of Air Pollution and Development of Renewable Energy Sources include:

A. *Executive Order 472, Series of 1998, a Presidential issuance creating the Committee on Fuel Conservation and Efficiency in Road Transport (CFCERT).* Its objective is to promote the judicious and efficient utilization of fuel in the road transport sector through awareness campaigns in major cities and municipalities around the country. A regional, city or municipal chapter was established to provide continuity of the program in the locality. The local chapter was headed by a representative from the transport association.
B. *Enactment of Republic Act 8794 otherwise known as the Motor Vehicle Users' Charge ("MVUC")* Law in Year 2000. This created the Special Vehicle Pollution Control Fund (SVPCF) which aims to promote sustainable improvement in air quality through abatement and mitigation of air pollution from mobile sources. It can be used for supporting the implementation of policies and measures in the field of low emissions transport.
C. *Republic Act 9136, otherwise known as the Electric Power Industry Reform Act of 2001 (EPIRA)* was enacted in 2001. It declares the policy of the State, among others to: a) assure socially and environmentally compatible energy sources and infrastructure; b) promote the utilization of indigenous and new and RE resources in power generation in order to reduce dependence on imported energy; and c) encourage the efficient use of energy and other modalities of demand side management.
D. *The Bio-Fuels Act of 2006 (Republic Act 9367)* was enacted in 2006 mandating 1.0% biodiesel blend in 2007, increasing to 2% in 2009 and bio-ethanol blend at 5% in 2009 increasing to 10% in 2011, with hopes to increase this to 20% coco methyl ester (CME) in diesel and 20% ethanol in gasoline by 2030. CME is domestically produced from coconuts, while 80% of the bio-ethanol supply will be sourced from imports due to the limited domestic production capacity.
E. *The Renewable Energy Act of 2008* was enacted, declaring the State's policy to further develop the country's RE potential. Note that much earlier, in 1994, to encourage the development of mini-hydro power plants, Philippine Congress enacted *Republic Act 7156, better known as the Mini-hydroelectric Power Incentive Act,* which created incentives for mini-hydro projects.

The Renewable Energy Act of 2008 created the National Renewable Energy Board (NREB.)[8], the agency that makes recommendations to the DOE with regard to RE projects and action plans, including the proposition of feed-in tariffs. In addition, the NREB is responsible for overseeing the Renewable Energy Trust Fund, and the benefits the fund may confer upon RE projects.

The *Renewable Energy Trust Fund* was launched in 2009 to help develop RE and promote the use of RE in the Philippines. The funds are generated from various government-owned corporations, and also from the government's royalties from several service contracts. The trust fund calls for USD8.5 billion to be invested in biomass, geothermal, hydro, ocean, wind, and solar energy in the next ten years.

The Philippines has likewise formulated the following Energy Efficiency and Conservation Programs which aims to increase energy savings from electricity and fuel consumption from 2,652 Kiloton oil equivalent (KTOE) in 2010 to 2,654 KTOE in 2016:

A. 2004: *Launching of the National Energy Efficiency and Conservation Program (NCEECP)* - Its primary goal is to make energy efficiency and conservation a way of life and the attainment of 229 MMBFOE total energy savings between 2005 – 2014.

B. 2009: *Formulation of the Clean Technology Fund (CTF) Country Investment Plan (CIP),* a proposal for the use of the CTF resources in the Philippines, potential pipeline of projects and notional resource envelope. This CTF investment plan is based on the economic development plans and the GOP investment programs and mature project proposals considered at this time. The CIP is developed by the GOP in agreement with the Asian Development Bank (ADB), the International Bank for Reconstruction and Development (IBRD), and the International Finance Corporation (IFC). The CIP iterates GOP's three key measures towards reduction of GHG emissions. It likewise provides GOP's goals and objectives for RE development strongly linked to future reductions in GHGs, as follows:
   i. Increase RE based capacity by 100 percent in ten years;
   ii. Be the number one geothermal energy producer in the world;
   iii. Be the number one wind energy producer in Southeast Asia;
   iv. Double hydro capacity with additional 3,000 MW;

8 Members of the Board represent the broadest spectrum of organizations involved in energy, including representatives from the DOE, DTI, Department of Finance, the DENR, representatives from the national utilities, as well as NGOs and private operators. The Renewable Energy Management Bureau, established within the board as of 2009, acts as a technical secretariat to the Board.

v. Be the solar cell manufacturing hub in ASEAN; and

vi. New contribution from biomass, solar, and ocean energy by more than 100 MW.[9]

C. 2009: *Formulation of Energy Efficiency and Conservation (EC) Action Plan Targets (2009-2030) also known as the National Energy Efficiency and Conservation Program (NEECP)* seen as an essential strategy in rationalizing the economy's demand for petroleum products and eventually lessening the impact of escalating prices on the economy (DOE, 2009). The program has a target of achieving an annual 10% reduction in its total energy demand by 2030 (Reyes, 2012).[10] Strategies include the implementation of:

i. Energy Conservation (EC) Program, involving:
   - Energy Labeling and Efficiency Standards
   - Energy Use Standards for Buildings
   - Energy Audit
   - Demand-Side Management
   - Financing Energy Efficiency and Conservation Projects

ii. Supply side energy efficiency to be achieved by heat rate improvement in power plants and system loss reduction.

iii. Energy use standards for buildings through MOUs with LGUs on the adoption of the Guideline for Energy Conserving Design of Buildings and Utility System.

iv. Fuel Economy Run *(which involves participating private vehicle manufacturers and assemblers showcasing the fuel efficiency of their vehicles)*

v. Implementation of recognition programs that include educational campaigns in schools, households, and municipalities and a tri-media campaign to ensure wider coverage to achieve the given goal.

D. 2009: *Launching of the Philippine Energy Efficiency Project (PEEP)* which aims to demonstrate energy efficiency projects in the different sectors—such as the public, commercial and residential sectors. Key targets include:

i. the retrofit of 135 government buildings with energy efficient lighting systems; the economy-wide distribution of compact fluorescent lamps (CFL) totaling 8.6 million CFL units; and

ii. the retrofit of public lighting (street and traffic lights) using light emitting diode (LED) lamps in three major cities.

9 *DOE and CTF Investment Plan for the Philippines*
10 *Philippines - APEC Energy Demand and Supply Outlook – 5th Edition*

Economic and environmental benefits from the PEEP showed a 243 MW deferment of power generating capacity additions, a reduction of oil imports by 83.1 kilotons of oil equivalent (ktoe), and the avoidance of 172 kilotons of CO_2 emissions.[11]

E. 2010: *Decrease electricity transmission losses, currently at 6.61% from the national grid, and 14.08% from distribution lines of electric cooperatives and 7.90% from MERALCO.*[12]

F. 2010: *DENR implementation of the "Chillers Energy Efficiency Project" (PCEEP),* a USD10.9 million World Bank (WB) funded project which aims to replace around 375 chillers used in industrial, commercial, service, and institutional establishments nationwide with more energy efficient and environment friendly technology. The project will provide financial incentive to chiller owners to encourage them to replace old chillers that consume around 50% more energy than new ones and emit harmful GHGs into the atmosphere.[13] Further, the refrigerants used in new chillers with low or non-ozone depleting potential include hydrochlorofluorocarbons (HCFC 123), hydrofluorocarbons (HFC-134a) and natural refrigerants like natural hydrocarbons (propane and isobutene) and ammonia, water and air.[14]

Additionally, the following are proposed to lower energy consumption:
- Energy Conservation Bill;
- Building Energy Efficiency Bill

The GOP's low-carbon strategy for the transport sector 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.[15]

Three major government departments, Department of Transportation and Communications *(DOTC)*; Department of Public Works and Highways *(DPWH)*, National Economic Development Authority *(NEDA)* Board and many independent regulatory and operational agencies formulate and implement the country's transport plan to guide infrastructure requirements of the country. Private sector entities, especially associations for public transport vehicles *(buses, jeepneys, FX vehicles, taxis, tricycles)* also play a major role in supplying transport services. To promote a holistic approach to energy efficiency in urban transport, further joint work between these entities is crucial.

12 *Philippine Development Plan 2011 - 2016, Results Matrices, NEDA*
13 *The "Chillers Energy Efficiency Project" aims to enhance the capacity of chiller owners, energy service companies, and commercial financing entities to take advantage of carbon financing using a "programmatic approach" to the Clean Development Mechanism (CDM) of the Kyoto Protocol, a departure from the conventional approach where projects were processed individually.*
14 *http://denr.gov.ph/news-and-features/latest-news/248-paje-outlines-benefits-from-new-energy-efficient-chillers-.html*
15 *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, Transport and Traffic Planners (TTPI) Inc., in association with CPI Energy Phils, Inc.*

Strategies include improvement of the country's road networks, including rehabilitation and maintenance, and reconstruction of the road structure, upgrading pavement design and bridges for heavier traffic, road widening or realignment and junction improvements, development of missing links, especially port and airport access roads, and new roads meant to stimulate development.

Already in 1995, to alleviate heavy congestion of the main arterial roads in Metro Manila, the Metropolitan Manila Development Authority *(MMDA)* implemented the Uniform Vehicular Reduction Program[16], with a car-less day for one day in the week, based on number ending of private motor vehicle plates. However, those who preferred individual transport and who could afford to acquire an additional vehicle did so, with the additional vehicle having a different number ending for the additional vehicle for use, when their other vehicle is blocked.

Later programs implemented by GOP towards reduction of CO_2e from the road transport, including:

A. *Reducing Emissions Per Unit of Fuel Used*
   - Implementation of the Motor Vehicle Inspection System (MVIS), which among others is to ensure compliance with emission standards;
   - Banning importation of two-stroke motorcycles, and encouraging retrofitting of two-stroke engine tricycles to four-stroke, though achieved in very limited in numbers.[17] A pilot program was also initiated by Partnership for Clean Air (PCA) retrofitting a two-stroke engine tricycle with an LPG gas engine;[18]
   - Provision of diesel particulate traps for buses and jeepneys;
   - Retrofitting of a limited number of taxis with LPG (liquefied petroleum gas) conversion kits, however, a setback was posed by leaking LPG tanks exposed taxi drivers to high levels of toxic substances in the blood compared to those who were driving gasoline or diesel-powered vehicles. Among these toxic gases are carbon monoxide at hydrogen sulfide;[19]
   - Issuance of Executive Order 290, Series of 2004, calling for the formulation of a Natural Gas Vehicle Program for Public Transport and since CNG for buses has been introduced (with a target of 5,000 CNG buses by 2026[20]); and
   - Introduction of Coco-Methyl Ester Blends (Diesel-CME) jeepneys pursuant to the Biofuels Act (also in limited numbers).

16 *MMDA Regulation No. 95-001 which disallows cars based on plate number ending from designated streets and areas once a week, during rush-hours of 7am to 9am and 5pm to 7pm*
17 *http://cleanairinitiative.org/portal/node/8236, Tricycles in the Philippines*
18 *Philippine Information Agency, 2-stroke Strikes in Mandaluyong converted to LPG-run engines By Alice V. Sicat, March 10, 2012*
19 *Toxic Taxis: Auto LPPG leaks pose health hazards, David Dizon, ABS-CBNNews.com, October 18, 2012*
20 *Philippine Energy Plan, 2008, Clean Technology Fund (CTF) Investment Plan, GOP, WB, ADB*

B. *Reducing Vehicle Kilometers*
   - Implementation of Transportation Demand Management (TDM)-demand restraint using administrative instrument such as limitation on vehicle use;
   - Introduction of intelligent transportation system (ITS) technologies;
   - Increasing in the share of public transport through expansion and closing the loop of urban rail network in Metro Manila and provision of inter-modal terminals; and
   - Promotion of non-motorized travel with the introduction of bikeways (albeit very limited) and improvement of pedestrian walkways;

In May 2011, to further reduce the country's carbon footprint and improve local air quality, the government formulated and launched a National Environmentally Sustainable Transport Strategy *(NESTS)* for the country, under Administrative Order 254. This set a new paradigm on the movement of passenger and goods by following the principle of "Those who have less in wheels must have more in road." NESTS 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. DOE reports efforts towards clean energy in the transport sector as follows:

A. Forty-one *(41)* CNG fed buses are commercially operating in the Batangas-Manila-Batangas route, and importation underway for an additional thirty-six *(36)* CNG fed buses with fuel displacement of 387,732 liters of diesel equivalent in 2010 and an additional 630,393 liters of diesel displacement in 2011;
B. 17,500 taxis converted to LPG, translating to 165 million liters of gasoline displacement with an additional 1,231 taxis in 2011 redounding to an additional displacement of 88.6 million liters of gasoline;
C. 217 auto-LPG refilling stations available nationwide;
D. 560 units of electric tricycles in 2010, increasing to 623 in the first half of 2011, replacement of an equivalent 701,120 liters of gasoline in 2010 and 391,244 liters in the first half of 2011.

Recent developments in the transport sector to abate CO_2 emissions include:

A. Launching of Market Transformation through Introduction of Energy Efficient Electric Tricycle Project *(2012–2016)*, an ADB assisted program involving the adoption and shift to 100,000 electric tricycles in the country.

B. Introduction of the first electric vehicle *(EV)* charging station *(e-Vehicle Power Station)* of the Manila Electric Company *(MERALCO)* powered by solar panels and wind turbines was inaugurated in Mandaluyong City, Metro Manila to serve automotive and electric tricycles *(July 2013)*;
C. Introduction of hybrid buses *(Green Frog Zero Emissions Transport)* in May 2013, starting with 2 buses, the fleet has now a total of 8 buses which ply in two routes in Metro Manila[21];
D. Prevention of entry to provincial buses and jeepneys without terminals within Metro Manila and provided terminals at the north and south gateways to the metropolis to decongest the major roads in Metro Manila by the Metropolitan Manila Development Authority *(MMDA)* in August 2013[22]; and
E. In 2014, launching of electric jeeps such as the City Optimized Managed Electric Transport or COMET, a joint venture of Philippine and American developers. The zero-emission e-jeep is envisioned to replace the traditional jeep to decrease carbon emissions and mitigate climate change[23].

The outcome targets of GOP in its energy efficiency programs in Metro Manila for transport are:

A. increased travel speed from 27.79 km/hr in 2010, to 38.2 km/hr in 2016; and reduced travel time from 2.17 minutes/km in 2010 to 1.57 minutes/km in 2016;
B. decrease locations of pedestrian vehicle conflict from 203 in 2010 to 10 in 2016;
C. Increased bus occupancy due to reduction of MM number of buses--- air-conditioned buses from 40 in 2010 to 45 in 2016 and 37 non-air-conditioned buses to 45 in 2016;
D. Increase annual ridership in light rail system from 219.27 million in 2010 to 270.10 million in 2016.[24]

We also note that GOP provides no targets in its 2011-2016 plans for rehabilitation of the country's 120-year old, 800 kilometer railway system in the Island of Luzon as a transport backbone from La Union and Ilocos Province to Legazpi in the Bicol Region by the Philippine National Railways *(PNR)*. Except for making the southern line to Bicol operational again after service was stopped due to damage caused by

21 *Magic Bus, 30 Minutes with Philip Go Apostol, Grid Magazine, March 2014 issue, Page 26*
22 *This, however, is being opposed by affected public utility operators due to high terminal charges, and by passengers since they will need to spend for the additional fare to their destination within. It is to be seen if political will is to prevail over public dissent.*
23 *Legarda Cites PHL-US Cooperation on Climate Security, Senate of the Philippines Press Release, May 10, 2014*
24 *Philippine Development Plan 2011 - 2016, Results Matrices, NEDA*

a typhoon in 2011 and provision of metro-commuter diesel multiple units *(DMUs)*, the proposed rehabilitation of the northern line still has to be completed since its decommissioning due to shift in policy to Pan-Philippine Highway Systems, in the 70's, where the rail system was allowed to deteriorate and its right-of-way taken over by informal settlements.[25]

In maritime transport, to lessen transport time for passenger and goods between islands, the GOP implemented a 919 kilometer nautical highway linking roll-on-roll-off *(RORO)* terminals/ports and roads that connects the three primary regions — Luzon, Visayas, and Mindanao. It comprises three major trade routes of the ROROs namely the Western, Central and Eastern Nautical Highways. The inter-modal-road-RORO Terminal System connecting Mindanao, Visayas, and Luzon has effected a reduction in travel time by around 12 hours and a reduction of transport cost by 37-43% for passengers and 24-34% for cargo.

In terms of air transport, in 2009, the International Aviation Industry agreed to have the three sequential goals:

A. Improve fuel efficiency with an average of 1.5% annually to 2020;
B. Cap net carbon emissions with carbon-neutral growth from 2020; and
C. Achieve a 50% reduction in net carbon emissions by 2050 compared with 2005.

To achieve this, all main aviation sectors have agreed to a four-pillar strategy comprised of new technology, more efficient operations, better infrastructure, and positive economic measures. Use of biofuels have taken place. However, sufficient quantities of sustainable biofuels at commercially viable prices remain a major barrier.

3.5.2 The Agriculture Sector

Agriculture represents about 20% of the total economy *(18% of GDP)* and generates 30% of the country's total employment. Although the country has been traditionally exposed to the many hazards and risks from typhoons and droughts even before the onset of climate change, the undefined shifting of rainfall patterns and rising temperatures due to climate change will cause confusion to many farmers in terms of when to plant and what to plant. Further, concentration of climate-vulnerable dams and irrigation in Luzon, which is the location of 60 percent of national irrigated rice production, will weaken the overall resiliency of the country's national

25 http://www.pnr.gov.ph

food security and self-sufficiency, including the increasing problems on water allocation and prioritization for water supply for irrigation, domestic water and energy.[26]

The objective of the National Strategic Priority on Food Security is to ensure availability, stability, accessibility, and affordability of safe and healthy food amidst climate change; and its focus is on two immediate outcomes:

- Enhanced CC resilience of agriculture and fisheries production and distribution systems; and
- Enhanced resilience of agricultural and fishing communities in the midst of climate change.

There are on-going efforts to provide timely information to farmers on climate so that adjustments in the cropping can be done to avoid losses. In the fisheries sector, coastal area management is being vigorously pursued.

Target outcomes for the Agriculture Sector's programs towards resilience to climate change risks is to reduce the average annual agri-production loss at a decreasing rate every year compared to losses of PhP13.8 billion for the period 2004 to 2010.[27]

In terms of GHG emissions, in Year 2000, emissions from agriculture contributed to more than 37 $MtCO_2e$ or about 30% of the country's emissions, higher than its contribution of 33.13 $MtCO_2e$ in 1994. Among mitigating measures proposed for the Agriculture Sector under the Initial National Communication were:

- Promotion of organic farming
- Use of rice straw, water management and low-emitting cultivars, and sulfate fertilizers to reduce methane emissions; and implementation of a Balanced Fertilization Program, which provides location specific recommendation for and distribution of organic and inorganic fertilizers aimed at sustaining high crop yields over long cropping seasons without depleting the natural resource base;
- Reduction of programmed area for irrigated rice fields;
- Judicious use of pesticides through Integrated Pest Management;
- Utilization of low-water use crops;
- Use of tubular polyethylene bio-digesters and urea-molasses mineral block as nutrient supplement in animal production;
- Upgrading of food storage and distribution systems; and

26 *Philippine National Framework Strategy on Climate Change 2010-2022*
27 *Philippine Development Plan 2011 - 2016, Results Matrices, NEDA*

- Promotion and implementation of judicious land-use planning

Agricultural products such as sugarcane, sweet sorghum, cassava and coconut as sources of biofuels and agricultural residue as a RE source are included in the country's alternative fuel and RE programs.

3.5.3 The Industry Sector

GHG emissions from the Industry sector are based on production and the transformation of raw materials. These include the production of minerals, chemicals, metals, pulp and paper, food and beverages, and the use of halocarbons. GHG emissions from the fuel consumption of industries are covered in the Energy Sector.

Government estimated that in 1994 industry's emissions was 10.603 $MtCO_2e$ or 10.51% of the country's total emissions. In 2000, government estimated this to be only 8.609 $MtCO_2e$ or 8.79% of emission that year. This was attributed to the closure of the Philippines' biggest steelmaker, the National Steel Corp (NSC) in November 1999.[28] The Government's GHG reduction strategies in industrial processes include:

- Implementation of energy efficiency measures;
- Promotion of energy conservation; and
- Use of alternative non-CO_2 emitting industrial processes.

It is noted that combustible fractions of the waste sector and agricultural residue are already being used as fuel sources by the cement industry.

3.5.4 Land Use Change and Forestry Sector

The DENR estimates that remaining forest cover has significantly dwindled to 7.17 million hectares or 24 percent in 2003, while other non-government sources argue that only 5.2 million hectares or less than 18 percent of forest cover remained by 2002. The Philippines' deforestation rate is estimated at 1.4 percent annually.[29] The aggressive deforestation rate is blamed on the Forestry Code of 1975 which allowed the wanton extraction of timber and other forest resources through the issuance of various timber permits, such as Timber Licensing Agreements *(TLAs)* and Integrated Forest Management Agreements *(IFMAs)*[30].

The National Framework Strategy on Climate Change 2010–2011 provides that

28 *Tracking Greenhouse Gases: An Inventory Manual, Philippines: Enabling Activities for the Preparation of the Second National Communication on Climate Change to the UNFCCC 2011*
29 *Food and Agriculture Organization United Nations (FAO-UN) (2003). State of the World's Forests*
30 *On the Road to Disaster: Gaps in Republic Act 9729 and Philippine Climate Change Policies, Copyright © 2011 by the Center for Environmental Concerns-Philippines*

LUCF registered a net uptake of *(104,040.29)* Gg CO_2 as contained in the second GHG inventory and incorporated in Second National Communication *(SNC)*. This is a big jump from the GHG inventory of 1990 *(US Country Studies Program)* of LUCF emission of 55.01Gg, 1994 inventory as presented in the Initial National Communication of *(0.13)* Gg. The big variance is attributed to adjustments made in view of new information on LUCF.

Due to controversies arising from this, a revalidation of government's forest database and sector specific factors is needed in accordance with actual forest conditions to finally determine the carbon sequestration value and emission levels from forest. Further, the government's aggressive mining policy, which allows open pit mining, must be tempered so as not to diminish the current value of the country's carbon sink.

Past initiatives towards protection of forest land include the formulation of the Master Plan for Forestry Development in 1990, the blueprint for managing the country's forest lands; GHG mitigation measures include soil and watershed conservation, people-oriented forestry, forest protection, and forest plantation establishment.

Growing concern that degradation of many ecosystems reduce their carbon sequestration and storage capacities, while leading to increase in emissions of GHG, the UNFCCC Conference of Parties *(COP)* is encouraging developing country Parties to reduce emissions from deforestation and forest degradation, and to conserve forest carbon stock *(REDD+)*. In 2010, the GOP with assistance from the German Agency for Technical Cooperation *(GTZ)* formulated the Climate Relevant Modernization of the National Forest Policy and Piloting of REDD measures. GOP has designated the DENR as implementer of REDD+, and CCC to coordinate climate change initiatives, REDD+ and other similar mechanisms.

In 2011, President Aquino issued Executive Order 26, Series of 2011 which called for the implementation of the National Greening Program, with a reforestation target of 1.5 millions trees by 2016. And, in view of growing concern with regard to effects of the current mining policy of the government, he issued Executive Order 79, Series of 2012, institutionalizing and Implementing Reforms in the Philippine Mining Sector Providing Policies and Guidelines to Ensure Environmental Protection and Responsible Mining in the Utilization of Mineral Resources, which closes the following areas to mining: a) Areas enumerated in Sec. 19 of RA 7942;

b) Areas established under RA 7586 *(NIPAS Law)*; c) Prime agricultural areas, land covered by RA 6657 *(Comprehensive CARP Law)*, strategic agricultural and fisheries development zones, fish refuge and sanctuaries declared as such by the DA Secretary; d) Tourism development areas identified under the National Tourism Development Plan; and e) Other critical areas, island ecosystems and impact areas of mining as determined by existing mapping technologies, that the DENR may hereinafter identify pursuant to existing laws, rules, regulations and conditions of the grant thereof.

GOP targets for forestry is to increase land coverage stated at 23.8% in 2010 to 30% in 2016, while terrestial and marine resources management for important biodiversity and ecosystems equitably managed through NIPAS to be increased from 2.10% for terrestial areas to 8.85%; from 0.09% for marine parks to 0.62%; and 0.0006% for critical habitats from 2011 to 1.01% in 2016. GOP also targets to achieve 100% rehabilitation of 6 abandoned mine sites in 2016 and to decrease land degradation hot-spots from more than 5.3 million hectares to 1 million with the development of sustainable management practices.[31]

Pending legislative bills include:

- Proposed Land Use Act
- Proposed Forestry Management Act
- Proposed Mineral Resources Management Act

3.5.5 The Waste Sector

Rapid urbanization results in the increase in the production and consumption of goods which leads to increase in the volume of waste generated by the commercial, domestic, and industrial sectors. The highest jump in emissions was caused by waste, up 63.5% from 7.094 Mt in 1994 to 11.599 Mt in 2000.

Concerns over the hazards of poor waste management prompted the enactment of the Ecological Solid Waste Management Act of 2000 *(Republic Act 9003)* in 2001 and the Philippine Clean Water Act of 2004 *(Republic Act 9275)* in 2004.

The Ecological Solid Waste Management Act of 2000 calls for diversion of waste from disposal and proper disposal of solid waste towards a healthier environment. This called for the institutionalization of a national program that will manage the control, transfer, transport, processing and disposal of solid waste in the country,

31 Philippine Development Plan 2011 - 2016, Results Matrices, NEDA

32 The NSWMC is chaired by the DENR and is composed of 17 Commission members, fourteen representatives from government agencies and three representatives from the private sector. The Environment Management Bureau (EMB) under the DENR provides secretariat support to the NSWMC.

and the creation of the National Solid Waste Management Commission *(NSWMC)*[32], the major agency tasked to implement Republic Act 9003 and to oversee the implementation of appropriate solid waste management plans by end-users and local governments as mandated by law. The Commission is ordered to establish the National Ecology Center which will serve as the depot of information, research, database, training, and networking services for the implementation of the provisions of the solid waste management act.

The daily generation of municipal solid waste by a Filipino is from 0.3 to 0.7 kg of garbage depending on the economic status, with population in urban areas generating more than those in the rural areas. Households produced 10 million tons of solid waste in year 2000 *(Environment Monitor, 2001)*. These are disposed in open and controlled dump-sites, with the country having only a limited number of appropriately engineered sanitary landfills, some of which are poorly managed and operate as open dump-sites.

According to the *NSWMC*, the national daily waste generation is expected to rise from 38,757 tons in 2013 to 38,092 in 2014. It was estimated at 37,427 in 2012 and is projected to climb to 40,087 in 2016. Metro Manila's waste is estimated to increase from 8,754 tons in 2013 to 8,907 tons daily in 2014.

The NSWMC is executing agreements with Subdivision Homeowners Associations (HOAs) and LGUs in Metro Manila with the following objective:

- To establish Environmental Solid Waste Management Plans with the following components: (a) Segregation at source; (b)Segregated collection; and (c) Materials Recovery Facility System, including managing biodegradable wastes, linking with junkshops for the marketing of non-biodegradable and recyclable wastes;
- To increase waste diversions of HOAs to a minimum of 50% from baseline waste generation;
- To publicize reports on (a) issued and updated anti-littering ordinances; (b) apprehend and penalize violators of anti-littering ordinances; (c) recognize model solid waste management practitioners at the household, HOA and barangay levels;
- To document experiences / lessons learned.

As of 2013, 711 Memorandum of Agreement have been executed with HOAs in Metro Manila out of a total of 4,717 subdivisions. The monitoring/validation activity in the 711 HOAs was done using the sampling technique formulated by Michael Slovin *(Slovin's formula)*, with computation for waste diversion and scorecards finalized and good practices of HOAs identified. Another 300 are proposed for 2014.[33]

NSWMC also reports that Metro Manila's garbage is 52 percent biodegradable, 41 percent recyclable and 7 percent residual, and that waste diversion rate, or the amount of trash diverted away from dump-sites, landfills and incinerators, is at 41 percent in Metro Manila; while it is 36 percent outside Metro Manila.

In terms of waste disposal, the Environment Management Bureau reported that the closure of open and controlled dump-sites increased by 7.9% from 1,027 open and controlled dump-sites recorded in Year 2011 to 946 in Year 2012.

The Philippine Clean Water Act of 2004 calls for formulation of the National Sewerage and Septage Program by the Department of Public Works and Highways *(DPHW)* and the implementation of wastewater treatment. DPWH is tasked to undertake infrastructure needed prioritizing highly urbanized cities, except in Metro Manila where the responsibility falls on the two water concessionaires of the two zones under Metropolitan Manila Water and Sewerage System (MWSS) and in those cities where there are existing water districts which are responsible for same. In the case when DPWH shall construct the said facilities, the local government unit (LGU) is responsible for provision of land and necessary right-of-way.

In 2008, GOP estimates that 8% of its population still practice open defecation and that only 76% have access to basic sanitation. By 2016, GOP programs for sanitation aim to eradicate the practice of open defecation and to increase population access to basic sanitation to 83.8%. As of 2009, less than 10% of the household population is connected to a sewerage system, while only 85% of households in Metro Manila is covered by septage management systems. GOP sanitation program targets a 100% coverage for septage management in Metro Manila, while outside Metro Manila, the aim is to provide coverage for 1.08 million households.[34]

Between 1996-2001, DENR EMB monitored about 141 rivers, with 41 rivers having minimum Dissolved Oxygen (DO) values of 5 mg/l, which affects fish; and 92 rivers *(or 64 percent)* had maximum values of Biochemical Oxygen Demand (BOD) that exceeded the criterion for Class A waters, indicating high percentages of organic

33 *Establishment of Home Owners Association ESWM in Metro Manila, http://www.emb.gov.ph/portal/nswmc/MetroManilaHOAsESWM.aspx*
34 *Philippine Development Plan 2011-2016, Results Matrices, NEDA*

pollution. It was estimated that about 60 percent of the country's population live along coastal areas and contribute to discharge of untreated domestic and industrial wastewater from inland.[35]

Until today, solid and liquid waste continue to pollute Philippine water resources, notable among this is the Laguna Lake-Manila Bay river basin, with the Supreme Court needing to issue an order for all pertinent government agencies to clean up and to prevent its continued pollution. MMDA reports that its pumping stations are only 70% efficient due to clogging by solid waste and that heightened measures against flooding may not be enough this year if residents in Metro Manila continue to throw garbage indiscriminately in its waterways.[36] In Estero de Vitas, Tondo alone, MMDA collects about 16cu.m. of garbage daily.[37]

The Philippine Development Plan 2010-2016 Results Matrices provides that GOP is targeting to reduce 2010 BOD levels in 12 priority rivers which are not within water criteria, including Manila Bay-Pasig River by 35% in 2016; and to sustain river quality criteria for 8 priority rivers *(NEDA)*.

Clearly, government initiatives in terms of water pollution are inadequate with monitoring only a fraction of its water resources and focusing pollution reduction in only 20 rivers.

3.6 THE NATIONAL BIOFUELS PROGRAM

The Bio-Fuels Act of 2006 *(RA 9367)* mandated the blending of 1.0% biodiesel in 2007, increasing to 2% in 2009 and bio-ethanol blending at 5% in 2009 increasing to 10% in 2011; and created the National Biofuels Board *(NBB)* to monitor the implementation of the National Biofuels Program, including the monitoring of the supply and utilization of biofuels and biofuel blends. In the Philippines, sugarcane and coconut methyl ester *(CME)* are the current ethanol and bio-diesel feedstock of choice. Since 2007, when RA 9367 took effect, no new issuances were made as compliance with the mandated biofuels blends has been mixed due to the inadequate capacity of existing sugarcane distilleries.

The target ethanol and bio-diesel blends under the National Biofuels Program to Year 2030 are presented in Table 3.1.

35 *Philippine Environment Monitor 2003, sourced from: Local Government Development Foundation (LOGODEF) and Konrad Adenauer Stiftung (KAS). Instructive Guide in the Replication of the Tubigon-LOGODEF-KAS Mariculture Project. (Manila, September 2001).*
36 *MMDA: Garbage problem renders anti-flood measures inadequate, June 19, 2010, http://www.gmanetwork.com/news/story/193891/news/nation/mmda-garbage-problem-renders-anti-flood-measures-inadequate*
37 *Tons of garbage clog Tondo waterway daily, http://www.gmanetwork.com/news/photo/39395/tons-of-garbage-clog-tondo-waterways-daily*

Table 3.1 Target for Biofuels Blending, 2012-2030 Philippines[38]

YEAR	2012	2013-2015	2016	2020	2025	2030
Bio-diesel	B2%	B3%	B3%-5%	B5%	B10%	B20%
Ethanol	E10%	E10%	E10%	E10%	E20%	E20%-85%

3.6.1 Bio-Diesel

Coconut oil is the most popular feedstock for biodiesel in the Philippines which is sold in the market in the form of CME *(coco-methyl ester)*, an oleochemical derived from coconut oil *(CNO)*. CNO is derived from copra, the dried meat of the coconut. There are currently nine bio-diesel producers locally, with total annual capacity of 355 million liters.

Copra meal and glycerine are by-products in the CNO extraction process. Oleochemicals are used in the manufacture of soaps, detergents and other cosmetic items and toiletries; and because CME has many uses, determining CME used for biodiesel production is difficult to ascertain.

The country's coconut inventory is about 331 million trees planted in about 3.3 hectares all over the country and the government encourages investment in biodiesel production for export and local use to meet the demand which is expected to rise further when the required blend is increased to 3%-5%. Demand for 2% blend in Year 2014 is shown in Table 3.2.

Table 3.2 Demand for Biodiesel, 2010 - 2014

Blend	Year	Diesel Demand (*)	Bio-diesel Requirement
		In million liters	In million liters
2%	2010	6,935	139
	2011	7,195	144
	2012	7,465	149
	2013	7,745	155
	2014	8,035	161

Source: Board of Investments
(*) Based on DOE Demand Estimates for Diesel (2007-2014 Philippine Energy Plan)

38 *Philippines Biofuels Industry Situation and Outlook, USDA Foreign Agricultural Service by Perfecto G. Corpuz, July 20, 2012*

The Board of Investments *(BOI)* provides cost estimates for a 2 million liter capacity plant (Table 3.3).

Table 3.3 Estimated Project Cost for a 2 million Capacity Biodiesel Plant, BOI

Related Expenses	Cost in Thousand *(USD)*
Pre-Operating Cost	20.70
Cost of Land (Lease of Land for First Year)	8.28
Site Development	931.00
Equipment Cost	620.73
Working Capital	62.07
TOTAL	**1,642.78**

3.6.2 Bioethanol

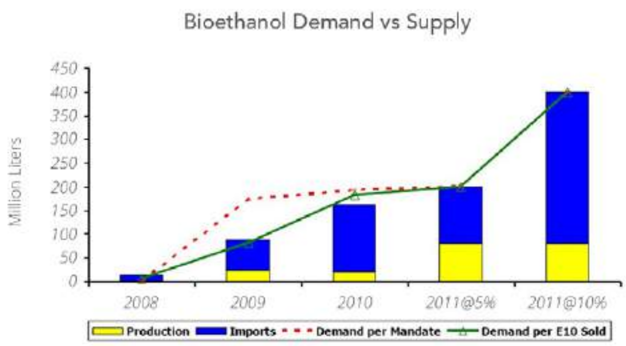
The government has formulated a program for the establishment of support mechanisms to ensure adequate supply of feedstock and the adoption of appropriate technology for vehicles/engines to be able to use alternative fuels. At present, bio-ethanol is mainly produced by sugar fermentation and distillation process. This activity started when both Leyte Agri Corporation and San Carlos Bioenergy, Inc. commenced operations in 2008.

Beginning 2009, the Bio-fuels Act mandated the sale and distribution of 5% ethanol-blended gasoline by volume by all gasoline stations. The higher 10% ethanol blend was implemented in August 2011 *(after a transition period of six months for oil companies to attend to distribution and logistics infrastructure concerns)*, with some exemptions on certain gasoline grades. By the 5th year of implementation of RA 9367 *(on February 6, 2012)*, all gasoline grades were mandated to be of 10% blend. The country continues to import bio-ethanol to comply with the required blending with gasoline and ethanol imports are expected to increase through at least 2013 in order to satisfy the ethanol-blend mandate.

Sugarcane is the 5th major crop of the Philippines, planted to a total area of 404,000 hectares as of 2009. Cassava is the top regional crop in the Autonomous Region in Muslim Mindanao *(ARMM)* with a 57% share. To increase the volume of feedstock, the government has identified 500,000 hectares suitable for the plantation bio-ethanol crops—sugarcane, sweet sorghum and cassava.

There are currently only three *(3)* ethanol producers with total annual capacity of 79 million liters *(Mli.)*. An additional 133Mli of ethanol production capacity is expected by the end of 2013 with the completion of three new distilleries. Despite this anticipated additional capacity, local ethanol production will still fall far short of meeting the current ten percent blend mandate. Figure 3.1 presents the bio-ethanol demand versus supply from 2008–2011 in the Philippines.

Figure 3.1 Bioethanol Supply and Demand in the Philippines, 2008 - 2011, DOE



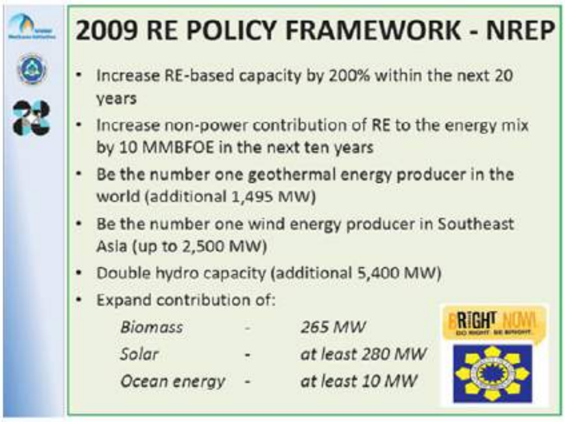
Notes:
- *Ethanol demand (green line) as 10% of E10 sales*
- *Ethanol demand (red line) as 5% of total gasoline sales*
- *Ethanol demand as 10% of total gasoline sales by 2011*
- *Full utilization of ethanol production capacity by 2011*

3.7 THE NATIONAL RENEWABLE ENERGY PROGRAM (NREP)

The Philippine government enacted Renewable Energy Act of 2008 *(RA 9513)* to spur investments in the RE sector and to make the country 60% energy self-sufficient by 2010. The law provides fiscal and non-fiscal incentives to accelerate the exploration and development of RE resources, to increase its use and to promote its efficient and cost effective commercial application. The GOP launched the National Renewable Energy Program *(NREP)* in 2009, which embodies the RE policy of the Philippines. Highlights of the RE Policy Framework[39] are shown in Figure 3.2.

39 *Challenges and Incentives for Renewable Energy Project presented by Ruby B. de Guzman, OIC-Chief Biomass Energy Management Division at the Philippine Landfill Gas Forum Workshop, 21 February 2012.*

Figure 3.2 Highlights of the NREP 2009 RE Policy Framework, DOE



In 2009, the Philippine government included investments in RE sources in its Investments Priorities Plan (IPP), with the NREB tasked to make recommendation with regard to the minimum percentage of generation from eligible RE sources such as wind, solar, ocean, run-of-river hydro-power and biomass power plants; and to formulate feed-in tariff *(FIT)* system rules.

The incentives provided for new RE projects are as follows:

A. Non-Fiscal Incentives
- *Renewable Portfolio Standard (RPS)*
    - i. mandatory (percentage) utilization of RE generation system in on-grid systems.
- *Feed-in Tariff*
    - i. priority connection to the grid;
    - ii. priority purchase and transmission of and payment for by grid system operators.
    - iii. Fixed tariff for at least 20 years
    - iv. To be applied for generation utilized in complying with RPS
- *Green energy option*
    - i. End users' option to purchase electricity from RE facilities (open access)
- *Net Metering*
    - i. Connection / sale of customers; RE generation to the grid
- *Renewable Energy market*
    - i. Creation of separate RE market
    - ii. Establishment of RE registrar for certification of RE generation which can be used for RPS compliance
- *Transmission and distribution system*
    - i. Interconnection with grid system

- *Intermittent RE Resources*
    - i. Priority ("must") dispatch
- *Off-grid RE Development*
    - i. Mandated minimum percentage of RE generation
    - ii. Eligible for RE Certificates

B. Fiscal Incentives

- *Government Share*
    - i. 1% of gross income on RE development projects except for geothermal resources;
    - ii. 1.5% for geothermal resources;
    - iii. Exemptions: biomass and micro-scale projects for communal purposes and non-commercial operations *(up to 100 kW)*
- *Income Tax Holiday*
    - i. 7-year tax holiday, including additional investments, but not to exceed three times
- *Duty free importation*
    - i. 10-year exemption from tariff duties
- *Special Realty Tax Rate on equipment and machinery*
- *Net Operating Loss Carry Over*
    - i. 3-year losses carried over 7 years, except those resulting from availment of other incentives
- *Corporate Tax Rate*
    - i. 10% of net taxable income after ITH
    - ii. Not to exceed 1.5% of original cost

C. Fiscal Incentives for RE Commercialization

- *7-year income tax holiday*
- *Zero-rated Value Added Tax (VAT) transactions–0% VAT on transactions with local suppliers of goods, properties and services*

D. Other Incentives

- *For farmers engaged in plantation of biomass resources–10 year duty free importation on all types of agricultural inputs, equipment and machinery*
- *Tax rebate for purchase of RE components–RE equipment for residential, industrial and community use*

3.7.1 NREP Target RE Capacities 2015 - 2030

DOE provides that the NREP is a live document and is subject to public consultations, and that figures presented may change based on regular updates.[40] As presented in Tables 3.4 and 3.5 below, initial targets have been lowered from a total RE capacity target of a total of more than 15,000 MW in 2030 to under 10,000 MW due to apprehension by government decision makers of cost impact in electricity cost with deployment of additional RE sources.

The total renewable energy *(RE)* sources installed capacity for electricity generation as of 2010 was over 5,000 MW. The targets for RE resources capacity from 2015-2030 is presented in Table 3.5 with more than 15,000 MW in Year 2030.

Table 3.4 NREP Targeted RE Capacity, 2015–2030, DOE[41]

SECTOR	Installed Capacity, MW as of 2010	Target Capacity Addition by				Total Capacity Addition, MW 2011-2030	Total Installed Capacity by 2030
		2015	2020	2025	2030		
Geothermal	1,972.0	220.0	1,100.0	95.0	80.0	**1,495.0**	**3,467.0**
Hydro	3,333.0	343.3	3,161.0	1,891.8	0.0	**5,396.1**	**8,729.1**
Biomass	30.0	276.7	0.0	0.0	0.0	**2,767.0**	**306.7**
Wind	33.0	1,048.0	855.0	442.0	0.0	**2,345.0**	**2,378.0**
Solar	1.0	269.0	5.0	5.0	5.0	**284.0**	**285.0**
Ocean	0.0	0.0	35.5	35.0	0.0	**705.0**	**70.5**
TOTAL	**5,369.0**	**2,157.0**	**5,156.5**	**2,468.8**	**85.0**	**9,855.4**	**15,236.3**

However, the previous given target of NREP (Table 3.4) was revised in 2012, from its original target of 15,000 MW to only about 10,000 MW. (Table 3.5)

In May 2014, DOE announced, nonetheless, that it was increasing by Year 2015 the target allocation of only 50 MW for RE solar to 500 MW which will be granted guaranteed Feed-in Tariff Rates, in addition to the current development of 414 MW natgas plant in Luzon. This increase is aimed to boost electricity supply during the summer or dry season when demand is at its highest and electricity reserves become tight thereby effecting better price relations compared to other sources.[43] As of the report's writing, the recommended increase in solar installation to 500 MW, is being deliberated upon by the ERC.

40 *Renewable Energy Outlook of the Philippines, presented by Atty. Marissa P. Cerezo, Assistant Director, Renewable Energy Management Bureau, DOE, APEC-ENGRET 41, October 16-17, 2013, Beijing, China*
41 *The National Renewable Energy Program, the Road Starts Here, presented by DOE Undersecretary Jose M. Layug, Jr. at the European Union–Philippines Meeting on Energy, February 27, 2012.*
43 *DOE considers entry of more solar plants by Riza T. Olchondra, Philippine Daily Inquirer, Tuesday, May 6, 2014.*

Table 3.5 2012 Revised NREP Targeted RE Capacity, 2015–2030, DOE[42]

Ensure Energy Security *(Triple the RE Cacity by 2030)*				
SECTOR	SHORT TERM (2011-2015)	MEDIUM TERM (2016-2020)	LONG TERM (2021-2030)	TOTAL (in MW)
Geothermal	220.0	1,100.0	175.0	**1,495.0**
Hydro-power	341.3	3,161.0	1,891.8	**5,394.1**
Biomass	276.7			**276.7**
Bio-fuels	• DC on E10 in 2011 • Mandatory E10 to all Gasoline by 2012 • PNS for B5 by 2014 • DC on B5 by 2015 • Mandatory B5 to all Diesel by 2015	• PNS for B20 and E85 by 2020 • DC on B10 and E20 by 2020	• DC on B20 and E85 by 2025	
Wind	200.0	700.0	1,445.0	**2,345.0**
Solar	50.0	100.0	200.0	**350.0**
Ocean Power	0	35.5	35.0	**70.2**
TOTAL	**1,088.0**	**5,096.5**	**3,746.8**	**9,931.3**

Source: NREP 2011-2030

3.8 NREP MILESTONES, POLICY AND PROGRAM SUPPORT

The projected milestones for GOP's NREP 2011-2030 is summarized in Table 3.6 below.

Table 3.6 NREP Milestones

SECTOR	Target indicative capacity addition achieved by	Others
Geothermal	2027	Low-Enthalpy Geothermal Resource Assessment completed by 2015
Hydro	2023	Construction of Sea Water Pumped Storage Demo Facility by 2030
Biomass	2015	Mandatory E10 blend for all gasoline vehicles by 2012
Wind	2022	Grid parity by 2025
Solar	2030	Smart Grid and Concentrated Solar Thermal Power Demo completed by 2015; Grid parity by 2020
Ocean	2025	1st Ocean Energy Facility operational by 2018

Successful implementation of GOP's NREP is hinged on the assumption that RE policy and incentives provided for under the RE Law are in place, including all remaining activities needed to formulate required mechanisms involving coordination among stakeholders (Table 3.7). Remaining RE policies that need to be put in place, not requiring legislation, should be considered by DOE initially. Those that require legislative action, shall be considered only after assessment of the effectiveness of the RE Law in supporting the growth of the RE industry.

Table 3.7 Mechanisms for RE Law Implementation
1. Establishment and Implementation of Renewable Energy Policy Mechanisms, including:
• **Renewable Portfolio Standard (RPS)** - Rules promulgation - Implementation • **Feed-in Tariff** - FiT rates; FiT All - Implementation • **Green Energy Option Program (GEOP)** - IRR for the Program - Implementation • **Net Metering** - Formulation of Rules - Public consultations - Rules promulgation - Implementation • **RE Market** - Framework establishment - Rules for the operation of REM under WESM - Implementation • **RE Registrar** - PEMC to operationalize RE Registrar - Implementation • **Formulation of Rules on Off-grid RE Development** • **Transmission and Distribution System Development** • **Fiscal Incentives** (e.g., tax credit, tax rebates, cash incentives of RE developers for missionary electrification, etc.) - Formulation of guidelines - Implementation • **Incentives for Renewable Energy Host Communities/LGU's** - Formulation of Rules - Implementation
2. Administration of Renewable Energy Trust Fund (RETF)
• **Formulation of mechanism for fund transmittal to DOE** • **Guidelines in utilization** • **Promulgation**
3. Continuous monitoring and review of implemented RE Policies
• **Recommendations for possible amendments, if any, to RE Policy Mechanisms implemented**
4. Impact Assessment of RE Policies and mechanisms implemented

Proposed program support mechanisms include the establishment of:

- A one-stop-shop to process applications for RE service/operating contracts; to provide integrated RE services with participation of concerned government agencies; to integrate web-based RE systems infrastructure and database; and to automate RE applications.

- RE Information Exchange to provide accurate RE resource and market information to target clients such as investors and policy makers to resolve information barriers encountered in the past, including technical data for design phase, and to manage public perception on impact of rules and regulations such as the FIT system; and to implement an information-education communication (IEC) plan.

- Integrated RE Monitoring and Evaluation Center or RE M&E System to assess the effectiveness of NREP and impact of the RE Law, considering lessons from the past implementation of RE Law and RE projects with view to make appropriate recommendations for action from concerned groups.

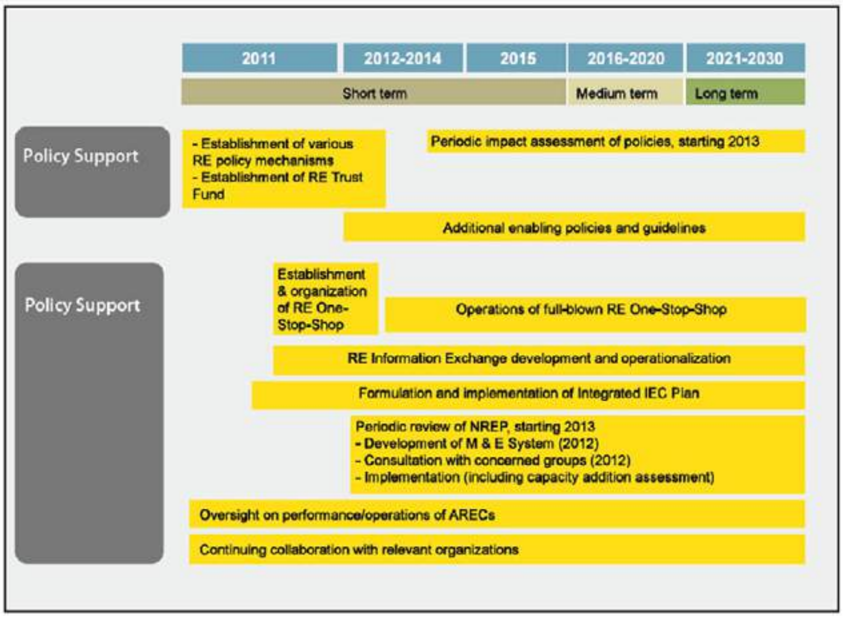
- Affiliated Renewable Energy Centers (ARECs) to serve as extension arm of DOE at the regional and provincial levels and extend the following services:
    i. Monitor operations of existing RE resource inventory;
    ii. Provide technical assistance and extension services to RE users and clients;

iii. Develop regional/provincial RE energy database;
iv. Assist in conduct of RE resource inventory;
v. Assist in conduct of IEC campaigns on RE;
vi. Undertake R&D activities on RE.

There are currently 21 ARECs in the various state universities and colleges in the country expected to play a major role in the RE M&E.

DOE shall ensure that NREP is consistent with commitments in GOP's bi-lateral and multi-lateral agreements; and continue to collaborate with local, regional and multi-lateral organizations, in particular, those relating to the ASEAN RE and energy efficiency programs. FIgure 3.3 indicates the period of implementation of the NREP.

Figure 3.3 Timeline for NREP Policy and Support Program



3.8.1 Investment Cost for NREP Program

The target of more than 9,000 MW of RE under the NREP (Table 3.8) below will require an investment of PhP1.2 trillon or USD26 billion. Of this amount, PhP17.2 billion has already been committed by the private sector for the development of indicative projects with a total capacity of 9,740.7 MW. NREP envisions funding sources to include multi-lateral financing organizations through their Clean

Technology/Clean Energy financing windows, the RE Trust Fund, bilateral partners and the private sector.

Table 3.8 Financial Requirement for RE Projects

RE RESOURCE	Indicative Capacity (MW)	Estimated Investment Requirement (Million USD)	Estimated Investment Requirement (Million PhP)
Committed Projects			
Geothermal	70.00	210.00	9,450.00
Hydro-power	27.80	69.50	3,127.50
Biomass	26.80	102.10	4,592.90
Sub-TOTAL	**124.60**	**381.60**	**17,170.40**
Indicative Projects			
Geothermal	1,425.00	4,275.00	192,375.00
Hydro-power	5,366.30	15,112.80	680,073.75
Biomass	249.90	622.40	28,010.01
Wind	2,345.00	4,690.00	211,050.00
Solar	284.00	710.10	31,955.06
Ocean	70.50	246.80	11,103.75
Sub-TOTAL	**9,740.70**	**25,622.10**	**1,154,792.57**
GRAND TOTAL	**9,865.30**	**26,038.70**	**1,171,737.97**

3.8.2 Investment Barriers to RE

As reported in the 2013 WWF report, *"Meeting Renewable Energy Targets: Global lessons from the road to implementation"*, the Philippines risks losing "over USD2.5 billion in potential RE investments, as RE project investors are experiencing frustration and uncertainty due to lack of clarity in policies, as well as delayed action in the crafting of rules and mechanisms and tedious process in the approval of pending applications. The usual prolonged pre-development timeline due to red-tape and the acquisition of approvals from myriad of government agencies encountered in power infrastructure project implementation in the country also increases cost for investment in RE.

As of October 2013, there were 371 registered and 261 pending Renewable Energy Service Contracts representing a potential investment value of USD31.5 billion for awarded contracts and another USD29.6 billion for pending contracts, capable of providing additional generation capacity of 6,065 MW for the former and an additional 3,523 MW for pending contracts *(Woottoon, 2013).*

The current national priority in RE development for Off-Grid RE systems has the goal of improving people's livelihood in the rural areas by providing them adequate and sustainable energy services. DOE still has to provide a more concrete policy with regard to deployment of RE capacities to maintain serious interest of investors in RE projects. With DOE first lowering then considering increasing NREP target capacities, this will only result in loss of investors confidence, since DOE can again simply lower currently given capacities any time in the future.

The government acknowledges that RE development is confronted with the following challenges:

- Government red tape in approval process and implementation of RE projects;
- Regulatory environment at the Local Government level;
- Social acceptability, in terms of siting;
- Impact of RE FIT to be shouldered by consumers;
- Integration of RE into grid operations; and
- Intermittent nature and reliability of RE, possibly rendering the grid unstable due to voltage fluctuations.

On the other hand, RE project developers are confronted with the following issues:

- Prolonged issuance of regulations and guidelines for RE implementation;
- Prolonged application and approval process for RE projects;
- Government's policy of allocating FIT on a first come first serve basis with approval of applications for FIT eligibility to be granted when the applicant's RE plant is installed and commissioned, resulting to high financial risks to investors and lenders;[44]
- Relatively lower approved FIT rates than recommended *(although the author believes this is justified based on current cost of RE technologies compared to previous years)*;
- Lowered cap for RE capacities to enjoy FIT rates, with three-year cap on RE capacities to 760 MW as compared to the initial target of 2,157 MW by 2015;
- Accessibility to grid of RE-sourced sites;
- Availability of constant volume of feedstock for RE biomass plants; and
- Government's policy to continue reliance on coal-fired plants for increasing capacities to meet growing demand which would be operational in the next 25 years, automatically limiting entry of RE capacities.

44 *It is now necessary to complete at least 80% of the construction of the renewable generation facility after which it is then possible to apply for Feed in Tariff eligibility. Source: The Enigma of Renewable Energy in the Philippines, Mike Wootton, November 28, 2013, http://www.energybiz.com/article/13/11/enigma-renewable-energy-philippines*

45 *Energy Sector Investment Opportunities presented by DOE Sec. Jose D. Almendras, Finance Asia, Infrastructure Philippines 2010, Investing and Financing in Public-Private Partnership Projects.*

In Luzon, DOE power sources that went on stream in 2013 comprised: coal 600 MW, bunker fuel 21 MW, and only 67.5 MW from wind, 13 MW from biomass and 1.2 MW from landfill gas, or only a total of 81.7 MW for RE as compared to 621 MW for those using coal and bunker fuel. As of June 28,2013, The DOE's approved grid-use solar power projects totalled 432.706 MW. In May 2014, the first large-scale, commercially financed and commissioned 22 MW solar power plant switched on.

The government's policy to continue to rely on fossil-fired plants is evident with the aggressive pursuit in exploration and development of its coal and natgas resources. In 2010, DOE had over thirty (30) coal mine sites in the development and operating stages; and DOE has put on the table investment opportunities for exploration and development of twelve (12) oil and gas sites, and an additional thirty (30) coal mine sites for exploration[45]. This means that additional development and operation of coal mine sites will produce GHG emissions, along with a negative impact on the carbon sink when these sites fall within forested areas.

The Rules Governing the Establishment of Renewable Portfolio Standards (RPS) issued in October 2011, provides that the DOE will increase the RPS rate by at least one percent *(1%)* of its annual energy demand within the period of ten *(10)* years from effectivity. Further, the Mandated Sector shall also increase the share of RE in their energy portfolio annually by at least one percent *(1%)* or by the annual rate to be determined by the DOE. Rather than a limited period of 10 years, the government must extend this period, as well as increase the 1% share in RE required from the Mandated Sector to further push velocity towards the 100% RE vision.

In so far as regulations and guidelines are concerned, the feed in tariff rates for RE were only approved in July 2014, and Net-metering interconnection standards and pricing methodology to usher in the implementation of the net-metering for RE program were only approved by the ERC in July 2013, or 4 and 5 years after the enactment of the RE Law, respectively.

Further, investments in RE are detrimentally affected when there is no long term commitments with power distribution utilities or the government for the purchase of the RE-generated power.

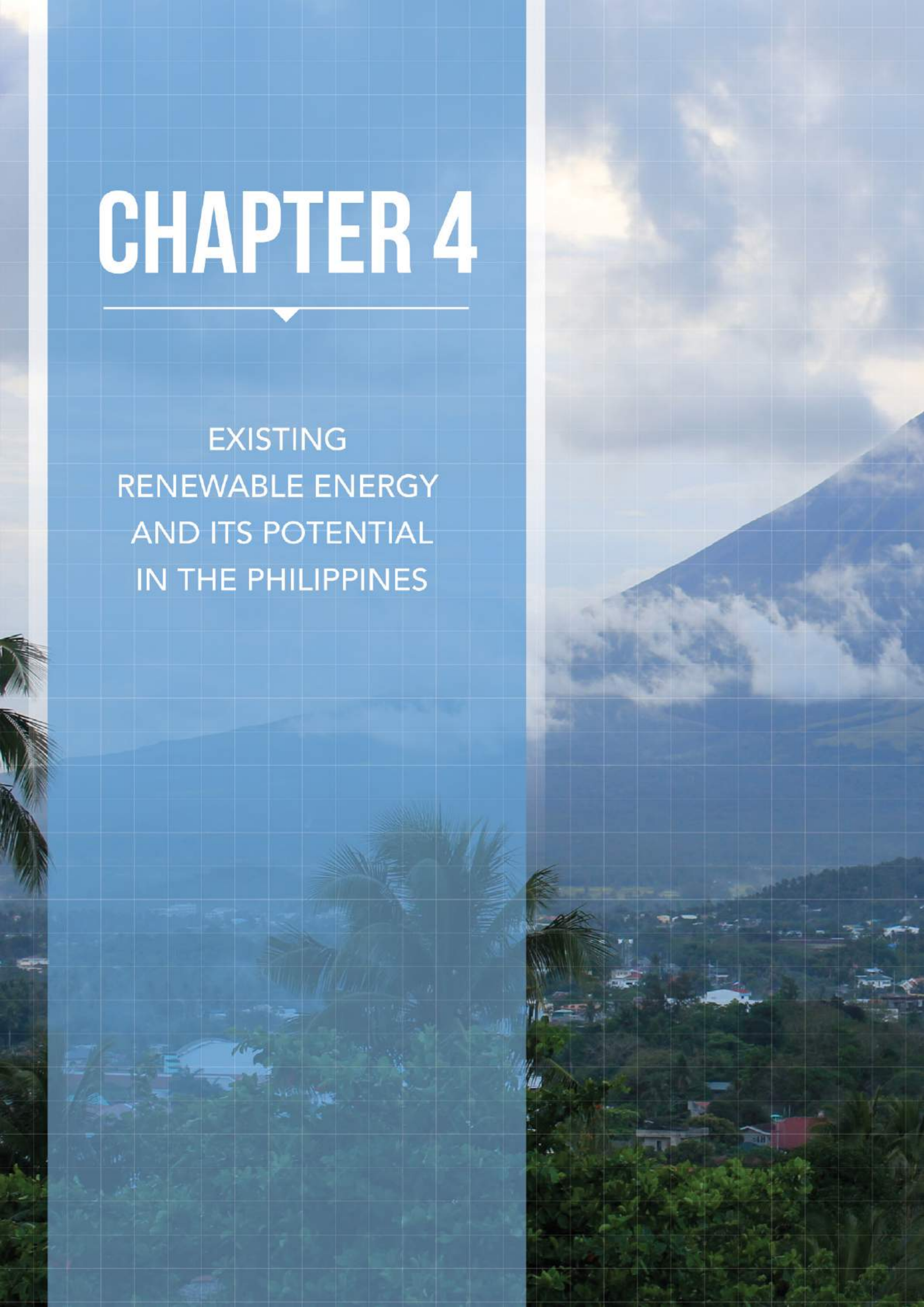
Financing of RE is another challenge, with the DOE's position that construction of RE projects will need to be at least 80% complete, before it is possible to apply for Feed in Tariff eligibility.[46]

46 *The Enigma of Renewable Energy in the Philippines, Mike Wootton, November 28, 2013,*

3.8.3 Net Metering Program

Section 10 of Republic Act No. 9513 or the Renewable Energy Act mandates the Energy Regulatory Commission *(ERC)*, in consultation with the National Renewable Energy Board *(NREB)*, to establish the net-metering interconnection standards and pricing methodology to usher in the implementation of the net-metering for RE program. NREB developed the draft net-metering rules, which after being subjected to public consultations and after a series of coordination meetings and workshops between the ERC and the NREB Technical Working Groups and the relevant stakeholders, was adopted and approved by the ERC.

ERC provides that the" Net-metering Rules allow electricity end-users who are updated in the payment of their electric bills to their distribution utility *(DU)* to engage in distributed generation. They can generate electricity from RE sources like solar, wind, biomass or such other RE Systems not exceeding 100 kW that can be installed within the end-users' premises and supply the electricity they generate in excess of what they can consume directly to their DU.



CHAPTER 4

EXISTING RENEWABLE ENERGY AND ITS POTENTIAL IN THE PHILIPPINES

4.1 INTRODUCTION

Energy is a main driver of the world economy. However, growing reliance on fossil energy sources for energy has huge economic and environmental consequences. Fossil fuel accounts for about 65% of the world's GHG emissions *(OECD/IEA 2009)* resulting in global warming.

Unfortunately, GOP's least-cost approach policy for power generation does not internalize environmental cost. DOE continues to aggressively pursue the roll-out of coal-fired power generation plants with 17 coal plants coming on line within the next few years, which will lead to higher GHG emissions. It is therefore important to review the Philippines' Renewable Energy (RE) potential.

4.2 RE POLICY - ELECTRICITY GENERATION

The Philippines has been identified as having a high potential for RE and is implementing a National Renewable Energy Program pursuant to Renewable Energy Act of 2008 *(RA 9513 or RE Law)*.

The RE Law provides for: *a) priority purchase, transmission and payment for such electricity by system operators; and b) a fixed feed-in tariff (FIT) to be paid for electricity produced from each type of RE resource over a fixed period not less than twelve (12) years*. It also provides for a "green energy option" that allows consumers to choose RE and the establishment of a net metering system. Under the net metering scheme, distributed generation, which is connected to and operated in synchronism with the on-grid distribution utilities *(DUs)* can apply to single phase or three phase generation with a maximum capacity of 100 kW.

The RE Law provides that government share in existing new RE development projects shall be equal to 1% of the gross income of RE resource developers from the sale of RE; and 1.5% of the gross income of such other income incidental to and arising from RE generation, transmission and sales of electric power except for indigenous geothermal energy. Government share is waived for communal and non-commercial operations not greater than 100 kW.

The country's National Renewable Energy Program aims to add almost 10,000 MW RE capacity by 2030. However, its initial target to add more than 2,000 MW Re capacity by 2015 was trimmed down to 1,000 MW.

4.3 CURRENT DOMINANT PLAYERS IN ELECTRICITY GENERATION

DOE's first come first serve policy, wherein FIT allocation will be given to the developers who first commence commercial operation and the absence of contractual arrangements in the pre-development phase, present challenges to prospective RE investors. This results in the uptake of larger capacity RE projects by existing players engaged in power generation and other utility services. This, unfortunately, does not foster free and fair market competition in the generation and supply sectors; does not protect the public from the adverse effects of a monopolistic situation; and could lead to unjustified higher electricity rates.

As background, the Electric Power Industry Reform Act *(EPIRA)* signed into law in 2001 and implemented in 2008, paved the way for the privatization of the power industry. It effected elimination of subsidies, mass unbundling of generation, transmission and distribution, with over 80 per cent of assets privatized today, with latest mandates in 2013 related to open access. EPIRA promised reasonable rates, but electricity prices have remained high. In January 2014, the cost of a unit of electricity from the Luzon grid was at 12.45PhP/kWh (USD0.28/kWh).[1]

EPIRA bars a company or group of related companies from owning, operating or controlling more than 30 percent of the installed generating capacity of a grid and/or 25 percent of the country's total. The biggest power players in the power sector today are San Miguel Corporation controlling about 22% of power sold to the grid, Aboitiz Power Corporation, with 21% excluding those sold directly to electric cooperatives, and the Lopez group, the largest geothermal and natural energy producer in the country.[2] Ayala and DMCI, both engaged in the water utilities sector have also invested in the power sector.

Wind projects subject to FIT are capped at 200 MW until 2015, with an additional 700 MW by 2020. As of September 2013, DOE data provide a total of 669.50 MW wind projects under FIT system, including those of Ayala and Lopez groups-81 MW Caparispisan project and 45 MW Baloi project of Northern Luzon UPC Asia Corporation *(an Ayala JV)*; 84 MW Pagudpud project, 87 MW and 63 MW Burgos projects of Energy Development Corporation (Lopez).

Solar projects subject to FIT are capped at 50 MW until 2015, and 100 MW going to 2020. In June 2014, however, DOE announced the increase in the current cap on solar energy from 50 to 500 MW to compensate for hydro sources affected by the El Niño phenomenon. As of January 2014, DOE data provide a total of 180 MW wind projects under FIT system, the largest of which is the Darong project of the Ayala group.

4.4 IMPACT OF ELIGIBILITY TO FIT SYSTEM ON ELECTRICITY COST

RE developers have an economic advantage in acquiring FIT eligibility as this secures priority purchase and transmission of, and payment for, such electricity by the grid system operators. They also enjoy a secure tariff rate based on current rate approved by ERC for the types of new RE sources.

1 *Special Country Report: The Philippines addressing the power surge, March 18, 2014, http://www.powerengineeringint.com/articles/print/volume-22/issue-3/special-country-report-the-philippines/special-country-report-the-philippines-addressing-the-power-surge.html*
2 *Infographic: Top power players in the Philippines, http://www.rappler.com/rich-media/14729-infographic-top-power-players-in-the-philippines*

Among the reasons provided by DOE for caps on and back-pedalling on caps is the fear it will increase cost of electricity, which can be supplied from cheaper coal-fired sources, as well as over-supply in dispatch capacity.

We note that approved tariff rates could be higher than necessary for economic viability, which will unnecessarily increase electricity charges to users and allow RE developers under the FIT system windfall profits, but other long term benefits to the consumers will eventually be experienced.

As an example, in 2013, a 1 MW mini-hydro developer was granted approval by ERC to supply an electric cooperative and charge PhP5.20 per kW, originally proposed at PhP5.85, for 4.3 million kW for a period of 15 years, compared to PhP5.90 approved FIT rate. Although the power generation cost from this 1 MW is higher than those of already existing power generation plants, it will have a connection to the electric cooperative's distribution system, thus grid transmission cost and related losses in transmission are also eliminated, and effectively have a lower over-all electricity cost.[3]

4.5 EXISTING AND TARGET RE CAPACITY

The Philippines has long since harnessed its water and geothermal resources for electricity generation. As of 2012, the Philippines had more than 5,400 MW installed RE capacity for generation of electricity, or more than 32% of the total 16,900 MW installed capacity. RE sources generate more than 4,500 MW, resulting in a dependable ratio of 82% of installed capacity. RE sources are dominated by hydro at 21% and geothermal at 11% of the country's total installed capacity of 16,900 MW. (Table 4.1).

Table 4.1 Installed Capacity, in MW, 2010 - 2012, DOE

YEAR	2010	% to Total	2011	% to Total	2012	% to Total
FOSSIL						
Coal	4,870	**29.77%**	4,917	**30.58%**	5,568	32.93%
Natural Gas	2,860	**17.48%**	2,861	**17.79%**	2,862	16.93%
Oil	3,190	**19.50%**	2,994	**18.62%**	3,074	18.18%
Sub-Total	**10,920**	**66.75%**	**10,772**	**63.71%**	**11,504**	**68.04%**
RE						
Biomass	40	**0.24%**	83	**0.52%**	119	0.70%
Geothermal	1,970	**12.04%**	1,783	**11.09%**	1,848	10.93%
Solar	0	**0.00%**	1	**0.01%**	1	0.01%
Hydro	3,400	**20.78%**	3,491	**21.71%**	3,521	20.83%
Ocean	0	**0.00%**	0	**0.00%**	0	0.00%
Wind	30	**0.18%**	33	**0.21%**	33	0.20%
Sub-TOTAL	5,400	33.01%	5,308	31.40%	5,403	31.96%
TOTAL	16,320	99.76%	16,080	95.11%	16,907	100.00%

3 *ERC Case No. 2013-197-RC*

YEAR	2010	% to Total	2011	% to Total	2012	% to Total
% INCREASE						
Fossil			-1.36%		6.80%	
RE			-1.47%		5.14%	

Government data for existing capacities provides the dependable ratio of fossil sources to range from 83%-96%, as compared to RE at 52% for *wind; 64% for biomass; 80% for geothermal and 85% for hydro.* (Table 4.2)

Table 4.2 Installed and Dependable Capacity, in MW, 2012, DOE

TYPE	Installed Capacity	% to Total	Dependable Capacity	% Ratio
FOSSIL				
Coal	5,568	**32.93%**	5,206	**93.50%**
Natural Gas	2,862	**16.93%**	2,760	**96.44%**
Oil	3,074	**18.18%**	2,561	**83.31%**
Sub-Total	**11,504**	**68.04%**	**10,527**	**91.51%**
RE				
Biomass	119	**0.70%**	76	**63.87%**
Geothermal	1,848	**10.93%**	1,462	**79.11%**
Solar	1	**0.01%**	-	**0.00%**
Hydro	3,521	**20.83%**	2,983	**84.72%**
Ocean	0	**0.00%**	-	**0.00%**
Wind	33	**0.20%**	17	**51.52%**
Sub-TOTAL	**5,522**	**32.66%**	**4,538**	**82.18%**
TOTAL	**17,026**	**100.70%**	**15,065**	**88.48%**

4.6 CAP FOR NEW RE TO 2015

Energy sector decision makers have concerns with regard to dispatch vis-a-vis intermittent supply of RE source, as well as the perceived high cost of solar energy. This has resulted in a more cautious approach in NREP implementation with the reduction of its given FIT based RE targets. The target for additional RE by 2015 of about 2,000 MW was initially reduced to about 1,400 MW, then further reduced to 760 MW. (Table 4.3)

The current policy thrust of DOE and existing development activity are primarily focused on coal-fired plants in terms of megawatts to supply future demand. Oil-based plants have been introduced to fix the shortage in supply in the Mindanao grid, blamed on drought events affecting supply of hydro-electricity. Additional entry of fossil based sources will naturally limit entry of on-grid RE sources.

Table 4.3 Comparative RE Installed Capacity and Targets, NREP 2009, DOE 2012 and DOE CAP 2012-2015 Subject to FIT, in MW				
	Existing RE	NREP Target	DOE Target	DOE Given Cap
YEAR	2010	by 2015	2012-2015	2012-2015
Hydro(*)	3,333	**220**	310	**250**
Geothermal	1,972	**343.3**	50	
Solar	1	**276.7**	269	50
Wind	33	**1,048**	678	**200**
Biomass	30	**269**	81	**250**
Ocean	0	**0**	0	**10**
TOTAL	**5,369**	**2,157**	**1,388**	**760**

(*) New hydro qualified for FIT covers run of river only.

4.7 RE POTENTIAL CAPACITY

In 2008, the DOE reported RE sources contributed to 43% to the country's installed capacity, among the highest in Southeast Asia. These are mostly from hydro and geothermal sources, contributing to about 61% and 37% respectively of the existing 5,500 MW RE capacity that year, with additional supply from new RE sources *(biomass at 68 MW; solar at 5 MW; and wind at 33 MW.)* Existing RE capacity as of 2008 and given target for additional RE, doubling its RE capacity, are presented in Table 4.4.

Table 4.4 Existing RE Capacity and Additional Capacity Target, 2008[4]		
Resource	Existing Capacity (MW)	Target
Geothermal	2,027	1,070
Hydro	3,367	3,400
Wind	33	515
Solar	5	30
Biomass	68	200
Ocean	0	120
TOTAL	**5,500**	**5,355**

Source: Department of Energy (DOE)

DOE 2008 estimates show that the Philippines has at least 250,000 MW of RE potential, excluding that of solar. Notable among these are: 170,000 MW of untapped ocean energy potential and 76,600 MW of wind energy potential; and its untapped vast potential of solar energy. (Table 4.5)

4 Harnessing the Potential of Philippine Renewable Energy, Capital Research, February 2010, Issue No. 1, First Metro Investment Corporation.
5 Harnessing the Potential of Philippine Renewable Energy, Capital Research, February 2010, Issue No. 1, First Metro Investment Corporation.

Table 4.5 RE Potential, 2008

Resource	Potential Capacity (MW)
Geothermal	1,200
Hydro	10,500
Wind	76,600
Solar	Untapped vast potential
Biomass	235.7
Ocean	170,000

Source: Department of Energy

To compare, RE potential estimated for the Philippines in a World Bank (WB) 2010 report[6] show a potential of 12,000 MW for the Philippines as compared to estimates for Thailand at 6.7 thousand MW and Vietnam at 26.4 thousand MW, Indonesia at 161 thousand MW and China at 840 thousand MW (Table 4.6).

The WB 2010 report estimates geothermal to be double than that estimated by DOE, at 3,000 compared to 1,200 MW; biomass at 500 compared to 236 MW; but gave lower estimates for hydro at 3,000 against 10,500 MW; and only 5,500 MW for wind against DOE's estimate of 76,600.

Table 4.6 Capacity for RE Resources, Selected East Asian Countries, in MW

RE TECHNOLOGY	Philippines	Thailand	Vietnam	Indonesia	China
Biomass	500	4,400	1,000	50,000	60,000
Geothermal	3,000	0	1,400	0	0
Solar	Excluded	Excluded	Excluded	Excluded	Excluded
Hydro	3,000	700	22,000	75,000	400,000
Ocean	Excluded	Excluded	Excluded	Excluded	Excluded
Wind	5,500	1,600	2,000	9,000	380,000
TOTAL	**12,000**	**6,700**	**26,400**	**161,000**	**840,000**

Source: Winds of Change, East Asia's Sustainable Energy, Xiaodong Wang, Noureddine Berrah, Subodh Mathur, Ferdinand Vinuya, World Bank, 2010

4.8 BIOMASS

Biomass has been a traditional source of energy in the Philippines, primarily used for cooking in households and as source of heat in cooler, upland areas; and to fuel ovens, kilns, furnaces by industry. Until today, households in the lower income level and rural areas rely on biomass, and will continue to do so with the rising cost of electricity and liquified petroleum gas *(LPG)*.

Modern biomass technologies used mostly for generation of electricity and transportation such as bioethanol and biodiesel are already existing in the country. As of January 2014, awarded biomass

6 *Winds of Change, East Asia's Sustainable Energy, Xiaodong Wang, Noureddine Berrah, Subodh Mathur, Ferdinand Vinuya, World Bank, 2010*

projects have a total installed capacity of 150.60 MW and a potential capacity of 285.15 MW, with twenty four *(24)* facilities in Luzon with a total installed capacity of 56.60 MW and a potential capacity of 123.15 MW; nine *(9)* in the Visayas with a total installed of 70 MW and potential of 105 MW; and seven *(7)* in Mindanao with a total installed capacity of 24 MW and potential of 57 MW. Certificates of Registration have been issued to twelve *(12)* proponents with installed capacity of 143.18 MW *(DOE, 2014)*.

4.8.1 Biomass Sources and Potential

The Philippines, being predominantly an agricultural country, has an abundant supply of biomass from agriculture residue. These include rice hull, sugarcane bagasse, cane trash and coconut shells, husk, and coir, corn husk and cobs; as well as domestic livestock manure.

A study prepared by the Society for the Advancement of Technology Management in the Philippines *(SATMP)* published in 2009,[7] estimated the volume of residues from rice, coconut, palm oil, sugar and wood industries at 16 million tons per year. Bagasse, coconut husks and shell can account for at least 12 percent of total national energy supply as reported in an EC-ASEAN COGEN Programme study. Further, a World Bank-Energy Sector Management Assistance Program study states potential from residues from sugar, rice and coconut is estimated at 90 MW, 40 MW, and 20 MW, respectively. Detailed calculations for RE Biomass potential are presented in a separate chapter in this study report.

4.8.2 Cost of Biomass Energy Generation

Project costs of recently awarded biomass projects by DOE, two of which are subject to FIT, are enumerated in Table 4.7.

Table 4.7 Project Cost of Awarded DOE Biomass Projects

PROPONENT/TYPE	Location	Installed Capacity in MW	Total Cost in PhP	Cost per Installed Capacity kW in PhP
1. San Jose City 1 Power Corp. *Subject to FIT, Rice Hull*	San Jose, Nueva Ecija	9.8	1,234,000,000	125,918
2. Isabela Biomass Energy Corp. *Subject to FIT, Rice Hull*	Isabela	17.5	1,680,000,000	96,000
3. Asian Energy System Corp. *Landfill Methane*	Consolacion, Cebu	3.6	199,000,000	55,278
4. San Carlos Biopower, Inc. *(with existing 8.3MW Plant) Bagasse*	San Carlos, Negros Occ.	18	3,500,000,000	194,444

Sources of Costs: 1,3, 4 - DOE reports; 2 - NEDA, Public-Private Partnership (PPP) Priority Projects in Power, Energy and Electrification

7 *Philippines, Harnessing Biomass for Off-Grid Rural Electrification, July 2009 http://egs.apec.org/more-articles/140-philippines-harnessing-biomass-for-off-grid-rural-electrification*

The SATMP study published in APEC EGS in July 2009[8] estimates investment costs and levelized energy costs of similar installations with much lower generation capacities (Table 4.8 and 4.9).

Table 4.8 Comparative Cost for Rice Hull Biomass Thermal Plant, SATMP, in PhP

TYPE OF SYSTEM	Rice Hull 1	Rice Hull 2
Capacity (kW)	3kW	6kW
Fuel	Rice Hull	Rice Hull
Location	Santiago, Isabela	Cabanatuan, Isabela
Feedstock Source	71 Rice Mills within a radius of 10 kms	71 Rice Mills within a radius of 15 kms
Bulk Density of Rice Hull	125kg/cu.m.; one truckload can carry 25 cu.m. or 3.2 metric tons per trip with transport cost of P63.75 per k.m.	
OPERATING PERIOD		
Rice Mills	8 hours/day, 210 days or 7 months, due to seasonality of rice farming	
Power Plant	24 hours/day, 365 days a year	
Heating Value of Rice Hull	16.80MJ/kg	
Feedstock Volume	12,489 Mt	23,093Mt
No. of Trips		7,000
Investment Cost	P311,000,000	P436,500,000
Investment Cost per kW	103,667	82,750
ANNUAL COSTS		
Transport	1,833,932	6,385,500
Materials	1,873,368	3,441,312
Operations & Maintenance	1,400,000	2,235,000
Life-cycle Cost	584,229.60	961,893
Levelized Cost per kWh	2.98/kWh	2.45/kWh
Estimated Annual Revenue		P80,800,000
Estimated Interest Cost		52,500,000
Interest Charges Factor		10% for 20 Years
Estimated Annual Net Profit		P16,200,000

Note: "The data used in the simulation are based on the Biomass Atlas of the Philippines which provides estimates on available biomass resource, costs of transporting biomass fuel, and prices of technologies. The estimates have been carefully validated using ground data of operating rice or sugar mills within a certain economical radius of potential sites. In addition, the use of Differential Geo Positioning System increases the reliability of the estimates, especially on transport costs that were based on actual road network in rural areas. Nonetheless, the estimates remain theoretical as the feasibility of setting up renewable power plants of this magnitude in rural areas remains to be proven." (SATMP Study)

8 The report is undated, but published in 2009 APEC Environmental Goods and Services Information Exchange. http://egs.apec.org/more-articles/140-philippines-harnessing-biomass-for-off-grid-rural-electrification

Table 4.9 Comparative Cost for Bagasse Power Plant, SATMP, in PhP

TYPE OF SYSTEM	Bagasse 1	Bagasse 2
Generating Units	2 x 85MWe and 1 x 60MWe	1 x 85MWe, 1 x 6MWe and 1 x 3MWe
Cost of Gensets in USD	USD82,930,000	USD63,640,000
Capacity (kW)	220-MW	97-MW
Site Considered	Victorias, Northern Negros	Southern Negros
Feedstock Volume	1,114,432 DM Bagasse tonnage	448,016 DM Bagasse tonnage
Load per Truck	30 tons per truckload trip	
Cost of Transport	P63.75 per k.m.	
Supply Source	18 mills with rated capacity of 98,729 ton can per day	4 mills
Operating Period	365 days per year	
Plant Efficiency	50%	
Bagasse Heating Value	12.5MJ/kg.	
INVESTMENT COST		
In Philippine Pesos	P11,475,000,000	P4,954,000,000
Investment Cost per kW	52,159	52,702
ANNUAL COSTS		
Transport	421,031,149	270,638,893
Materials	344,883,364	150,956,399
Operation & Maintenance	51,640,000	24,770,000
Life-cycle Cost	26,255,603,872	12,014,324,022
Levelized Cost per kWh	1.82/kWh	1.95/kWh

Cost assumptions: (1) 20-year life of the system; (2) 12% capital recovery factor; (3) 12% cost of loan with repayment over the life of the system.

4.9 GEOTHERMAL

The Philippines hosts several volcanic areas, with abundant geothermal resources. Since the first geothermal plant *(3 MW)* in Leyte started operations in 1977[9], the Philippines has become the second largest producer of geothermal power in the world, next to the United States. The geothermal plants installed capacity of about 2,000 MW in 2010 is expected to increase by an additional of 340 MW by 2015.

Tiwi-Makban is composed of the 289 MW Tiwi plants in Albay and the 458MW Makban facilities in Laguna and Batangas which are currently operated by AP Renewables, Inc., a subsidiary of Aboitiz Power Corporation.

9 *The Philippines geothermal success story, Birsic, R. J. , September 1980, http://adsabs.harvard.edu/abs/1980GeoE....8...35B*

In 2001, DOE projected that for the next ten years, geothermal energy would displace an average of 25 MMBFOE of imported fuel yearly, equivalent to foreign exchange savings of about USD588.4 million *(based on an average crude price of USD25 per barrel)*. With an estimated untapped geothermal energy of about 2,600 MW, plans to develop proven reserve areas will make possible the availability of a maximum capacity of 1,200 MW of this estimated potential. Of these, about 610 MW are situated within service contract areas belonging to the government-owned Philippine National Oil Corporation-Energy Development Corporation *(PNOC-EDC)*.[10]

PEP 2006-2014 identifies 20 potential geothermal sites with an estimated yield of 750 MW (Table 4.10).

Table 4.10 Potential Geothermal Sites in the Philippines, PEP 2006-2014

REGION	Project	Location	Potential Capacity (MW)	Year Available
CAR	Batong Buhay	Kalinga	60	2011
	Buguias-Tinoc	Benguet-Ifugao	60	2012
	Daklan	Benguet	20	2012
II	Baua	Cagayan	20	2012
III	Natib	Natib, Bataan	40	2010
IV-A	Mabini	Mabini, Batangas	20	2010
IV-B	Montelago	Mindoro Oriental	40	2010
V	Tanawon	Albay and Sorsogon	40	2009
	Manito-Kayabon	Albay and Sorsogon	40	2011
	Rangas	Albay and Sorsogon	40	2012
VI	Mandalagan	Negros Occidental	20	2014
VII	Dauin	Negros Oriental	40	2011
VIII	Biliran	Biliran, Leyte	20	2009
	Cabalian	Cabalian, Southern Leyte	100	2011
IX	Lakewood	Zamboanga del Sur	40	2012
XI	Amacan	North Davao	20	2013
	SE Apo	Davao del Sur	40	2014
XII	Mindanao Geothermal Optimization	North Cotabato	20	2009
	Mindanao Greenfield*	North Cotabato	50	2011
	NW Apo	North Cotabato	20	2011
TOTAL			**750**	

Projects undertaken and operated by Energy Development Corporation (EDC), currently the world's largest vertically integrated geothermal company have a total installed capacity of more than 1,100 MW. EDC is currently exploring/developing an additional three sites with a potential of 120 MW (Table 4.11).

10 *https://www.doe.gov.ph/renewable-energy-res/geothermal*

Table 4.11 Geothermal Energy Projects of EDC in the Philippines

GEOTHERMAL PRODUCTION FIELD, LOCATION, CONTRACT AREA AND TOTAL CAPACITY	Production Wells	Reinjection Wells	Pipe Network (km)	Plant Capacity (MW)
BacMan Location: **covers the boundary of Legaspi City, Sorsogon City, Bacon District of Sorsogon City and the town of Manito Albay in the Bicol Region, South of Luzon** GRES Contract Area: **18,870 hectares** Total Plant Capacity: **130 MW**				
Bacman I	22	9	28.6	110
Bacman II	8	7	3.7	20
Mindanao Location: **Kidapawan City, North Cotabato** GRES Contract Area: **701 hectares** Total Plant Capacity: **106 MW**				
Mindanao I	10	7	10.4	52
Mindanano II	9	2	9.8	
Northern Negros Location: **North Western part of Mt. Kanlaon, approximately 60 kms. from Bacolod City** GRES Contract Area: **4,310 hectares** Total Plant Capacity: **49 MWe**				
Northern Negros	10	3	6.1	49.4
Southern Negros Location: **Valencia, Negros Oriental** GRES Contract Area: **64,299 hectares** Total Plant Capacity: **192.5 MW**				
Palinpinon I	28	10	19.8	112.5
Palinpinon II	16	6	16.1	80
Leyte (World's largest wet steamfield) Location: **Ormoc City and Kananga Municipality in West Leyte** GRES Contract Area: **50,361 hectares** Total Plant Capacity: **over 700 MW**				
Tongonan 1	27	6	13.2	112.5
Upper Mahiao	29	10	28	125
Malitbog	30	12	16.3	232.5
Mahanagdong	30	14	30.3	180
Leyte Optimization				50.9
TOTAL Operational in MW				**1,124.8**

4.9.1 COST OF GEOTHERMAL ENERGY

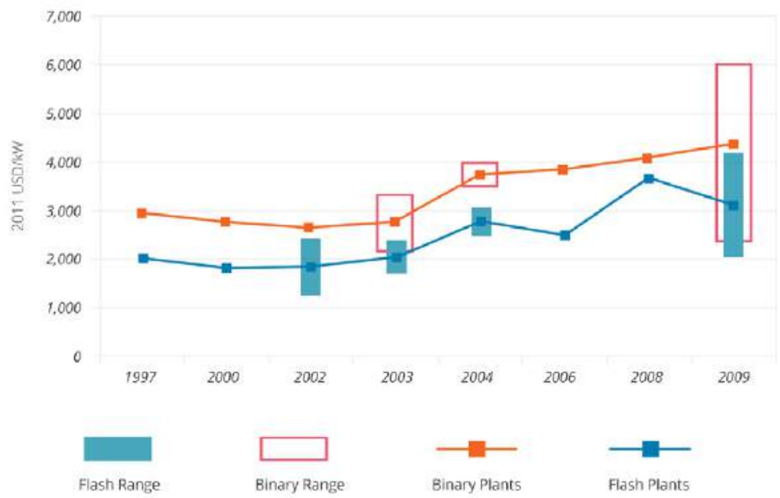
In 2008 capital costs for greenfield geothermal flash plant developments ranged from USD2,000/kWe[11] to USD4,500/kWe, with lower temperature binary developments at USD2,400->5,900/kWe. Capital cost pay-back times for ground source heat pumps typically range from four to eight years in Europe.

In the International Renewable Energy Agency (IRENA) 2012 report, the cost of developing geothermal electricity projects has risen with other engineering costs, particularly due to increased costs of procuring drilling rigs. It reports that the average costs for condensing flash power plants are estimated to be around

11 kWe = kilowatt-electric
= one thousand watts of electric capacity

USD2,000 to USD4,000/kW, and for binary cycle plants are in the range USD2,400 to USD5,900/kW *(Bromley et al., 2010)*. Capital costs for geothermal power stations from 1997 - 2009 are shown Figure 4.1. Costs can be lower, especially where capacity is being added at an existing geothermal reservoir which is already well characterized and existing infrastructure can be utilized, as well as when adjacent resources or untapped potential in an already operating field are being developed.

Figure 4.1 Installed Costs for Geothermal Power Stations, 1997-2009, IRENA



Source: IPCCC, 2011.

In the Philippines, EDC reported an investment cost of USD225 million, in the 50 MW Mindanao 3 geothermal project, following the higher end of given rule of thumb that as much as USD4.5 million will be needed to produce a MW of geothermal power *(reported to cost USD250 million by DOE)*.[12] EDC's other geothermal projects - *a) 50 MW Nasulo Geothermal Project in Nasuji, Valencia, Negros Oriental was reported to cost USD91 million, or USD1.82. MW;* and *b) Mindanao III with an installed capacity of 50 MW, scheduled for commissioning in June 2016 was reported to cost USD250 million or USD5 million/MW.* The 20 MW Maibarara Geothermal Plant located in Barangay San Rafael, Sto. Tomas, Batangas scheduled commercial operations in October 2013 was reported to cost USD79.4 million *(PhP3.4 billion at PhP42.80 to USD1)* or USD3.97 million per MW.[13]

12 *EDC disclosure to PSE dated May 15, 2013*
13 *Management Association of the Philippines, presentation of Sec. J. Petilla, DOE Committed Projects, DOE, Electric Power Industry Management Bureau*

4.10 SOLAR

Solar energy systems have been in existence in the Philippines, primarily for heating water, and electrification of remote rural areas, where the costs of grid extension and maintenance of conventional power supply systems can be prohibitive. Photovoltaic *(PV)* converts solar radiation directly into electricity. PV systems are modular and can be employed for both small and large-scale power generation. PV modules have proven to have high reliability, long lifetime, low maintenance cost and zero fuel requirement.

With the advent of the net metering scheme, households and businesses with small RE facilities such as a solar PV panel systems can now get credit for any surplus energy they supply to the distribution system. The Manila Electric Company has installed its own 6.16 kWp grid-tied system providing AC net of 4.43 kW AC. The Asian Development Bank *(ADB)*, has also installed its own solar energy system providing initially 3.5 percent of total electricity needs of ADB Manila offices[14].

4.10.1 Solar Energy Potential

The main advantage of solar over other RE technologies is its virtually inexhaustible source of power. The geographical location of the Philippines enables it to harness solar energy because of high daily solar radiation, with low seasonal variation of solar radiation. The solar potential is greatest during the summer months of May to July when the sun is positioned over the Northern Hemisphere. Conversely, the months with the weakest sunlight are November to January *(SATMP-Solar)*[15].

A National Renewable Energy Laboratory study *(NREL)* study shows that solar radiation nationwide can produce a potential average of 5.0-5.1 kWh per m^2 per day (DOE, 2007), ranging from 128-203 watts per m^2, or an average of 161.7 watts per m^2, based on sunlight duration. This would translate to potential power generating capacity of 4.5-5.5 kWh per m^2 per day.

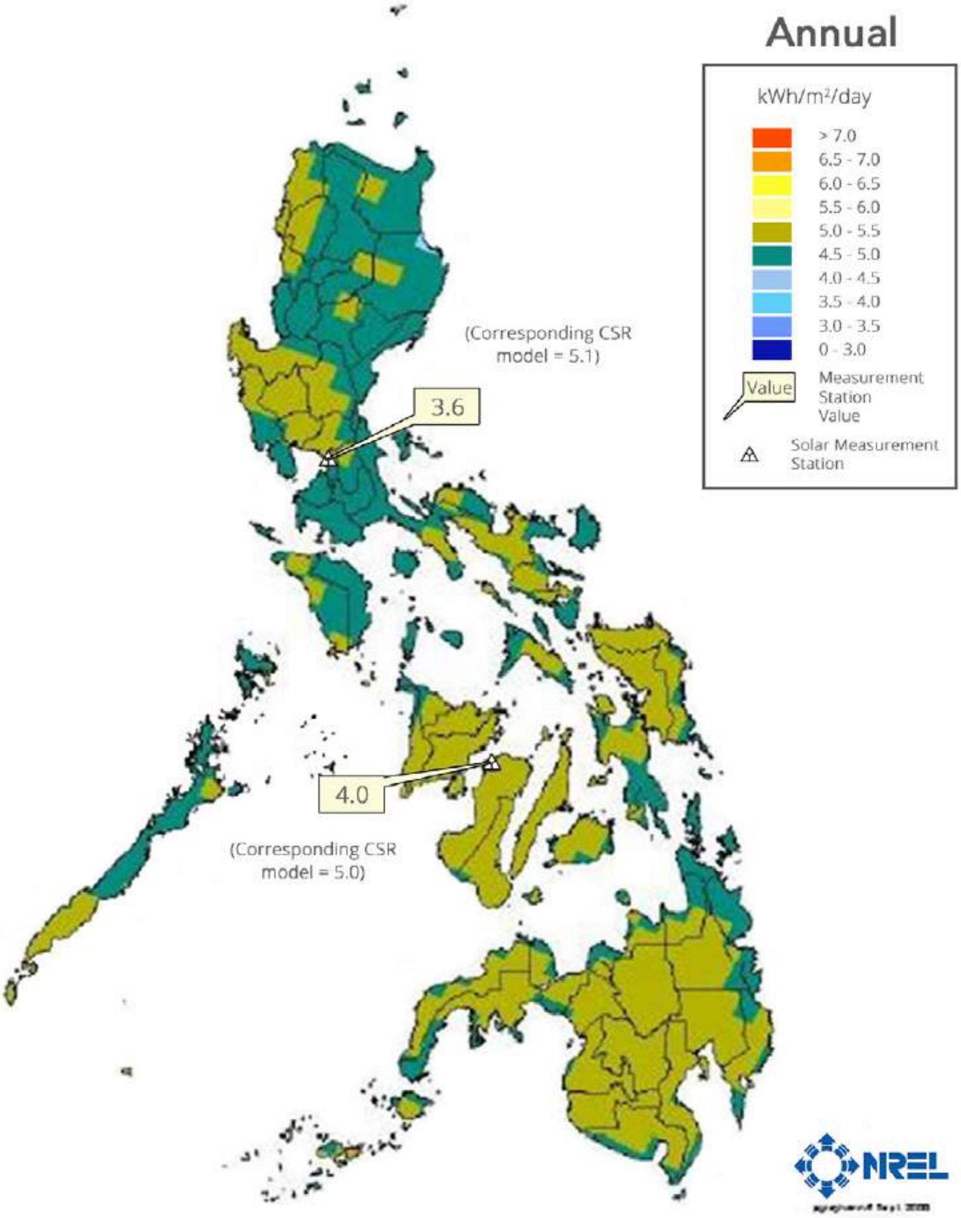
Both the northern and southern parts of the country would be ideal locations for installing solar power facilities. The northern part of the Philippines has enough sunlight to generate an average of 4.5-5 kWh per m^2 per day, while areas in the south have the potential to produce an average of 5-5.5 kWh per m^2 of solar power per day.[16] (Figure 4.2)

14 *MERALCO's solar power center leads the way for net metering system, Philippine Daily Inquirer, September 28, 2013.*

15 *Philippines: Harnessing Solar Energy for Off-grid Rural Electrification, Prepared by the Society for the Advancement of Technology Management in the Philippines with the support of the Department of Energy and U.S. Agency for International Development as part of the Technical Assistance to the DOE for Enhancing Private Sector Participation in Renewable Energy. July 2009 http://egs.apec.org/more-articles/142-philippines-harnessing-solar-energy-for-off-grid-rural-electrification*

16 *It's More Sun in the Philippines, Facts and Figures on Solar Development in the Philipines Project Development Programme (PDP) Southeast-Asia, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in cooperation with Renewable Energy Developers Center (REDC) and WWF-Philippines.*

Figure 4.2 Annual Solar Potential in the Philippines in Two (2) Measurement Stations, NREL



4.10.2 Solar Technologies

Solar energy uses energy from the sun to generate electricity and to heat water. Solar energy is converted into three types of energy: solar thermal, solar photovoltaic (PV) and concentrated solar. Solar thermal energy refers to solar energy converted to heat. An overview of solar technologies is presented in Figure 4.3.

Own-use solar-PV facilities have been installed in the country, initially for water heating, and now for electrical power for street lighting, households, water pumps and mobile phone cell sites. Institutions are also now employing solar-powered air-conditioning system and Solar PV Generator Systems, such have been installed in a hospital in Makati City, among others.

The concentrated photovoltaic *(CPV)* is a type of solar thermal energy used to generate electricity, most often aimed at large-scale energy production. Concentrated solar power technologies use lenses or mirrors to reflect and concentrate sunlight onto receivers *(a small beam)*. The concentrated heat is then converted to thermal energy, which in turn produces electricity via a steam turbine or heat engine driving a generator.

Photovoltaics *(PV)* is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. Photovoltaic solar panel is the most commonly used solar technology to generate electricity energy.

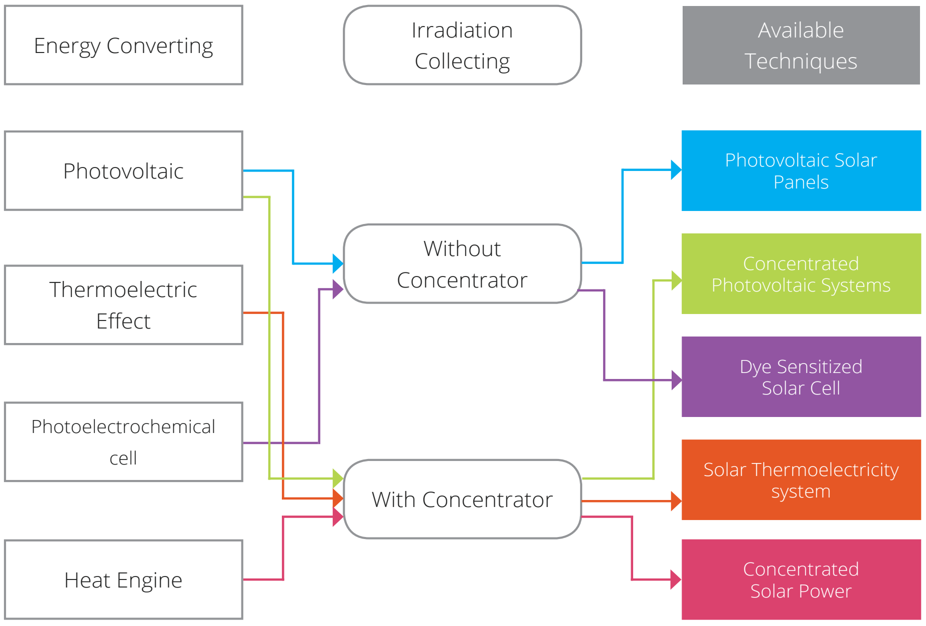
4.10.3 Cost of Solar Energy

The first on-grid solar-PV power plant project was undertaken by Cagayan Electric Power & Light Co., Inc. (CEPALCO) in Cagayan de Oro City with a grant from the Global Environment Facility (GEF) of USD4 million. Total cost was USD5.8 million.[17] It began its operation in 2004, serving 900 residential users and exporting a total of 4,169,100 kWh or an average of 1,389,700 annually, 10% higher than the expected annual energy generation of 1,261,400 kWh. The plant was expected to expand its total capacity to 10 MW.

17 *Case Study 4, Cagayan Electric Power & Light Company, IFC*

Since 1975, much of the work on PV is focused on increasing the efficiency and stability of different PV cell technologies and on reducing manufacturing costs. As a result, prices of solar technologies continue to drop.

Figure 4.3 Overview of Solar Technologies



Photovoltaic Solar Panels	Most commonly used techniques in today's market
Concentrated Photovoltaic Systems	The highest efficiency ever achieved in lab
Dye Sensitized Solar Cell	Biomimics techniques based on cheap organic materials
Solar thermoelectricity system	Based on application of thermoelectricity materials
Concentrated Solar Power	Commonly used based on the application of mature heat engine

Yinghao Chu, GENI

Calculation of investment costs for a 20 MW solar plant *(PV)* for the Philippines as presented by PV2 Energie GmbH in a GIZ RE forum excluding pre-development cost, permits, cost of land, access and connection to grid is presented in Table 4.12.

Table 4.12 Investment Costs for a 20-MW Solar PV Plant for the Philippines, PV² Energie GmbH

Investment Cost			
Solar Modules	756,000,000	PhP	52%
Inverters	180,000,000	PhP	12%
Mounting System	120,000,000	PhP	8%
Installation Costs	120,000,000	PhP	8%
Grid Connection (AC)	204,000,000	PhP	14%
Financing Costs	19,680,000	PhP	2%
TOTAL	1,435,980,000	PhP	100%

This translates to a cost of about USD1,600 per kW (Table 4.13). The average production of the 20 MW PV plant, 24/7, 365 days per year, given a utilization factor of 17% results to electricity production of 3,400 kWh per hour. Land area requirement is 6.8 m² plus 20% reserve per kW peak or a total area of 17 has.

Table 4.13 Cost per kW for 20-MW Solar PV Plant in the Philippines, PV2 Energie GmbH

INVESTMENT COST	
Cost in Philippine Pesos	1,435,980,000
Conversion Rate Pesos to USD	45
Cost In USD	31,910,667
Cost per MW, in USD	1,595,533
Cost per kW peak	**1,595.53**
Utilization Factor	17%
Average kWh per hour	3,400.00

Excludes pre-development cost, permits, cost of land, access and connection to grid.

The cost per kW shown for a 20-MW solar PV plant as presented by PV2 Energie GmbH is only at USD1,600 per kW. However, cost per kW in several ongoing and proposed solar projects in the Philippines shown in Table 4.14, range from USD2,045 - USD4,317 per installed kW.

Table 4.14 Comparative Project Cost of Solar Plants in the Philippines

PROPONENT/LOCATION/LAND AREA	Installed Capacity	Project Cost in USD	Cost per MW in USD	Cost kW in USD
1. Mirae Asia Energy Corp. Currimao, Ilocos Norte	20	50,000,000	2,500,000	2,500
2. ATN Philippines Solar Energy Group, Inc. Macabud, Rodriguez, Rizal *324 has.*	30	129,529,895	4,317,663	4,318
3. PhilNewEnergy (JV Ayala/Mitsubishi) Purok Cardava, Barangay Darong, Municipality of Sta. Cruz, Davao del Sur *150 has.*	42	149,312,000	3,597,880	3,555
Subject to FIT	92			
4. Phil Solar Farm Leyte, Inc. Ormoc, Leyte *44 has.*	30	72,000,000	2,400,000	2,400
Indicative	30			
5. San Carlos Solar Energy, Inc. Negros Occidental *20 has.*	22	45,000,000	2,045,455	2,045
TOTAL	144			

Conversion Rate: PhP43.82=USD1
Sources: DOE, San Carlos Solar Energy Inc.

4.11 HYDRO (RUN OF RIVER)

While conventional hydropower projects require dams for water storage, run of river hydro uses water within the natural flow range of the river and gravity to generate electricity, requiring little or no impoundment. A portion of a river is diverted downward through a pipeline or tunnel to power turbines and generate electricity. It is estimated that a 5 MW small hydro power plant that can supply power to about 5,000 families, replaces 1,400 tons of fossil fuel and avoids emissions of 16,000 tons of CO_2 and more than 100 tons of SO_2 annually.[18] Run-of-river plants are common to small hydropower and are often seen as the most sustainable form of hydropower as these avoid large dams to store water.

Republic Act 7156, also known as the Mini-hydroelectric Power Incentive Act, promulgated on 12 September 1991, provides the necessary incentives and privileges to mini-hydroelectric power developers. Apart from the incentives provided under RA 7156, privately-owned mini-hydroelectric power plants shall be eligible for foreign loans and grants without further evaluation by the National Economic and Development Authority (NEDA).[19]

18 *Harnessing Hydro Energy for Off-Grid Rural Electrification, Prepared by the Society for the Advancement of Technology Management in the Philippines with the support of the Department of Energy and U.S. Agency for International Development as part of the Technical Assistance to the DOE for Enhancing Private Sector Participation in Renewable Energy.*
19 *Harnessing Hydro Energy for Off-Grid Rural Electrification, Prepared by the Society for the Advancement of Technology Management in the Philippines with the support of the Department of Energy and U.S. Agency for International Development as part of the Technical Assistance to the DOE for Enhancing Private Sector Participation in Renewable Energy.*

It should be noted that in the Philippines, the El Niño phenomenon has affected power production of hydroelectric plants, particularly in Mindanao and Luzon.[20] Deforestation and inappropriate land use practices also disrupt the hydrological condition of watersheds. Likewise, population growth, pollution and indiscriminate development deplete water sources, bringing about flash floods and prolonged drought, accelerated soil erosion, siltation of water bodies and reservoirs, and poor water quality.[21] Integrated watershed management is key to preserving water resources. But particularly for hydroelectric power generation, to maintain and enhance stream flow to deliver given plant capacities, it is important to rehabilitate pertinent deforested areas and protect forested areas especially where headwaters of rivers emanate.

4.11.1 Run of River Hydro Technology

Run-of-river hydroelectric plants do not have the same kinds of adverse effect on the local environment as large-scale hydro, as the "dam" or barrage is quite small, usually just a weir, and little or no water is stored. These facilities use conventional hydropower technology to produce electricity by diverting river flow through turbines that spin generators before returning water back to the river downstream.

4.11.2 Potential for Run of River Hydro Technology

The Philippine climate and its rainfall pattern, with a mean annual rainfall of the Philippines varies from 965 mm to 4,064 mm, provides a good potential for hydropower. A 1999 assessment of hydropower potential of the Philippines is provided in Table 4.15.

As early as 1937, The first hydroelectric plant in the country, the Escudero Hydroelectric Power at Villa Escudero has generated power for the Escudero coconut plantation in Tayabas, Quezon. Many hydropower plants across the country have been developed since then.

The small hydro capacities in the Philippines is provided by Jose D. Logarta, Jr., Philippine Association of Small-sale Hydro Developers, Inc. *(Pass-Hydro)* is presented in Figure 4.4. Mr. Logarta reports that all of the run-of-river small hydropower plants are in private hands. About 888 sites have been identified as having mini-hydropower potential totaling 1,847 MW, the remaining 29 MW being micro hydropower potential.

20 *16th Status Report on EPIRA Implementation*
21 *Watershed Management: Saving Forests, Storing Water for the Future, Service Delivery with Impact: Resource Books for Local Government, Aileen de Guzman and Joyce Reyes, Copyright @2003 Philippines-Canada Local Government Support Program*

Table 4.15 Philippine Hydropower Potential, DOE, 1999 (SATMP Study)

STATUS	Type	No. of Plant/ Sites	Capacity		Annual Energy	
			MW	%	GWh	%
Definite Design	Large	3	1,130.00	8.40	3,312.00	7.60
	Small	2	43.00	0.30	211.10	0.45
	Mini	40	56.00	0.40	245.20	0.56
	Sub-TOTAL	**45**	**1,229.00**	**9.20**	**3,768.30**	**8.70**
Feasibility Study	Large	17	3,229.80	24.10	10,617.50	24.45
	Small	41	873.10	6.50	3,113.10	7.20
	Mini	25	88.70	0.70	388.60	0.90
	Sub-TOTAL	**83**	**4,191.60**	**31.20**	**14,119.20**	**32.50**
Pre-FS and Desk Study	Large	37	4,646.00	34.60	11,957.00	27.50
	Small	93	1,721.00	12.80	6,676.50	15.40
	Mini	823	1,638.90	12.20	6,906.60	15.90
	Sub-TOTAL	**953**	**8,005.90**	**59.60**	**25,540.10**	**58.80**
TOTAL		1,081	13,426.50	100.00	43,427.60	100.00

Source: Guide on Mini-Hydropower Development in the Philippines, Mini-hydro Division, Energy Utilization Management Bureau, Department of Energy, February 1999.

Figure 4.4 Small Hydro Capacities in the Philippines

Source: World Small Hydropower Development Report 2013 South-Eastern Asia, UNIDO - ICSHP[22]

22 Liu, H., Masera, D. and Esser, L., eds. (2013). World Small Hydropower Development Report 2013. United Nations Industrial Development Organization; International Center on Small Hydro Power. Available from www.smallhydroworld.org.

Barriers to the development of these small hydropower plans are delays in the implementation of the Renewable Energy Act, and the policy shift by the National Water Resources Board (NWRB) to drastically reduce the maximum water flow rates from rivers that can be used for electricity generation, rendering projects that have already been awarded service contracts by the Department of Energy unviable.

4.11.3 Cost of Run of River Technology

Cost analysis provided in SATMP's *Harnessing Hydro Energy for Off-Grid Rural Electrification* with support of the DOE and USAID as part of the Technical Assistance to the DOE for Enhancing Private Sector Participation in Renewable Energy[23] state that some large mini-hydro installations achieve economies of scale and are not only competitive against conventional power systems, but can also be sold below grid electricity prices.

Table 4.16 Cost of Mini-hydroelectric Systems in the Philippines, SATMP

	Hydro 1	Hydro 2	Hydro 3
CAPACITY (kW)	*550*	*960*	*1,500*
LOCATION	Loreto, Dinagat Is., Surigao del Norte	Inarihan, Camarines Sur	Malabang, Lanao Sur
YEAR INSTALLED	2001*	1998	1995
HISTORICAL INVESTMENT COST	-	48,000,000	40,000,000
PRESENT VALUES			
Investment Cost	42,179,534	67,309,170	70,002,747
Investment Cost per kW	76,690	70,114	46,668
ANNUAL COSTS			
Operation	1,182,279	1,496,872	1,253,837
Insurance	105,449	168,273	175,007
Maintenance	227,456	1,871,091	2,696,425
Life-Cycle Cost	**85,282,109**	**144,350,463**	**153,469,801**
Levelized Cost per kWh	**3.78**	**3.65**	**1.71**

**Scheduled for construction in July 2001.*

23 *Undated report, published in APEC-EGS in July 2009*

In mid 2014, two new run of river hydropower plants were completed by Aboitiz Power subsidiary Hedcor Sibulan Inc.'s in Sta. Cruz, Davao del Sur. The two units of the Tudaya hydropower plant have a combined capacity of 13.6 megawatts which is expected to ease the on-going Mindanao power crisis. Total investment is reported at almost PhP2.4 billion.

The given technical specifications are provided in Table 4.17 below.

Table 4.17 Technical Specifications for Tudaya 1 & 2 Run-of-River Hydroelectric Power Plant

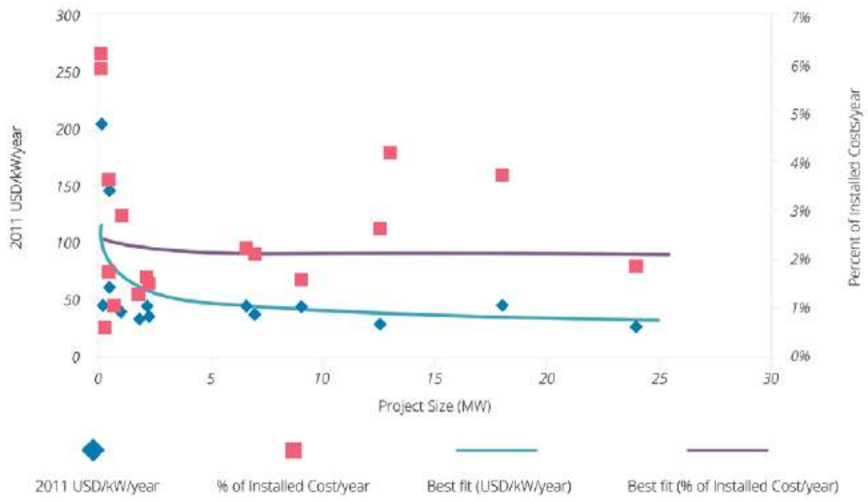
		Tudaya 1	Tudaya 2	
			Unit 1	Unit 2
Generator	Model	LSA-1120-X/14	LSA-1120-S/12	LSA-710-M/8
	Rated Output Power	8,318 kVA	6,703 kVA	3,469 kVA
	Power Factor	0.8	0.8	0.8
	Rated Capacity	6,654 kW	5,362 kW	2,775 kW
Turbine	Model	Pelton	Francis	Francis
	Net Head	227.69m	82.81m	82.81m
	Power Output	6,851 kW	5,517 kW	2,558 kW
Average Lifetime		**25 years**		

Source: UNFCCC/CCNUCC Project Design Document Hedcor Tudaya 1&2 Hydroelectric Power Project

The total installed capacity will be approximately 14.8 MW2 and based on the reported cost of PhP1.165 billion, the investment cost for the 14.8 MW is PhP78,716 per kW or USD1,749 *(at PhP45=USD1)*. The combined energy output is estimated to be 78.448 GWh per year and expected to contribute to emission reductions of 62,931 tCO_2e annually. No cost for operations and maintenance could be acquired.

The IRENA 2012 Report provides capital cost and operations and maintenance cost for hydropower presented in Figure 4.5.

Figure 4.5 Operations and Maintenance Costs for Small Hydro Projects in Developing Countries, IRENA



Source: IRENA/GIZ, 2012.

4.12 OCEAN ENERGY

Ocean and marine energy refers to various forms of renewable electric energy harnessed from the ocean. There are two primary types of ocean energy: mechanical and thermal. The rotation of the earth and the moon's gravitational pull create mechanical forces. The rotation of the earth creates wind on the ocean surface that forms waves, while the gravitational pull of the moon creates coastal tides and currents. Thermal energy is derived from the sun, which heats the surface of the ocean while the depths remain colder. This temperature difference allows energy to be captured and converted to electric power.

4.12.1 Ocean Energy Technology

Thee are four types of existing ocean energy conversion: *wave energy, tidal energy, marine current energy, and ocean thermal energy conversion*.

4.12.2 Ocean Energy Potential in the Philippines

In 1996, DOE attempted to assess the ocean wave energy resources in the Philippines with the assistance of UNDP. This was undertaken by the Oceanographic Company of Norway, OCEANOR, covering the Islands of Batanes, Polillo in Aurora, and Bolinao in Pangasinan among others. The conclusion was that the ocean energy potential of the country is enormous and that these energy source could be a significant resource option. In addition, DOE has estimated a potential of 170,000 MW and has identified 22 prospective sites that can be developed by interested investors to produce the ocean thermal and tidal energy potential.

- Fourteen *(14)* Potential Ocean Thermal Energy Sites: *San Vicente, Ilocos Sur; Agno, Pangasinan; Palauig, Zambales; Mananao, Mindoro; San Jose, Antique; Manukan, Misamis Occidental; Omosmarata, Basilan; Palaui Island, Cagayan; Dijohan Pt., Bulacan; Mascasco, Masbate; Batag Island, Northern Samar; San Francisco, Surigao del Norte; Lamon Pt., Surigao del Sur, and Lacaron, Davao del Sur.*
- Eight *(8)* Potential Ocean Tidal Energy Sites: *the Hinatuan Passage, Bohol/ Taliban Strait, Surigao Strait, Gaboc Strait, Basiao Channel, San Bernardino Strait, Basilan Strait and San Juanico Strait.*

In 2010, DOE Assistant Energy Secretary Mario Marasigan reported that the Philippines has two proponents for ocean energy projects -

- US firm Deep Ocean Power Philippines Inc. is currently conducting studies in at least 36 sites covering 21,000 hectares in Ilocos, Pangasinan, Zambales, Mindoro, Isabela, Panay, Negros, Samar, Leyte and some parts of Mindanao, for possible ocean power sources; but efforts were expected to be focused primarily on Occidental Mindoro and Antique; and
- Bell Pirie Power Corp. was also awarded a RE service contract for the Cabangan ocean energy project in Zambales.

However, he stated that the development of ocean energy is capital extensive as references have indicated that a 100 MW project would require a USD250 million investment.[24]

The UK company Energy Island Bell Pirie Ltd. *(Energy Island)* was planning to construct a 10 megawatt closed-cycle OTEC (Ocean Thermal Energy Conversion)

24 22 sites eyed for ocean energy, http://globalnation.inquirer.net/region/philippines/view/20101110-302508/22-sites-eyed-for-ocean-energy, November 2010

facility in Cabangan, Philippines as a pilot project, which is deemed as having the largest potential amongst marine energy resources such as wave energy and tidal energy, and the sites offer the possibility to operate the OTEC plants year round, providing base load power supply.

Energy Island proposed a tariff for the OTEC plant of PhP17.65 per kWh *(currently approximately USD0.42)* based on a set of parameters provided by the ERC. However, the ERC did not accept the PhP17.65 per kWh tariff. Hence, the challenge for Energy Island is to address their concerns by presenting further data. Energy Island, though is optimistic, that supported with the right mechanisms, more experience can be gained, generation costs will go down and OTEC plants will become competitive with fossil energy production. Scaling up the capacity of OTEC facilities to utility-sized power plants costs will go quickly, and that over 10 years, a 100 MW OTEC plant can be installed with a generation cost of 6.56 Philippine pesos *(PhP)* per kWh.[25]

4.12.3 Cost of Ocean Energy

Luis Vega, Ph.D. of the Pacific International Center For High Technology Research *(PICHTR)*, Hawaii provides cost for OTEC open cycle systems. Installed cost estimates are summarized in Table 4.18.

Table 4.18 OTEC Cost, Vega, 2009

NOMINAL PLANT SIZE MW-NET	Installed Capital Cost USD/kW	Plant Location (Land or Floater)	Source Extrapolated
1.4	41,562	Land	Vega, 1992
5	22,812	Land	Jim Wenzel, 1995
5.3	35,237	Floater	Vega et al, 1994
10	24,071	Land	Vega, 1992
10	18,600	Floater	Vega, 2010 Report
35	12,000	Floater	Vega, 2010 Report
50	11,072	Floater	Vega, 1992
53.5	8,430	Floater	Vega, 2010 Report
100	7,900	Floater	Vega, 2010 Report

Source: Economics of Ocean Thermal Energy Conversion (OTEC): An Update, Luis A. Vega Ph.D., National Marine Renewable Energy Center at the University of Hawai'i , Copyright 2010, Offshore Technology Conference

25 *OTEC potential in the Philippines, OTEC News, September 15, 2012*

NOMINAL PLANT SIZE MW-NET	Installed Capital Cost USD/kW	Plant Location (Land or Floater)	Source Extrapolated
53.5	8,430	Floater	Vega, 2010 Report
100	7,900	Floater	Vega, 2010 Report

Source: Economics of Ocean Thermal Energy Conversion (OTEC): An Update, Luis A. Vega Ph.D., National Marine Renewable Energy Center at the University of Hawai'i , Copyright 2010, Offshore Technology Conference

Considering given capital and operations and maintenance cost (Table 4.18), the electricity outputs, the levelized cost per kWh for the selected plants is presented in Table 4.19 below:

Table 4.19 Levelized Cost of Electricity for OTEC, US Cents per kWh, Vega, 2010

IDENTIFIER NOMINAL SIZE, MW	Capital Cost, USD/kW	O&M, USDM/ year	R&R, USDM/ year	COEcc, c/kWh	COE OMR&R, c/kWh	COE, c/kWh
1.35	41,562	2.0	1.0	60	33.7	**94.0**
5	22,812	2.0	3.5	66	17	**50.4**
10	18,600	3.4	7.7	26.9	16.8	**44.0**
53.5	8,430	3.4	20.1	12.2	12.2	**19.0**
100	7,900	3.4	36.5	36.5	11.4	**18.0**
						8%/15 years

Source: Economics of Ocean Thermal Energy Conversion (OTEC): An Update, Luis A. Vega Ph.D., National Marine Renewable Energy Center at the University of Hawaii, Copyright 2010, Offshore Technology Conference

4.13 WIND ENERGY

The Global Wind Energy Council identifies the Philippines as one of the important emerging wind markets in Asia. It has a cumulative installed wind capacity of 33 MW as of 2011 and is expected to install in excess of 500 MW by 2020 according to forecasts by Emerging Energy Research.[26]

Wind power is used in a number of different applications, including both grid-connected and stand-alone electricity production, as well as water pumping. Large wind farms may be connected to the electricity power transmission network; while smaller turbines are connected through the distribution grid. It has been employed in the Philippines, primarily for own-use. The first wind energy project wind for distribution by on-grid distribution utilities was implemented by Northwind Power Development Corporation *(Northwind)* in 2005 in Bangui, Ilocos Norte, with the installation of 15 wind turbines with a total capacity of 24.75 MW. This was expanded to another 8.5 MW in 2008, with an additional 5 wind turbines for a total of 33 MW of wind energy. The project is expected to expand to supply about 100 MW in the future.[27]

26 *Vestas wins order for largest wind energy project in the Philippines http://www.vestas.com/Default.aspx?ID=10332&action=3&NewsID=3309*
27 *Philippine Wind Farm Analysis and Site Selection Analysis, December 2001, National Renewable Energy Laboratory, Karen Conover, Global Energy Concepts, LLC, Kirkland, Washington*

Electricity generated was initially sold to the Ilocos Norte Electric Cooperative *(INEC)* providing about 40% of INEC's power requirements under preferential rates, among others. Note, however, that in November 2010, INEC and Northwind filed a joint petition with the ERC to terminate its Energy Sales Agreement *(ESA)*, after failed negotiations with regard to pricing scheme, since preferential rates enjoyed by INEC terminated in March 2010 due to the privatization of the grid system and take over by National Grid Corporation of the Philippines (NGCP) from the National Power Corporation *(NPC)*.

As of 2008, the Bangui wind project emission offset reached up to 57,000 tons of carbon dioxide equivalent, Certificate of Emission Reductions (CERs) for the first three years of operation were sold to World Bank, the trustee of the Prototype Carbon Fund in 2004 agreement. Under the agreement, World Bank agreed to buy each ton of carbon dioxide equivalent for USD4.25 for 10 years.[28]

4.13.1 Wind Energy Technology

Energy is generated from wind turbines which operate on a simple principle. The energy in the wind turns two or three propeller-like blades around a rotor. The rotor is connected to the main shaft, which spins a generator to create electricity. Wind direction determines the design of the turbine.

Wind turbines are designed according to international and national codes and standards generally based on European and North American conditions. In the Philippines, the challenge is to cost optimize the wind turbine design for sites with risk of cyclones. There is a need to modify or extend existing methodologies used in the wind turbine design codes and standards so that the designs can be optimized to the specific wind conditions in cyclone risk areas.[29]

4.13.2 Wind Energy Potential

According to NREL's Wind Energy Resource Atlas of the Philippines, wind resources cover over 10,000 m^2 with 76,600 MW potential installed capacity;[30] The NREL report provides that: *"The wind resource in the Philippines is strongly dependent on latitude, elevation, and proximity to the coastline. In general, the best wind resource is in the north and northeast, and the worst resource is in the south and southwest of the archipelago.*

28 *Capital Research, February 2010, Issue No. 1, First Metro Investment Corporation, MetroBank Group*
29 *Design of Wind Turbines in an Area with Tropical Cyclones presented by Niels-Erik Clausen, Edmund M. Pagalilawan and Samuel Hernando (PNOC) at the European Wind Energy Conference, Athens, 27 February–2 March 2006*
30 *Outlook of Biomass Industry in the Philippines, Ruby B. de Guzman, Supervising Science Research Specialist, Alternative Fuels and Energy Technology Division, DOE, presentation 4th Biomass Asia Workshop, Malaysia, November 2007*

The wind mapping results show many areas of good-to-excellent wind resource for utility-scale applications or excellent wind resource for village power applications, particularly in the northern and central regions of the Philippines. The best wind resources are found in six regions: (1) the Batanes and Babuyan islands north of Luzon; (2) the northwest tip of Luzon (Ilocos Norte); (3) the higher interior terrain of Luzon, Mindoro, Samar, Leyte, Panay, Negros, Cebu, Palawan, eastern Mindanao, and adjacent islands; (4) well-exposed east-facing coastal locations from northern Luzon southward to Samar; (5) the wind corridors between Luzon and Mindoro (including Lubang Island); and (6) between Mindoro and Panay (including the Semirara Islands and extending to the Cuyo Islands).

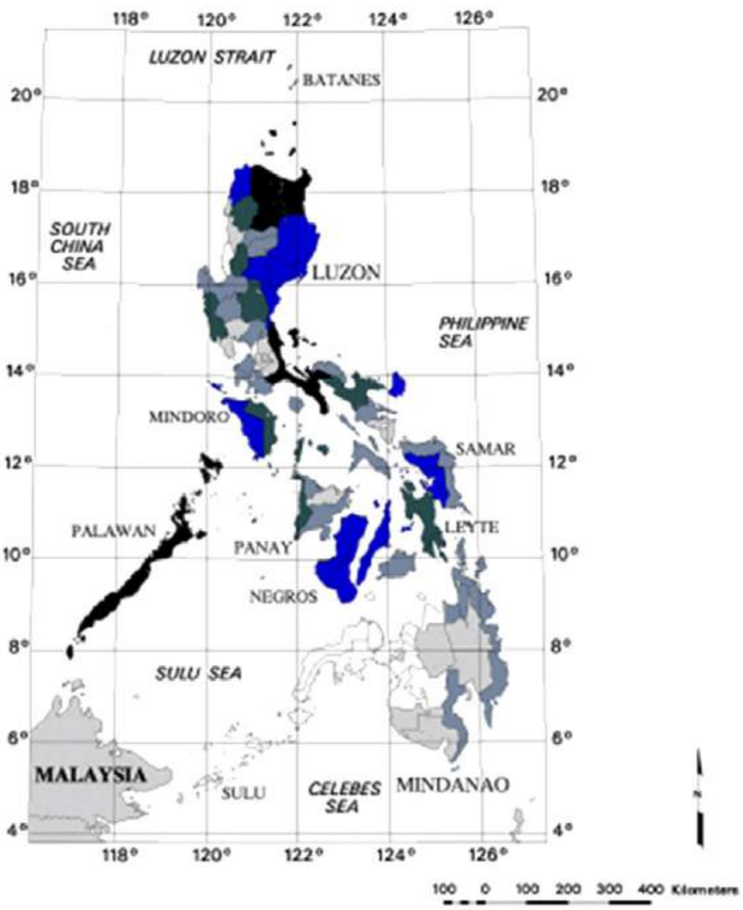
More than 10,000 km^2 of windy land areas are estimated to exist with good-to-excellent wind resource potential. Using conservative assumptions of about 7 MW per km^2, this windy land could support more than 70,000 MW of potential installed capacity. Considering only the areas of good-to-excellent wind resource, there are 47 provinces out of 73 with at least 500 MW of wind potential and 25 provinces with at least 1,000 MW of wind potential. However, to accurately assess the wind electric potential will require additional studies, considering such factors as the existing transmission grid and accessibility." [31]

Figure 4.6 shows map of areas in the Philippines of good to excellent wind resources for utility scale applications or good wind resource for village power applications.

To maximize wind potential, wind turbines must be positioned in strategic locations so as to maximize wind potential. Low or intermittent output is a challenge, as are objections to noise and visual effects.

[31] Wind Energy Resource Atlas of the Philippines, D. Elliott, M. Schwartz, R. George, S. Haymes, D. Heimiller, G. Scott, NREL, February 2001

Figure 4.6 Map of Philippines Wind Electric Potential
Good to Excellent Wind Resources at 30m (Utility Scale)



Philippines Total - 76,600 MW

Wind Electric Potential
Megawatts

- < 100
- 100 - 500
- 500 - 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- 3,000 - 5,200

The following assumptions were used in calculating the total potential wind electric capacity installed:

Minimum wind power - 300 W/m²
Turbine size - 500kW
Hub height - 40 m
Rotor diameter - 38 m
5D Side-to-side spacing - 190 m
10D Front-to-back spacing - 380 m
Swept area - 1134 m²
Turbines/km² - 13.9
Capacity/km² - 6.9 MW

US Dept. of Energy - National Renewable Energy Laboratory

NREL

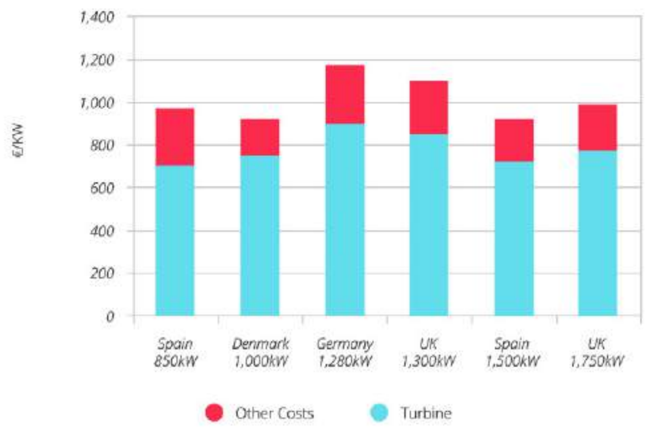
28-AUG-2000 16.7

4.13.3 Cost of Wind Energy

The rapid development of wind power in Europe, as well as globally, has significantly influenced the cost development of wind power within the past 20 years. Development of electricity production efficiency owing to better equipment design, has improved significantly over the last few years.

As of 2001, the total investment cost per installed kW of wind power capacity differs significantly between selected EU countries, as shown in Figure 4.7 *(note, based on limited data)*. The cost per kW typically varies from approximately 900 €/kW to 1,150 €/kW.

Figure 4.7 Total Investment Cost, Including Turbine, Grid Connection for Different Turbine Sizes and Countries



Based on reported data from Germany[2], UK, Spain and Denmark.
Source: Morthorst, Wind Energy - The Facts, Section 2, Costs and Prices

The 2001 investment cost per kW typically of between 900 €/kW to 1,150 €/kW translates to about USD1,000 to USD1,278 *(at €0.90=USD1)*. O&M costs are, in general, estimated to be at a level of approximately 1.2 to 1.5 c€/kWh of produced wind power seen over the total lifetime or from US cents 1.33 to US cent 1.67 per kWh.

In 2004, the initial phase of the Bangui wind farm with an installed capacity of

24.75 MW is presented in Table 4.20 below. Part of investment financing was a USD29.5 million "mixed credit" or zero-interest loan from the Danish International Development Agency (DANIDA).[32] Capital cost of the project was at USD51.203 million, or USD2,069 per MW installed *(2004 prices)*. Based on a production of 86,724,000 kWh/year and O&M Cost of USD1 million per year, O&M cost per kWh was at USD0.0115.

Table 4.20 Bangui, Ilocos Norte Wind Project Investment and O&M Costs/Year

Financial Details	
Foreign Exchange Rate	PhP57/USD1
Costs of Equipment and Plant (intial investment cost)	USD51,203,000
Electricity Tariff	UDS0.078/kWh (PhP4.43/kWh)
Electricity Sales (86,724 MWh/year)	USD 6,740,128
Project Life	21 years
O&M Costs/year	USD1,000,000
Project IRR	9.3%

Source: CDM-PDD NorthWind Bangui Bay Project

The 2012 RE power generations costs report of the International Renewable Energy Agency *(IRENA)*[33] provides that average installed costs in 2011 in China were among the lowest in the world at USD1,114 to USD1,273 attributed to overcapacity in manufacturing, a large domestic market, low commodity *(steel and cement)* costs and an ever-increasingly competitive development industry.

As of 2012, capital cost for wind energy has dropped to USD1,940/kW and expected to drop further as lower cost turbines were sold in 2011/2012 for installation in 2013/2014. The average cost of energy, likewise dropped from 0.06 US cents for PPAs signed in 2010 to 0.04 US cents signed in 2011, down further to an average of US cents 0.038 cents in 2012.

Reported investments / project costs per kW in wind energy projects in the Philippines are presented in Table 4.21.

32 *Bangui wind farm: 'Green' and profiting, Judy T. Gulane, Business World Sub-Editor, July 31, 2008*
33 *Renewable Power Generation Costs in 2012, An Overview, International Renewable Energy Agency (IRENA) prepared by the IRENA Secretariat. The paper benefitted from an internal IRENA review, as well as valuable comments and guidance from Emmanuel Branche (EDF), He Dexin (CWEA), Robert Gross (Imperial College London), Stefan Gsänger (WWEA), Craig Turchi (NREL) and Mercedes Mostajo Veiga (Prysma). Copyright (c) IRENA 2013*

Table 4.21 Investment Cost per kWh, Wind Energy Projects in the Philippines Years 2004, 2012 and 2013 (On Shore)				
PROPONENT/LOCATION OF PROJECT	Installed Capacity in MW	Cost /MW in USD	Cost per kW Installed	Year Prices
1. NorthWind Power Development Corp. Bangui, Ilocos Norte	24.75	51,203,000	2,069	2004
2. Philippine Hybrid Energy Systems Inc. Puerto Galera, Oriental Mindoro	48.00	113,900,000	2,373	2012
3. Alternergy Wind One Corp. (AWOC) Pililla Wind Farm	67.50	180,000,000	2,667	2013
Sembrano Wind Farm	72.00	200,000,000	2,778	2013
4. Northern Luzon UPC Asia Corp. Pagudpud, Illocos Norte	81.00	250,000,000	3,086	2013
5. Energy Development Corp. Burgos, Ilocos Norte 87.00 300,000,000 3,448 2013	87.00	300,000,000	3,448	2013

Sources:
(1) CDM-PDD NorthWind Bangui Bay Project
(2) CDM-PDD Puerto Galera Wind Energy Power Systems (WEPS) Project
(3) Alternergy wind sets aside USD380 million for two Rizal wind projects, Manila Bulletin, June 20, 2013, (Interview with Director Knud Hedeager)
(4) Caparispisan wind energy project breaks ground, Press Room, Ayala Group, September 4, 2013
(5) http://www.energy.com.ph/news/edc-signs-300m-deal-for-the-87-mw-burgos-wind-project-with- vestas-of-denmark/

4.14 COMPETITIVE ELECTRICITY COST FROM RE SOURCES

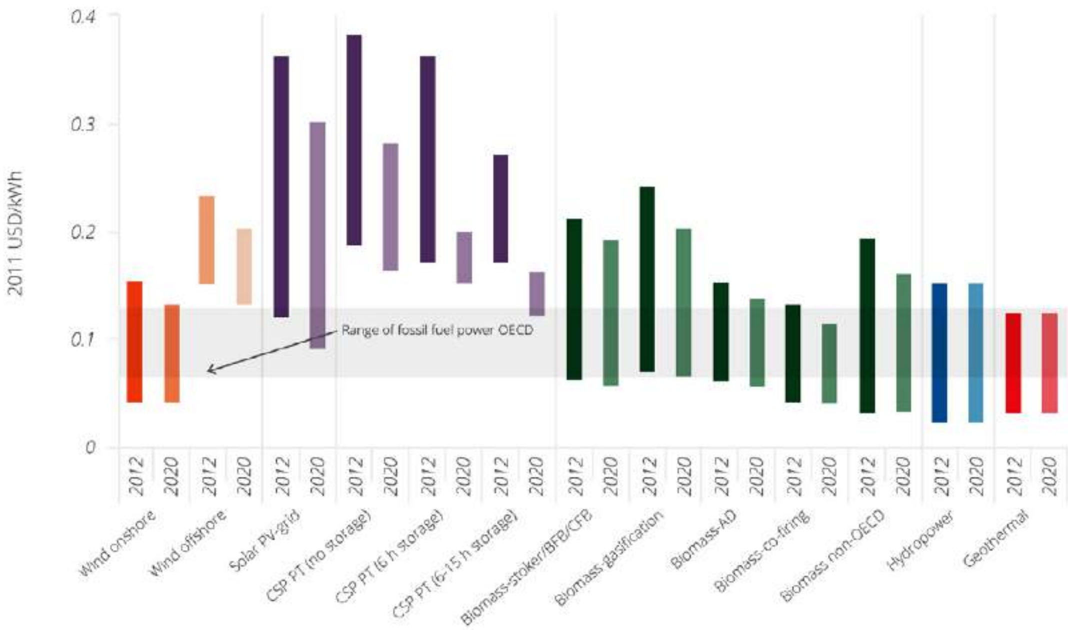
Declines in cost, as in the case of solar PV, leads to dramatic declines in the Levelized Cost of Electricity (LCOE) of REs. This reflects the increasing maturity of non-hydro technologies such as solar, wind and biomass. The improvement in the competitiveness of REs is changing the power generation landscape to one where REs are fast becoming the economic choice not only for off-grid and mini-grids, but also are increasingly competitive in supplying electricity to the grid.

The declining trend is shown for cost of RE in Year 2020 based on IRENA 2012 estimates. The levelized cost ranges for RE to Year 2020 as compared to 2012 costs is shown in Figure 4.8.

The government's policy to go slow on RE is primarily because of its cost concerns. However, with cost of RE technologies going on a downtrend, the government should pay greater attention to its uses and applications.

The author does not believe that the lower approved FIT rates than those recommended by NREB need be a barrier to investment in RE. The recommended FIT rate for example for Solar-PV at PhP17.95 per kWh reduced to PhP9.68 is justified due to much lower cost of solar panels today. To compare, electricity cost or tariff rates from Fossil and RE-sources are presented in Table 4.22.

Figure 4.8 Comparative Cost for RE 2012 and 2020, IRENA



Note: This is based on an assumed cost of capital of 10%. The bands reflect ranges of typical investment costs (excluding transmission and distribution), fuel costs and capacity factors. PT=parabolic trough, ST=solar tower, BFB/CFB=bubbling fluidized bed/circulating fluidized bed, AD=anaerobic digester.

Table 4.22 Comparative Cost of Electricity per kWh, in PhP (USD1=PhP45)

POWER PRODUCERS/SOURCE	Type of Plant	Levelized Cost of Electricity	ERC/CDM PDD	Subject to FIT(*)	MERALCO Dec. 2013	MERALCO Jan. 2014
1. Fossil Fueled						
SEM - Calaca Power Corp.	Coal-Fired				0.0864	0.0947
Masinloc Power Partners, Corp.	Coal-Fired				0.1420	0.1143
Therma Luzon, Inc.	Coal-Fired				0.0920	0.0954
San Miguel Energy Corp.	Coal-Fired				0.0759	0.0962
Quezon Power Phils, Inc.	Coal-Fired				0.1042	0.1388
South Premiere Power Corp.	Natural Gas Combined Cycle				0.1322	0.1119
First Gas - Sta. Rita	Natural Gas Combined Cycle				0.1589	0.1342
First Gas - San Lorenzo	Natural Gas Combined Cycle				0.1527	0.1271
Therma Mobile, Inc.	Oil Power Barge				0.2281	0.4922

POWER PRODUCERS/SOURCE	Type of Plant	Levelized Cost of Electricity	ERC/CDM PDD	Subject to FIT(*)	MERALCO Dec. 2013	MERALCO Jan. 2014
2. RE Fuelled						
A. Hydro (Run of River, 1-10MW Capacity)/ Mini-Hydro						
China, IRENA 2011		<0.075				
Philpodeco, MERALCO					0.1176	0.1170
Bicol, ERC, 2014	960kW Capacity		0.1056			
B. Wind						
China, IRENA 2011	Onshore	<0.075				
Pililla Wind Power Project	Onshore			0.1896		
Burgos Wind Power Project, CDM PDD, 2006(**)	40 MW Onshore		0.1018			
C. Solar-PV (with more than 500kW Capacity)						
China, IRENA 2011	Solar PV	<0.200				
Philippine Solar Farm-Leyte Inc.	Solar PV			0.2151		
D. Wind						
China, IRENA 2011		<0.075				
Isabela Biomass Energy Corp.	Rice Husk-Fired			0.1473		
Montalban Methane	Landfill Gas				0.0866	0.0930
Baca Valley Energy	Landfill Gas				0.0867	0.0901
Pangea Green Energy	Landfill Gas				0.0854	0.0941
E. Geothermal						
Greenfield Higher Temperature, OECD/ IEA 2010	Flash Plants	0.05 -0.12				
Greenfield Low Temperature , OECD/ IEA 2010	Binary Plants	0.07 - 0.20				
Expansion, OECD/IEA 2010		0.03				
Maibarara Geothermal Plant, CDM PDD, 2011	Single Flash		0.0895			

(*)Subject to ERC Approved Digression Rates
(**)Tariff expected to increase 4% p.a. due to inflation

As shown above, cost of electricity from geothermal and hydro is competitive to those of coal-fired plants supplying MERALCO. Biomass is competitive to that of Natgas, and in all cases, cost from oil-fired plant is higher than cost of all RE sources.

To promote greater RE adoption, RE power generation costs will have to continue to decline and performance improve. At the same time, further policy measures will be required to overcome those market barriers, unrelated to price, which hinder the accelerated deployment of renewable power generation technologies *(IRENA 2012)*.

4.15 ESTIMATION OF TOTAL RE POTENTIAL TO YEAR 2050

Without the development of RE sources, a low carbon pathway would not be possible even if all available energy saving measures would be applied. Table 4.23 estimates the potential RE sources in the Philippine based on DOE estimates, which have been expanded based on study team calculations for RE biomass sources from Residual Forest, Fuel Crops, Livestock, Waste and Sewer.

In the calculations, it is highlighted that production of RE biomass sources from agriculture and forestry should be sustainable and not affect food security or adversely impact the ecosystem. Allocated land area for propagation of fuel crops is limited to 2 million hectares to 2030 and increases to 3 million hectares going to 2050, while allocated forested area for harvesting of forest residuals is limited to 10 million hectares in 2030 to the end of the study period. Further discussion on the energy and power potential from biomass is presented in Chapter 8.

Table 4.23 Total Potential RE Sources in the Philippines[34]

RE POTENTIAL	2030	2030	2050	2050	ha (2030)	ha (2050)	2010, % share for revised estimated values	2030, % share for revised estimated values	2050, % share for revised estimated values	Estimated conversion share through steam process	e-Power conversion efficiency (eta-e) steam process	e-Power conversion efficiency (eta-e) combus-tion engine process
Note: All values in MWh-e per h, year if not indicated otherwise.												
Hydro (+mini,micro)	6,830		10,500				46.9%	4.3%	3.2%			
Geothermal	2,369		4,537				27.9%	1.5%	1.4%			
Wind	76,489		76,489				0.4%	48.1%	23.5%			
Solar	41,667		166,667		20,000	80,000	0.0%	26.2%	51.2%			
Ocean	17,000		51,000		10%	30%	0.0%	10.7%	15.7%			
Biomass (Total)	14,785		16,626				24.8%	9.3%	5.1%			
Forest Residual		1,784		1,784	10,000,000	10,000,000	0.0%	1.1%	0.5%	100%	25%	
Fuel Crops		5,708		8,562	2,000,000	3,000,000	0.0%	3.6%	2.6%	100%	25%	
Indicative Capacity							9.6%	0.0%	0.0%	100%		
Sugar Cane Cogen (a, b, c)		540		540		80,000	0.0%	0.3%	0.2%	100%	25%	

34 *JLBTC Model Calculation, Transport-cars+Biomass.xlsx*

RE POTENTIAL	2030	2030	2050	2050	ha (2030)	ha (2050)	2010, % share for revised estimated values	2030, % share for revised estimated values	2050, % share for revised estimated values	Estimated conversion share through steam process	e-Power conversion efficiency (eta-e) steam process	e-Power conversion efficiency (eta-e) combus-tion engine process
a. Ricehull		1,256		1,256		30%	0.0%	0.8%	0.4%	100%	25%	
b. Coconut residues		20		20		30%	0.0%	0.0%	0.0%	100%	25%	
c. Bagasse		235		235		30%	0.0%	0.1%	0.1%	100%	25%	
					2010-2030	2010-2050						
MSW/Full Recycling		5,017		3,859	4.71	3.62	15.2%	3.2%	1.2%	55%	25%	43%
					8.06%	3.27%						
Livestock		75		134						0%		43%
Sewer		150		237						0%		43%
TOTAL (MW-e)	159,139		235,819				100.0%	100.0%	100.0%			

Source: Department of Energy except for Landfill Gas estimates and target made by Study team
1GOODImportantPH_Low_Carbon_Transport_and_Powercopy.pdf
Table 4.1-2: RE Potential, Installed Capacity and Indicative Additions

As shown in Table 4.23, total potential from RE sources total almost 160,000 MWh-e per hour in 2030 and almost 326,000 MWh-e per hour in 2050.

4.16 ESTIMATION OF TOTAL BIOFUEL POTENTIAL

Rising oil prices and the need to reduce emissions from fossil fuels have positioned biofuels as a potential substitute for fuel.

In line with the Biofuels Act, biofuel blends to gasoline and diesel has been implemented since 2009 with an initial 1% biodiesel in diesel and 5% bioethanol in gasoline. Biodiesel blend is now at 5%, while bioethanol blend at 10%. Although biodiesel demand is locally supplied, the country is a net importer of bioethanol with an estimated import value requirement of 172 million liters *(BOI)*.

4.16.1 Fuel Crop Versus Food Crop Demand

The GOP's initial strong thrust to promote cultivation of jatophra as a biodiesel source has been reversed due to concerns raised by food security advocates about biofuel crops encroaching on land planted for food crops, which impact food security. The GOP is now looking at marine or aquatic algae as an alternate biofuel source. Effects of water use in biofuel production will also need to be considered.

The US Government Accountability Office states that biodiesel requires 1 liter of water per liter of product, while corn based enthanol requires 3-4 liters and cellulosic ethanol requires 2-6 liters of water per liter of product.

4.16.2 Availability for Fuel Crop Cultivation

Department of Agriculture *(DA)* 2010 statistics show more than 4 million hectares of land are planted to biofuel source crops as follows: coconut at 3,575,900 hectares; sugarcane at 354,900; cassava at 217,600 hectares.

Additionally, the Board of Investments reported in 2011 that more than 500,000 hectares of land area have been identified suitable for the plantation bioethanol crops (Table 4.24). DENR's Upland Development Program states that a total of no less than two *(2)* million hectares are available for biofuels plantation.[34]

Table 4.24. Suitable Land for Bioethanol Crops, BOI, 2011

REGION	SUITABILITY (in hectares)	
	Very Suitable for Bioethanol Crops	Suitable for Bioethanol Crops
CAR	12,991.74	26,093.22
Region I	34,700.06	29,128.14
Region II	24,712.23	22,162.84
Region III	62,844.87	31,174.30
Region IV-A	57,524.04	4,240.16
Region IV-B	119,256.28	10,651.99
Region V	81,703.56	50,486.51
Region VI	95,515.88	90,316.31
Region VII	61,406.82	27,125.10
Region VIII	77,213.91	109,671.10
ARMM	22,343.59	4,065.54
CARAGA	32,515.29	50,425.25
Region IX	28,762.53	8,967.95
Region X	28,218.17	10,680.22
Region XI	17,728.31	21,227.51
Region XII	11,811.07	11,743.62
TOTAL	**769,248.35**	**508,159.76**

Source: Soil Suitability Atlas for Biofuels, PADCC & BSWM

34 *PhilForest Accomplishments, http://www.philforest.denr.gov.ph/about-us/what-we-do/philforest-accomplishments*

4.16.3 Coco Biodiesel or CME

Coco Biodiesel or Coco-methyl ester or CME is the Philippine biodiesel feedstock, and is an oleo-chemical derived from coconut oil *(CNO)*. The Philippine has a stable supply of coconut oil, with 68 out of 79 provinces planted to about 331 million coconut trees in about 3.3 million hectares *(BOI)*.

The Philippine Coconut Authority *(PCA)* estimates annual copra yield in Table 4.25.

Table 4.25 Copra Yield per Hectare, PCA[36]

YEAR	CONTROL		SODIUM CHLORIDE		MULTI-NUTRIENT FERTILIZER	
	Copra/tree/year (kg)	Copra/ha (kg)	Copra/tree/year (kg)	Copra/ha (kg)	Copra/tree/year (kg)	Copra/ha (kg)
1	10.0	1,230.00	12.5	1,537.50	15.0	1,845.00
2	10.0	1,230.00	15.0	1,845.00	20.0	2,460.00
3	10.0	1,230.00	15.0	1,845.00	25.0	3,075.00
4	10.0	1,230.00	15.0	1,845.00	25.0	3,075.00
5	10.0	1,230.00	15.0	1,845.00	25.0	3,075.00

However, yields are declining. In 2010, coconut production was 15.54 million metric tons. In terms of the country's production, 75% is exported, with only 25% utilized for domestic consumption and less than 5% of the 25% was used for CME production or about 65,000 to 70,000 metric tons *(BOI)*. Because CME has many uses, determining CME used for biodiesel production is difficult to ascertain *(Corpuz, 2010)*.

The demand for 2% biodiesel blend in 2010 was sufficiently met by nine *(9)* local CME biodiesel producers with an annual combined production capacity of 393 million liters compared to the requirement of 149 million liters based on the 2% blend. The industry requested DOE to increase the blend from 2% to 5%, and in 2013, the National Biofuels Board approved the increase to 5% expected to be implemented by October by DA Sec. Proceso Alcala.[37] The National Biofuel Board likewise announced that 20% biodiesel blending could be reached by 2030.[38] Chemrez Technologies, an industry player, claims the 5% biodiesel blend can save an estimated PhP13 billion worth of imported crude oil every year. Under the law, the amount of coconut oil for fuel to be blended with diesel may be increased, taking into account considerations such as domestic supply and availability of locally sourced biodiesel. The National Biofuels Board aims to help

36 *Coconut Yield and Profitability under Fertilizer Options: Common Salt (Sodium Chloride) and Multi-Nutrient, 14N-OP2O5-20K2OCl-4.5S-0.02B Applications on Bearing Trees (Technology Notes) by Severino S. Magat, PhD, Agricultural Research Management Department (ARMD) and Liberty H. Canja, PhD, Agronomy and Soils Division, Davao Research Center (DRC) RESEARCH & DEVELOPMENT, AND EXTENSION BRANCH (RDEB), Philippine Coconut Authority, http://www.pca.da.gov.ph/pdf/techno/econ_nacl.pdf*

37 *Agri chief says 5% biofuel blend to save billions of pesos in petroleum imports, VS GMA News, July 12, 2013 http://www.gmanetwork.com/news/story/317198/economy/agricultureandmining/agri-chief-says-5-biofuel-blend-to-save-billions-of-pesos-in-petroleum-imports*

38 *Philippine coconut producers seek increased biodiesel blending, June 8, 2012, http://www.biofuelsdigest.com/bdigest/2012/06/08/philippine-coconut-producers-seek-increased-biodiesel-blending/*

the local coconut industry, which is currently facing challenges from cheaper palm oil competition.[39]

The following Table 4.26, table presents conversion factors for coco biodiesel:

Table 4.26 Conversion Factors for CME (Coco Biodiesel), Philippines

Production in 1 hectare land	=	0.80 metric tons of Copra*
1 kilogram (kg) of Copra	=	0.63 kg of coconut oil (CNO)**
1 kg CNO	=	1 liter coco-methyl ester (CME)**
1 metric ton biodiesel	=	1,136 liters**
Average biodiesel density	=	0.88 grams/ml (=mt/cu.m.)***
Heat Value of 1 metric ton biodiesel	=	37.8 gigajoule***
Heat Value of 1 liter biodiesel	=	33.3 - 35.7 megajoule (MJ)***

Sources:
(*) PCA, yield for unmanaged coconut plantation, however a PCA study provides yield is at 1.23 metric tons per hectare.
(**) Philippine Biofuels Industry Situation and Outlook, Perfecto G. Corpuz, USDA Foreign Agriculture Service Gain Report, 2012
(***) Bioenergy Conversion Factors, https://bioenergy.ornl.gov/papers/misc/energy_conv.html

Project cost for a 2 million liter capacity plant is presented in Table 4.27 below. Crude oil costs is at an average of USD0.73 per kilo *(exclusive of VAT)* and contact price of CME to oil companies is USD0.74 to 0.98 per liter.

Table 4.27 Project Cost for a 2 Million Liter Capacity Coco Biodiesel Plant, Philippines, BOI, 2011

Related Expenses	Cost (in Thousand USD)
Pre-Operating Expense	20.70
Cost of Land (Lease of land for the first year)	8.28
Site Development	931.00
Equipment Cost	620.73
Working Capital	62.07
TOTAL	**1,642.78**

Engr. Godofredo P. Defensor, MIT and Head of the Mechanical Engineering Department and a Student, Doctor of Industrial Technology of Western Visayas College of Science and Technology in Iloilo City, estimates the cost for a mini-biodiesel plant to process 145 liters of Biodiesel at PhP10,000.00 *(USD232.56)*. Processing costs are found in Table 4.28.

[39] *DOE firms up plans for 5% biodiesel blend by Iris C. Gonzales, The Philippine Star, July 29, 2013 http://www.philstar.com/business/2013/07/29/1024471/doe-firms-plans-5-biodiesel-blend*

Table 4.28 Processing Cost for 145 Liters of Marketable Biodiesel, Defensor, 2010

a. 150 Liters of raw WVCO	PhP1,275.00
b. 30L Ethanol	1,500.00
c. 1.05kg Caustic Soda	100.00
d. Kerosene	68.00
e. Energy Cost (fuel & electricity)	100.00
f. Labor	250.00
g. TOTAL COST	**PhP3,293.00**

4.16.4 Jathropa Methyl Ester

In 2006, The Department of Science and Technology or DOST, identified potential areas for jatropha plantation in the Philippines at 2 million hectares. If farmers will be encouraged to plant even in field boundaries or hedges and to practice intercropping, a total of 5 million hectares can be utilized for the jatropha plant.[40] In 2006, President Gloria Macapagal Arroyo released PhP500M for planting jatropha in military camps. The Philippine National Oil Corporation *(PNOC)* through its Alternative Fuel Corporation *(PNOC-AFC)* grew jathropa in about 700,000 hectares order to produce a million MT of biodiesel by 2011.

However, in 2011, the GOP announced that the Philippine National Oil Co. Alternative Fuels Corp. *(PNOC-AFC)*, the biofuels arm of state-owned PNOC, will pursue the development of biofuels from non-food crops such as algae.

4.16.5 Marine or Aquatic Algae

Algae can be tapped for ethanol production and bio-methane production through anaerobic digestion and synthetic biofuels through thermo-chemical conversion.[41] The country's coastlines and oceans provide opportunities for algae energy.

Algae is seen as an ideal source of high-density fuels and sustainable substitute to biofuel crops with no need to compete for arable land and freshwater supply with food crops. It has the potential for higher biomass yields than land plants, and can be cultured quasi-continuously, in contrast to seasonal harvesting. Algae can be grown quickly in salt water in the desert. Its number one nutrient source is CO_2, consuming 13 to 14 kg of CO_2 per gallon of green crude and can scrub CO_2 from flue gases and nutrients from waste streams.

40 *Jathropa Methyl Ester, DOE https://www.doe.gov.ph/energy-resources-alternative-fuels/biofuels/biodiesel/323-jatropha-methyl-ester*
41 *A UK Roadmap for Algal Technologies, Collated for the NERC-TSB Algal Bioenergy-SIG by B. Schlarb-Ridley and B. Parker, Adapt, May 2013 https://connect.innovateuk.org/documents/3312976/3726818/AB_SIG+Roadmap.pdf*

in the Philippines, research has already begun in microalgal biodiesel. Among these is net energy analysis of production systems based on two types of oil-bearing algae *(Haematococcus pluvialis and Nannochloropsis)* undertaken by Luis F. Razon, MS, Ph.D. and Raymond Tan, MS, Ph.D. of De La Salle University. They report, however, that the energy ratios, based on the technology being proposed for commercial operation of such systems, fall far short of thermodynamic break-even.

They state that their results imply that significant innovation is needed in developing less energy-intensive techniques for separating oils from algal biomass.

4.16.6 Bioethanol

The Biofuels Act of 2006 created a market for bioethanol because of the mandate for oil companies to blend 5% bioethanol by volume in 2009, increasing to at least 10% in 2011. It is estimated that 1.17 million tonnes of sugarcane trash is recoverable as a biomass resource in the Philippines. In addition, 6.4 million tonnes of surplus bagasse is available from sugar mills. There are 29 operating sugar mills in the country with an average capacity of 6,900 tonnes of cane per day.

At present, bioethanol is mainly produced by sugar fermentation and distillation process. The current local production capacity is 79 million liters compared to the demand of more than 400 million liters for 2011 *(BOI)*.

Fuel crops identified for bioenthanol production in the Philippines include: *sugarcane, cassava, and sweet sorghum*.

Table 4.29 assumes a maximum allocation of 2 million hectares of land for bioethanol production. This is calculated to generate a potential of 5,708 MW-e up to year 2030 while 3 million hectares can generate a potential 8,560 MW-e up to year 2050.

Table 4.29 Potential Energy from Fuel Crop Production for Bioethanol Assuming Utilization of a Dedicated Land Area of 2 Million Hectares

PARTICULARS	Unit	Assumed Value	Output
Average Yield million gram (Mg) or one metric ton per Hectare	Mg/ha,a	25.00	
Harvest Potential	p.a.	100%	
Output in Mg per hectare per annum	Mg/ha, a		25
Heat Value of Output per Ton Oil Equivalent (toe)	MWh-pr/toe	11.63	
Heat Value of Output in MW/Mg or kW/kg	MWh-pr/Mg or kWh-pr/kg	4.00	
Energy Production Potential	MWh-pr/ha,a		100
Assumption for dedicated land available for fuel crop production	million ha	2.00	
Heat Value for Yield from total land available	TWh-pr/ a		200
	MW-pr / h		22,831
Conversion efficiency for biomass harvest by steam process	eta-%	25%	
Electrical Energy Equivalent from dedicated land available	TWh-e/ a		50
	MW-e		5,708
	GWh-e/a		50,000

BOI estimates total investments to be USD98 Million or PhP4.4 billion with project costs for a 100,000 liters per day Bioethanol distillery shown in Table 4.30.

Table 4.30 Project Cost for 100,000 Liters a Day Bioethanol Distillery, BOI, 2011

RELATED EXPENSES	COST (in Million USD)	
	Adjunct	Stand Alone
Industrial		
Civil Works, Land, Buildings	2.90	6.21
Machinery	11.59	17.59
Energy System, Environmental	2.07	3.10
Agricultural		
(if not yet developed) 7,000 has	14.48	14.48
TOTAL	31.04	41.38

Note: Gray areas will require 20%-30% more expenses agriculturally due to clearing and more extensive pre-development operations (add USD 4.14M). The high investment cost will necessitate a sound overall environment, specifically addressing the cane supply issue, before any investment will be realized.

4.17 CONCLUSION AND RECOMMENDATIONS

GOP's strategy leaning towards the deployment of more coal-fired plants will lead to higher GHG emissions. There are also many barriers to investors in RE such as the cap and policy for FIT eligibility for new RE projects, the first come - first serve policy, and requiring completion of construction of RE projects prior to FIT eligibility. This limits participation to established industry players, and does not foster free and fair market competition in the generation and supply sectors which could lead to unjustified higher electricity rates. Entry of new players could be beneficial in creating market competition towards lower electricity prices.

Current investment in RE solar and wind in the Philippines are higher compared to international costs. It is recommended that DOE, NREB and ERC review current policies and FIT tariff rates to lower the cost of RE electricity charged to users. As the cost of RE technologies drop and the cost of fossil fuels rise, electricity from RE sources will eventually be more affordable in the long run.

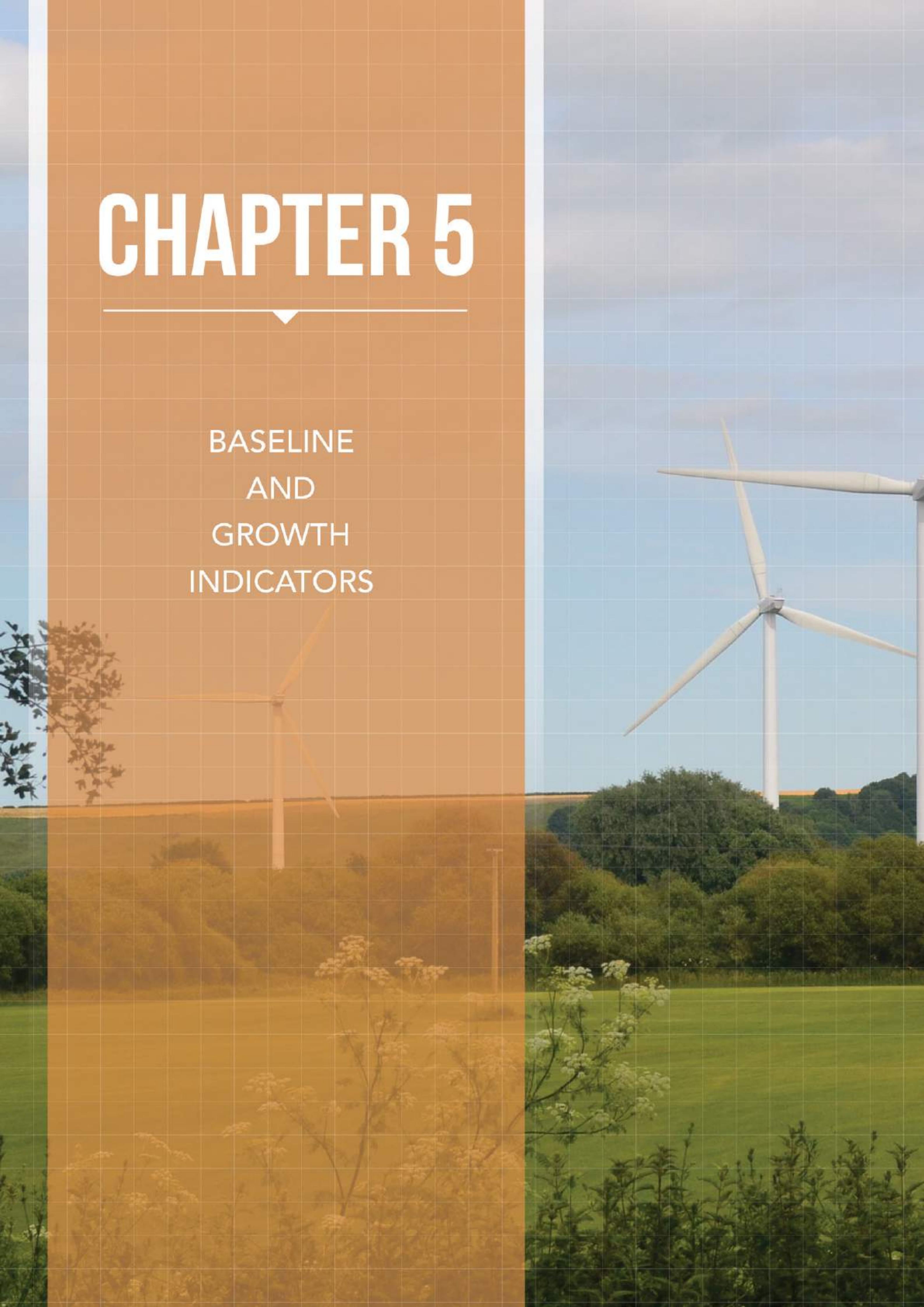
In terms of biofuel production, food crop production must take precedence over biofuel crops so as not to affect food security. The country's oceans yield algae, which provides opportunities for algae energy to be used as a sustainable fuel source, although much research and development is needed be able to produce this in commercial quantities. It is beneficial for GOP to immediately embark on and/or promote private investment in research and development of algal bioenergy technology as this is seen as the least source not to compete with food production.

The Philippines has adequate RE resources that can be tapped to supply the country's growing electricity demand and should tap its vast potential for solar and ocean energy, and substantial wind resources. With its vast RE potential, it is in the country's best interest to maximize use of RE, not only in reducing GHG emissions, but also in reducing reliance on imported fossil fuel and to achieving energy security.


CAUTION

CHAPTER 5

BASELINE AND GROWTH INDICATORS



5.1 TRANSITIONING TO RE

The BAU scenario focuses on the Energy Sector which contributes to more than 50%[1] of the country's emissions, increasing annually by 2.55% from its 1990 level. The Energy Sector's carbon emissions are hinged on the country's mix of energy supply sources which need to meet the demand of its increasing population and for its continued economic growth. Further focus is on electricity generation in relation to the country's NREP.

The country's projections presented by the Asia Pacific Energy Research Centre (APERC) in its APEC Energy Demand and Supply Outlook–5th Edition, February 2013 report reveals that electricity use will grow at a rate of 3.6% annually from 16 GW in 2010 to 58 GW in 2035. Fossil fuel sources are expected to dominate the supply mix for electricity generation, with coal at 70%, gas at 16% and oil at 2%, or 88% of the total requirement in Year 2035. Fossil-fuel sources share in the supply mix was lower at 67% in Year 2010.

To transition to LCD, it is important to determine the cost effectiveness of electricity production from RE sources, the capacities that can be generated considering the country's RE potential, and to identify storage technologies for intermittent RE sources and alternative distribution systems to maximize utilization of RE based plants. Clearly, it is only when the economics of RE become competitive and when solutions to technical barriers are addressed, will government decision makers resort to a more aggressive, if not full transition to RE.

5.2 BASELINE AND GROWTH INDICATORS

5.2.1 Physical Setting and Climate

The Philippines sits in the Pacific typhoon belt and experiences an average of 20 typhoons a year, with torrential rains and thunder storms, some of which prove costly and damaging. In 2011, the Philippines ranked 5th among countries worst hit by extreme weather events and in 2012, it ranked 4th.[2] In 2013, the country was ranked 3rd as the country most exposed to disasters, by the Alliance Development Works in its World Risk Index. Extreme events have resulted in losses of lives and in gross domestic product.

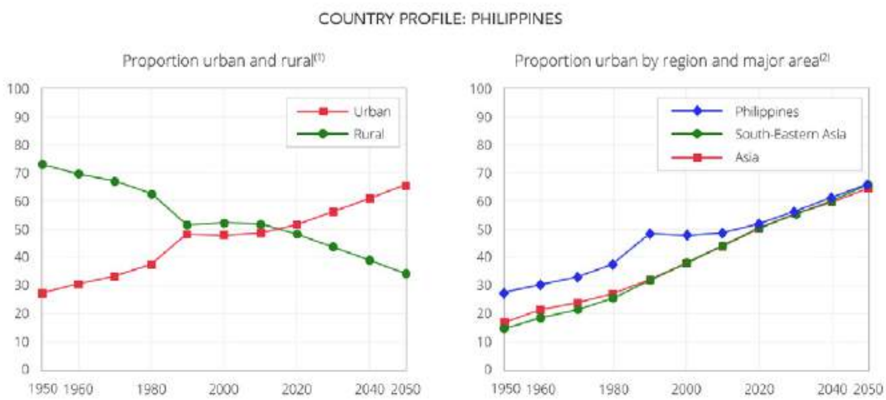
5.2.2 Population

The Philippine population taken during the 2010 census was 92.3 million with an annual population growth rate between 2000 and 2010 of 1.9%.[3] By July 2014,

1 Excludes LUCF, GOP estimates of emissions and carbon sink value have been excluded in its GHG inventory due to discrepancies in valuation.
2 Philippines 4th most vulnerable to climate change over past 20 years, 5th in 2011, Office of the President, Climate Change Commission, InterAksyon.com, Imelda V. Abano, 28 November 2012
3 Understanding Changes in the Philippine Population by Jose Ramon G. Albert, Ph.D http://www.nscb.gov.ph/beyondthenumbers/2012/11162012_jrga_popn.asp

the Philippine population reached 100 M mark, making the country the 12th most populous nation globally. Population growth estimates to Year 2035 is estimated to increase at an annual average of 1.49%. In 2010, the urban population was estimated at 49%. NSO projects that by 2030, more than two-thirds *(about 80 percent)* of Filipinos will be living in cities and urban agglomerations *(Porio, 2009)*.[4] Refer to Figure 5.1.

Figure 5.1 Outlook for Urban-Rural Population, 1950 - 2050, Philippines, SEA and Asia



Source: World Urbanization Prospects: The 2011 Revision

For the purpose of this study and given study period, the projected increase of the urban population in 2050 is assumed at 55%. The ratio of urban and rural population is critical in estimating RE biomass potential and GHG emissions from the Waste Sector, due to waste generation specifics for rural and urban population and its impact on total waste volume.

5.2.3 Economy

The Philippine economy has been largely transformed into an urban-based economy during the last decades. This can be seen in the continuous decline of the growth of the agricultural sector and with the increasing productivity, employment and income opportunities generated by the services and industrial sectors.

The Philippine economy of the Philippines is expected to grow at an average of 4.5% in the next 25 years. It is seen as one of the fastest growing economies in

[4] *Urban Transition, Poverty and Development in the Philippines, A Preliminary Draft by Emma Porio, Department of Sociology and Anthropology, Ateneo de Manila University, 31 August 2009*

the ASEAN region over the outlook period *(Ward, 2012)*. The forecast for economic growth of the Philippines is presented in Table 5.1. Economic performance is projected to be between 4% to 5% from 2010 to 2035, with the average annual growth rate *(AAGR)* from 1990 to 2035 at 4.21%.

Table 5.1 Projected GDP Growth, Philippines, 1990 - 2035

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
GDP	157.3	175.1	208.6	261	332.1	414.1	525.9	658.1	812.6	1006.3
AAGR			2.86%		4.76%		4.70%		4.45%	4.37%
AAGR 1990 - 2035										4.21%

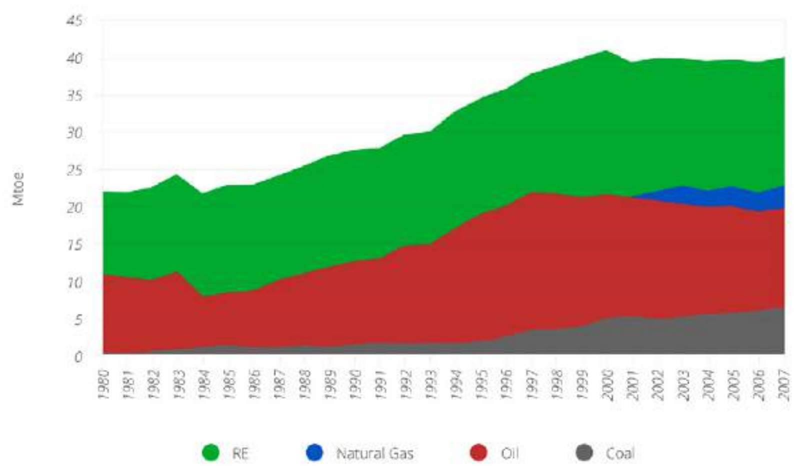
GDP (2005 billion USD purchasing power parity (PPP)
Source: APERC 2013

In 2012, the GDP per capita of the Philippines was estimated at USD4,500 compared to USD4,200 in 2010 *(WB.)*.

5.2.4 Energy Demand and Supply Outlook

There was a 7.88% increase in primary energy supply from 39.8 Million Tonnes of Oil Equivalent *(MTOE)* in 2011 to 42.9 MTOE in 2012.[5] Figure 5.2 below presents the country's primary energy demand from 1980 to 2007.

Figure 5.2 Primary Fuel Mix, Philippines, 1980-2007



Source: Clean Technology Fund (CTF) Investment Plan for the Philippines , GOP, WB, ADB

The Philippine Energy Plan *(PEP)* 2012-2030 provides two *(2)* scenarios developed for the supply side – *the Business-as-Usual (BAU) and the Low Carbon Scenario (LCS). The BAU scenario simulates the future energy supply based on market forces interaction. On the other hand, LCS scenario considers the policy interventions and aggressive implementations of plans and programs for clean and environment-friendly energy fuels and technologies. On the demand side, the LCS scenario serves as the reference case with inclusion of the sector's goal of 10.0 percent energy savings on the total energy demand of all economic sectors by the end of the planning period.*

PEP 2012-2030 projects total primary energy supply to grow at annual average rate of 3.4 percent, to reach 77.5 MTOE in 2030 under the BAU. In comparison, the growth rate of total energy supply in LCS will be higher by 2.0 percentage points. This is due to the utilization of more RE resources, such as hydro, geothermal, wind and solar, contributing about 37.3 percent average share to the total energy supply.

APERC 2013 estimates are found in Figure 5.3. Note that these are lower than figures projected in PEP 2012 - 2030.

Figure 5.3 Prime Energy Supply, BAU Scenario, Philippines, 1990 - 2035, APERC

Source: APERC Analysis (2012)

Table 5.2 Prime Energy Demand, BAU Scenario Philippines, 1990 - 2035, APERC in MTOE										
	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Coal	1.4	1.8	5.1	5.8	6.4	10.9	14.4	18.9	25.5	31.1
Oil	11.1	17.1	16.5	14.3	13.3	14.1	16.3	19.3	23	27.9
Gas	0	0	0	2.7	3.3	4.3	4.9	5.7	5.6	6.6
Hydro	0.5	0.5	0.7	0.7	0.9	0.7	0.9	0.9	0.8	0.9
NRE	15.8	14.5	18.1	15.7	15.7	14.7	15.5	16.2	15.2	16.5
TOTAL	**29**	**34**	**40**	**39**	**40**	**45**	**52**	**61**	**70**	**83**

The country's total primary energy supply is projected to grow moderately at an annual rate of 3% over the next 25 years, or from the 2010 supply level of 39.6 MTOE to 83 MTOE by 2035. These will come largely from imports.

Oil will continue to dominate the economy's energy mix from 2010–2025, accounting for one-third of its total primary energy supply. The transport sector will consume more than 60% of the economy's total oil supply during the period. Coal is projected to grow the fastest at an average annual rate of 6.5% during the outlook period. By the end of 2025, coal is likely to exceed oil as the primary energy supply, mainly as a result of coal use for electricity generation.

Considering new gas finds and other potential indigenous coal and RE sources projected to come into production within the outlook period, more than half of the country's requirements will still need to be imported, reaching 30 MTOE of oil imported by 2035, from its 2010 level of 13.7 MTOE.

Indigenous coal production is projected to increase at an average annual rate of 2.7% from its current level, to reach 7 MTOE by 2035. However, the economy's coal imports will continue to grow over the outlook period. This is due to the significant contribution of coal in the economy's energy mix, particularly with coal generation reaching about 70% of total electricity generation by 2035. A total of 28 MTOE of coal will be needed over the outlook period.

New renewable energy or NRE *(including geothermal)* supply is expected to continue to contribute to the total primary energy supply. Despite a modest annual growth rate of 0.2%, NRE *(including geothermal)* will likely account for about 20% of the economy's total primary energy supply by 2035. *(APERC 2013)*

PEP 2012-2010 projects the total final energy consumption *(TFEC)* will exhibit an annual average growth rate of 2.8 percent. TFEC will reach 39.1 MTOE in Year 2030. To compare, APERC 2013 estimates final energy demand in Year 2030 to reach 43.8 MTOE. (Table 5.3)

Table 5.3 BAU Scenario Final Energy Demand Philippines, 1990 - 2035, APERC

In MTOE	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Industry	4.6	5.4	5.3	5.3	6	7.2	8.6	10.1	11.7	13.5
Other	10.3	10.2	10.3	9.2	9.2	9.4	10.4	11.9	13.8	16.3
Non-Energy	0.4	0.4	0.4	0.2	0.3	0.3	0.3	0.4	0.4	0.4
Domestic Transport	4.6	7.4	8.3	8.5	8.4	9.1	10.5	12.6	15.3	18.8
International Transport	0.4	0.5	0.7	0.9	1.3	1.6	1.9	2.2	2.6	3
TOTAL	20.3	23.9	25	24.1	25.2	27.6	31.7	37.2	43.8	52

The APERC 2013 study estimates the final energy demand to expand at an average annual rate of 2.9% from 2010 to 2035. This translates to a total final energy demand of 49 MTOE by 2035, from the 2010 level of 23.8 MTOE. Together with the economy's fast-paced growth, the industry and domestic transport sectors are both projected to grow at an average annual rate of 3.3% over the next 25 years.

5.2.5 Electricity Production

In 2010, the total annual average demand of 7,800 MW was supplied by power generation plants with a total installed capacity of 16,000 MW, providing a dependable capacity of 85% or 13,000 MW. The distribution of installed capacity in 2010 is 67% fossil and 33% RE. Dependable capacity of fossil based plants averages 68%, and that of RE averages 32%. *Table 5.4* presents the plant mix and their existing capacities and dependable capacities.

Table 5.4 Plant Mix for Electricity Generation in the Philippines, 2010, DOE	2010 Installed	% to Total	Dependable Capacity	% to Total	Dependability % to Installed Capacity
FOSSIL					
Coal	4,867	30%	4,245	87%	31%
Natural Gas	2,861	17%	2,756	96%	20%
Oil	3,193	20%	2,488	78%	18%
Sub-Total	**10,921**	**67%**	**9,489**	**87%**	**68%**
RE					*0%*
Hydro	3,400	21%	3,021	89%	22%
Geothermal	1,966	12%	1,350	69%	10%
Solar	1	0%	1	100%	0%
Wind	33	0%	20	61%	0%
Biomass	39	0%	20	51%	0%
Ocean	0	0%	0		0%
Sub-TOTAL	**5,439**	**33%**	**4,412**	**81%**	**32%**
TOTAL	**16,360**	**100%**	**13,901**	**85%**	**100%**

DOE estimates that peak demand for power in 2012 will grow at an annual average growth rate of over 4% to Year 2030, requiring an additional 13,000 MW of new installed capacity to meet energy demand and reserve margin (Table 5.5). Successful implementation of NREP will triple its RE sourced generation capacity by 2030, and the ratio of installed capacity of RE to fossil will be 52%-48%, as compared to 2010 installed capacity of 33% RE and 67% fossil (Table 5.6).

Table 5.5 Projected Electricity Peak Demand to 2030, DOE in MW

GRID/YEAR	2012	2020	AAGR	2030	AAGR
Luzon	7,969	10,693	3.74%	16,477	**4.42%**
Visayas	1,568	2,237	4.54%	3,431	**4.37%**
Mindanao	1,407	2,068	4.93%	3,250	**4.62%**
TOTAL	**10,944**	**14,998**	**4.02%**	**23,158**	**4.44%**

APERC 2013 projects energy demand to increase by an annual average growth rate of 4.2%, resulting to 187 TWh by 2035, from 67 TWh level of year 2010. In 2030, APERC 2013 projects this to reach only 154.7 TWh, lower than the projected electricity demand of 202.9 TWh by DOE for the same year.

Table 5.6 Projected Installed Plant and Electricity Generation Capacity, Year 2030

	In MW	In MWh	In TWh
Installed Capacity, Year 2010	16,360.00	143,313,600	143.31
Committed	1,766.70	15,476,292	15.48
Sub-TOTAL	**18,126.70**	**158,789,892**	**158.79**
ADDITIONAL NEW CAPACITY			
Baseload Plants	8,400.00	73,584,000	73.58
Mid Range Plants	2,100.00	18,396,000	18.40
Peaking Plants	900.00	7,884,000	7.88
Sub-Total	**11,400.00**	**99,864,000**	**99.86**
TOTAL 2030, Installed Capacity	**29,526.70**	**258,653,892**	**258.65**
Year 2030 Estimated Peak Demand	**23,158.00**	**202,864,080**	**202.86**
Factor for reserve, plant efficiency and dependability			78.43%
PLANT MIX IN YEAR 2030			
RE fuel, NREP Revised Target	15,300.30	52%	
Fossil fuel	14,226.40	48%	
TOTAL	**29,526.70**	**100%**	

The APERC 2013 study also provides that fossil fuels will continue to dominate the economy's total power generation. Coal thermal alone is expected to provide almost 70% of its electricity generation by 2035, followed by natgas with a 16% share. APERC 2013 development scenario provides that the output from coal generation will reach 130 TWh by 2035, up from 20 TWh in 2010. Currently, natgas accounts for almost 30% of the economy's power generation and is expected to increase moderately by 1.7% annually over the next 25 years. Hydro and NRE fueled plants are expected to increase modestly by less than 1% annually from 2010 to 2035, posting a combined output of 22 TWh by 2035 (Table 5.7). The APERC 2013 projection is not in consonance with DOE's resulting plant mix pursuant to implementation of NREP, where RE will achieve a 52% share, and fossil 48%, in Year 2030.

Table 5.7 Supply Outlook for the Philippines to Year 2035, APERC

YEAR	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
INSTALLED GENERATION CAPACITY (MW)										
TOTAL		**9,732**	**13,185**	**15,619**	**16,361**	**27,606**	**33,919**	**40,881**	**53,141**	**58,461**
Thermal										
Coal		850	3963	3967	4867	11412	15412	21060	32700	37400
Oil		5425	4987	3663	3193	2651	2651	2651	2651	2651
Gas			3	2763	2861	5860	6960	8060	8660	9260
Hydro		2303	2301	3222	3400	5200	6200	6200	6200	6200
NRE		1154	1931	2004	2040	2483	2696	2910	2930	2950
CALCULATED EFFICIENCY RATES										
TOTAL					**29.90%**	**30.70%**	**31.40%**	**32.30%**	**34.10%**	**34.80%**
Thermal										
Coal					37.10%	37.70%	38.20%	38.70%	39.30%	39.80%
Oil					35.80%	35.70%	36.10%	36.10%	36.10%	36.20%
Gas					55.90%	45.60%	45.10%	44.80%	44.10%	43.40%
Hydro					100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
NRE					10.20%	10.10%	10.10%	10.10%	10.10%	10.20%
ELECTRICITY ONLY PLANTS/ELECTRICITY GENERATION OUTPUT BY FUEL (TWh)										
TOTAL	**26.3**	**33.6**	**45.3**	**56.6**	**67.1**	**83.4**	**103.8**	**127.6**	**154.7**	**186.8**
Thermal										
Coal	1.9	2.1	16.7	15.3	20.2	39.3	54.5	74.1	104.4	130.4
Oil	12.4	19.1	9.2	6.1	5.9	4	3.9	3.9	3.5	3.8
Gas		0	0	16.9	20	21.1	23.9	27.4	26.2	30.2
Hydro	6.1	6.2	7.8	8.4	10.1	8.7	10	9.9	9.5	10.3
NRE	5.9	6.1	11.6	9.9	10.9	10.3	11.5	12.3	11.1	12.1

Source: APERC 2013
Note: NRE - New RE includes Geothermal

5.2.6 Cost of Electricity and Per Capita Consumption in the Philippines

The power sector has undergone critical reforms, placing the sector on a full cost recovery basis. The electric power generation sub-sector has shifted to a purely commercial business with new capacity to be constructed by the private sector. Transmission operations have been privatized, operating on commercial principles with an independent regulator, along with distribution in the major metropolitan areas.

Philippine consumers pay some of the highest retail electricity prices in the Southeast Asia region: the average retail tariff is USD0.22 per kilowatt-hour *(kWh)*.[6]

A study made in October 2012 by the International Energy Consultants showed that the average retail rate of electricity is USD18.1 cents per kilowatt-hour in the Philippines, easing out Japan at the top, as having the most expensive electricity in Asia.

The high cost of electricity in the Philippines was traced to the fact that all costs - from producing power to distribution and taxes - are passed on to consumers. Further, the Philippines is the only country in the region that has privatized its electric power sector and has no state subsidy on rates.

Table 5.8 Cost of Electricity in the Philippines, DOE

DISTRIBUTION UTILITIES / REGION	Residential	Commercial	Industrial	Others	Average
Average Luzon	7.70	7.57	6.70	7.05	7.38
Average Visayas	5.87	6.04	5.82	5.87	5.89
Average Mindanao	4.58	4.81	4.59	5.11	4.68
Average Philippines	**7.10**	**7.26**	**6.29**	**6.19**	**6.90**

Average price is based on the reported revenue in Pesos divided by the reported Electricity Sales in kWh of the distribution utilities.

5.2.7 Availability of Indigenous Fossil Fuels

Government's policy is to optimize the development potential of its fossil resources *(coal, natgas and possibly oil)* to contribute to the attainment of the country's energy self-sufficiency program. It hopes to achieve a production level of 8.59 million barrels of oil, 294 billion cubic feet *(8.49 billion cubic meters)* of gas and 87.58 million barrels of condensate by the end of 2030. Assuming these targets are realized, hydrocarbon resources level will reach 45% by 2035 from the 2010 production level of 30%.

In 2007, 75 percent of the 10 Mmt of coal consumed in the Philippines came from Indonesia *(4.5 Mmt)*, followed by China *(2.1 Mmt)*. Coal is utilized by the cement industry *(about 20%)*, as well as other industries such as alcohol, sinter, rubber boots, paper and chemical manufacturing, fertilizer production and smelting process *(1%)*, while the larger portion is utilized by coal-fired plants. In 2008, the demand of 12 MMT (Million Metric Tons) was projected to reach 15 MMT in 2014. Local coal production was 3.4 MMT in 2007, as compared to 1.4 MMT in 2000 *(EIA, 2009)*.

The Philippines' coal reserves are summarized in Table 5.9 below.

Table 5.9 Philippine Coal Reserves and Production

INIDICATOR	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proves Coal reserves (2005)*	275	41	316	39 (0.04%)
Annual Coal Production (2008)**	2.36	0.003	2.36	43 (0.04%)

Source: EIA (2009)

In 2012, indigenous coal production *(run-of-mine)* was recorded at 7.4 MMT.

As of December 2012, the DOE listed 60 coal operating contracts (COCs), 29 of which are under exploration stage to verify potentials of the coal fields, and 31 COCs covering development and production. The Geothermal and Coal Resources Development Division *(GCRDD)* continuously conducts reconnaissance and semi-detailed mapping of under explored coal areas to supplement exploration activities. In addition, in the island of Cebu, where the majority of small-scale coal mines are located, two feasibility studies *(one funded by the U.S. Trade Development Program and the other by the Canadian International Development Agency)* have established that it would be technically and economically viable to put up a central coal preparation plant. There are Philippine coal deposits of such quality that do not require any coal preparation or blending with imported coals. DOE has entered into cooperative efforts under its Alternative Energy Program with research entities to determine the potential of coal deposits for coal liquefaction, coal briquetting and coal bed methane. DOE also advocates the introduction of clean coal technologies *(i.e., circulating fluidized bed combustion)*, particularly the utilization of coal for power generation and cement manufacturing companies, to minimize adverse effects of coal on the environment and still be competitive.

For the exploration of oil concession areas and natgas deposits, DOE enters into service contracts under a bidding process, subject to sharing their net proceeds with the government. As of 2009, 34 service contracts *(including those for geothermal)* have been supervised and monitored by the DOE and the number is likely to increase to 117 by 2030.

As of June 2011, the potential petroleum resources of the Philippines totaled to 27,905 million barrels of oil initially in place and 53,870 billion cubic feet of gas in place. The estimated recoverable discovered and undiscovered resources include 1,892 million barrels of oil, 10,349 billion cubic feet of gas and 164 million barrels of condensate *(DOE)*.

The Philippines has 16 sedimentary basins, covering about 519,841.73 line-kilometers *(ln-kms)* of 2D and 16,948.56 km^2 of 3D seismic data. Majority are in Luzon, particularly in Palawan. These basins extend on both offshore and onshore areas. The offshore regions comprise both shallow to deepwater areas for exploration.

In 1989, relatively large fields were discovered in the deep waters off Palawan when Occidental Petroleum tested gas in its Camago Structure. Alcorn Philippines, in 1990, discovered the West Linapacan Field and commenced production two years later until 1996. In 1990, Shell discovered Malampaya gas field becoming, by far, the largest gas discovery in the country. The field started to produce commercially in 2002, providing clean fuel for power generation to Luzon grid. Malampaya natgas provides about 40% of Luzon's power requirement today.

In 2012, the United Nations confirmed Benham Rise, an area which can potentially contain natural gas and important minerals, as part of the Philippines' continental shelf and territory. Research is still on-going to explore the 13 million hectare underwater plateau.

Onshore in northern Luzon, the Philippine National Oil Company developed and produced the San Antonio Gas Field in 1994 and supplied natgas as fuel to the local electric cooperative in the Province of Isabela.

As of end June 2011, the total oil production from the different fields totalled about 63,208,020.12 barrels. There are two *(2)* other fields that are being evaluated for rehabilitation, namely; Cadlao and West Linapacan fields that have produced 11,235,334 barrels and 8,528,118 barrels of oil respectively.

Shell Philippines Exploration B.V. *(SPEX)* produced from the Malampaya field *(SC 38)* a cumulative total of 1,083,551.282 million Standard Cubic Feet *(mmscf)* of natgas and 48,191,493.636 barrels of condensate from October 2001 until 30 June 2011. Another field, the Libertad gasfield, located in Bogo, northern Cebu is under development and expected to produce natgas as fuel to power a 1 Megawatt turbine for domestic electric generation in the area. The Libertad gasfield is under SC40 being operated by Forum Energy Philippines, Inc.

5.2.8 Investment Cost for Electricity Generation Plants and Operations & Maintenance Cost per kWh

The government recognizes that some estimates show that under a business as usual scenario, 50 percent of installed electricity generation capacity by 2030 will be accounted for by coal *(APEC, 2006)*. The shift towards using more coal to meet power expansion needs is primarily driven by cost consideration despite the availability of RE resources. The Philippine energy road map, endorsed by the President in 2008, also recognizes that technology and modal shifts can be implemented to mitigate power and transport sector emissions growth in the near future with a strong effort to address RE development, transmission and distribution system optimization, transport fuels, vehicle technology, infrastructure, and behavioral changes.

5.2.9 Biomass Potential from Agriculture Sector

The maximum potential for RE from methane emissions from the agriculture sector is not realized. According to a study conducted by the International Institute for Energy Conservation *(IIEC)*, potential methane recovery is approximately 61,509 tons methane per year for swine farming and 426 tons methane per year for slaughterhouses.[7]

As of the year 2010, there were about 300 operational biogas systems with varying capacities ranging from small scale operation for households to large scale process for commercial facilities are implemented *(around 7-9% of medium to large commercial farms)*. Methane produced from enteric fermentation and manure management which can be recovered for power generation are presented in Tables 5.10 and 5.11.

7 *These are computed using the Intergovernmental Panel on Climate Change (IPCC) Methodology.*

Table 5.10 Methane (CH_4) Emissions from Enteric Fermentation of Domestic Livestock, Years 2008 - 2011

TYPE/YEAR	2008	2009	2010	2011
Dairy Cattle	156,526,000	157,746,000	156,831,000	153,598,000
Non-Dairy Cattle	653,300	709,700	794,300	817,800
Non-Dairy Buffalo	183,645,000	182,655,000	179,850,000	169,125,000
Dairy Bufalo	737,000	748,000	764,500	808,500
Meat Goats	20,870,000	21,110,000	20,890,000	19,385,000
Diary Goat	4,500	4,500	6,000	6,500
HORSES				
Swine	13,701,000	13,596,000	13,398,000	12,303,000
POULTRY				
Chicken	0	0	0	0
Broiler	0	0	0	0
Layer	0	0	0	0
Native	0	0	0	0
Duck	0	0	0	0
CH_4 in kg	**376,136,800**	**376,569,200**	**372,533,800**	**356,043,800**
CH_4 in Tons	**376,137**	**376,569**	**372,534**	**356,044**
in CO_2e	**7,898,873**	**7,907,953**	**7,823,210**	**7,476,920**
Mt CO_2e	**7.9**	**7.91**	**7.82**	**7.48**

Table 5.11 Methane (CH_4) Emissions from Manure Management of Domestic Livestock, Years 2008 - 2011

TYPE/YEAR	2008	2009	2010	2011
Dairy Cattle	79,546,000	80,166,000	79,701,000	78,058,000
Non-Dairy Cattle	13,900	15,100	16,900	17,400
Non-Dairy Buffalo	6,678,000	6,642,000	6,540,000	6,150,000
Dairy Bufalo	26,800	27,200	27,800	29,400
Meat Goats	918,280	928,840	919,160	852,940
Diary Goat	198	198	264	286
HORSES				
Swine	95,907,000	95,172,000	93,786,000	86,121,000
POULTRY				
Chicken	3,085,180	3,173,260	3,179,680	3,254,440
Broiler	1,044,620	1,138,840	1,044,260	1,094,220
Layer	503,360	503,640	572,780	629,000
Native	1,537,220	1,530,800	1,562,640	1,531,220
Duck	210,160	211,540	205,360	202,160

TYPE/YEAR	2008	2009	2010	2011
CH_4 in kg	189,470,718	189,509,418	187,555,844	177,940,066
CH_4 in Tons	189,471	189,509	187,556	177,940
in CO_2e	3,978,885	3,979,698	3,938,673	3,736,741
Mt CO_2e	3.98	3.98	3.94	3.74

Although biogas systems are considered mature and their use have been amply demonstrated, the technology is not widely adopted in the Philippines. There is a need for technical and financial expertise to package bankable projects. There is also lack of product standards, quality control measures, testing, verification and monitoring of biogas technologies in the Philippines.

Government is trying to address institutional, technical and economic barriers in the pursuit of this towards creating a market-based environment to make it conducive to private sector investment and participation.

In terms of residues from agricultural crops, it was estimated that 64% of sugarcane fields and 90% of rice fields are burned every year *(Mendoza and Samson, 1999)*. This translates to approximately 3 million tons of sugarcane and 8.1 million tons of rice straw, equivalent to 30 million barrels of oil.[8] Rather than open burning of crop residue, crop residue produced by a cluster of farms or mills can be consolidated to achieve volumes required by biomass RE plants within short distance from the source.

Table 5.12 Agricultural Crop Residue in the Philippines, Years 2008-2011

CROP PRODUCTION IN METRIC TONS		FACTOR	2008	2009	2010	2011
Rice	Dry Season		7,120,000	7,380,000	6,620,000	Not Available
	Wet Season		9,690,000	8,880,000	9,150,000	Not Available
Sugarcane				22,932,800	17,929,300	28,376,500
Corn				7,034,000	6,376,800	6,971,200
RESIDUE TO CROP RATIO IN METRIC TONS		FACTOR	2008	2009	2010	2011
Rice Straw	Dry Season	1.4	9,968,000	10,332,000	9,268,000	7,214,746
	Wet Season	1.4	13,566,000	12,432,000	12,810,000	9,469,354
Sugarcane Trash		0.8		18,346,240	14,343,440	22,701,200
Corn Stovers		1		7,034,000	6,376,800	6,971,200
FRACTION BURNED IN FIELDS		FACTOR	2008	2009	2010	2011
Rice Straw	Dry Season	0.59	5,881,120	6,095,880	5,468,120	4,256,700
	Wet Season	0.12	1,627,920	1,491,840	1,537,200	1,136,322
Sugarcane Trash		0.25		4,586,560	3,585,860	5,675,300
Corn Stovers		0.25		1,758,500	1,594,200	1,742,800

8 *Philippines Agricultural Climate Change Project: "Conservation and Utilization of Crop Residues as a Greenhouse Gas Mitigation Strategy in the Philippines" March 2003, CIDA, prepared by Resource Efficient Agricultural Production (REAP), Canada; Paghida-et sa Kauswagan Development Group (PDG) Inc., Magsasaka at Siyentipiko para sa Pag-unlad ng Agrikultura (MASIPAG) Visayas and MAPISAN Farmers Alliance*

CROP PRODUCTION IN METRIC TONS	FACTOR	2008	2009	2010	2011
TOTAL In Metric Tons		7,509,040	13,932,780	12,185,380	12,811,123
In Gg		7,509	13,933	12,185	12,811
CH_4 Emission Ratio in Gg	0.004	30.04	55.73	48.74	51.24
in CO_2e in Gg		630.76	1,170.35	1,023.57	1,076.13
TOTAL in Mt CO_2e		0.631	1.17	1.024	1.076

5.2.10 Biomass Potential from Waste Sector

As reported in the IPCC Guidelines, the Municipal Solid Waste generation rate of 0.19 tons per capita/year is higher than waste generation data provided by the National Solid Waste Management Commission at 0.14 tons per capita/year. The average per capita waste generation used as basis for calculating biomass potential and carbon emissions with the given composition of the waste stream is at 0.179 kg. per day, excluding waste recycled at source.

5.3 LOW CARBON STRATEGIES OF THE GOVERNMENT

The Philippines government's low carbon strategy is outlined as follows:

- Increase generation capacity from 16 GW in 2011 to 29 GW in 2030 and expand grid to interconnect all major islands;
- Triple installed renewable capacity to 15 GW in 2030, with most of the growth from geothermal and hydropower;
- Achieve energy savings of 10% by 2030 relative to business-as-usual;
- Increase household electrification rate from 70% to 90% by 2017 and 100% sitio *("small township")* electrification by 2015;
- Implement an LPG conversion program, an electric vehicle demonstration initiative and increase the number of public utility vehicles running on CNG; and LPG to 30% by 2030 (from 10% today). Ethanol blend in gasoline to reach 20% by 2020. Biodiesel blend in diesel to reach 5% in 2015, 10% in 2020 and 20% by 2025.

5.3.1 Clean Technology Fund (CTF) Investment Plan[9]

The NEDA Board's Cabinet-level Infrastructure Committee has identified an ambitious CTF Investment Plan, which focuses on demonstration, deployment and

9 *Clean Technology Fund Plan for the Philippines, developed by the government of the Philippines (GOP) in agreement with the Asian Development Bank (ADB), the International Bank for Reconstruction and Development (IBRD), and the International Finance Corporation (IFC).*

transfer of low carbon technologies, in line with ADB, IFC and WB *(or IBRD)* policies and programs to reduce carbon emissions in Energy and Transportation.

The CTF Investment Plan for Electricity Generation calls for interventions that will layout the foundations for a transformation of the energy sector in a way that will distribute electricity generated from RE sources; and improve energy efficiency through demand side management. The plan provides:

A. Distributed Generation through Renewable Resources --- To match the archipelago's configuration of the country, this will be done by facilitating, in the short-term, distributed generation projects through scaling-up of renewable energy resources, which will displace about MW 300-400 of coal generation;

B. Energy Efficiency through Demand Side Management --- Address transmission constraints in the short term, particularly those faced in the Visayas and Mindanao regions by starting the development of a Demand Side Management Program (smart grid, demand side management) to improve the credit worthiness of power off-takers in the distribution side of the business, which will displace about MW 150-200 of coal generation.

The combined impact of the proposed interventions is intended to displace about MW 450-600 of coal generation equivalent to about 3 million tons of CO_2/yr. More important it will serve as a basis for the government's more ambitious goal of displacing 5,000 MW of coal generation under the low coal scenario.

The GOP proposed to allocate CTF resources to start moving from the BAU case to the medium carbon case first (30 percent below BAU CO_2e emissions) under the current allocation, as follows:

A. Renewable Energy: private sector investment in RE including wind, geothermal, biomass, solar power generation and small scale hydro (up to MW 10).

B. Energy Efficiency: private sector investments in energy efficiency including demand side management in the distribution sector, smart grid technology to integrate RE, and energy efficiency in commercial and public sectors.

Table 5.13 Results Indicator for Renewable Energy and Energy Efficiency Interventions, CTF Investment Plan		
INDICATORS	Baseline	Investment Program Result
New installed RE-based power generation capacity by 2020	340 MW	100-150 MW of equivalent installed coal capacity displaced by EE interventions by 2020 300-450 MW of installed coal capacity displaced by investments in RE-based generation by 2020
Estimated annual GHG emissions reduction	0 $MtCO_2e$/year	3 $MtCO_2e$/year
Rapid replication potential towards government goal to move from baseline to medium scenario (e.g. from 5,500 MW to 7,750 MW of installed RE-based generation by 2030)	Zero additional RE-based generation capacity from baseline scenario	Investments in RE and EE would result in displacing 450-600 MW equivalent coal installed capacity. It would jumpstart efforts to reach additional 2,250 MW installed RE-based generation capacity under the medium scenario.

The CTF Investment Plan for Transport proposes inclusion of BRT systems in Metro Manila and Cebu to provide for a cost-effective transport system alternative. The BRTs systems envisioned for the Philippines have the cumulative GHG emissions abatement potential of about 2-3 $MtCO_2e$/y. The proposed BRT interventions are estimated to reduce GHG emissions by about 0.6-0.8 $MtCO_2e$/y.

Without promotion of low carbon policies and strategies for the transport sub-sector, under a BAU regime, its contribution of 29 $MtCO_2e$ in Year 2008 in the country's total emissions is projected to increase to over by 133%, or by 68 $MtCO_2e$ in Year 2030 *(Fabian and Gota)*.[10]

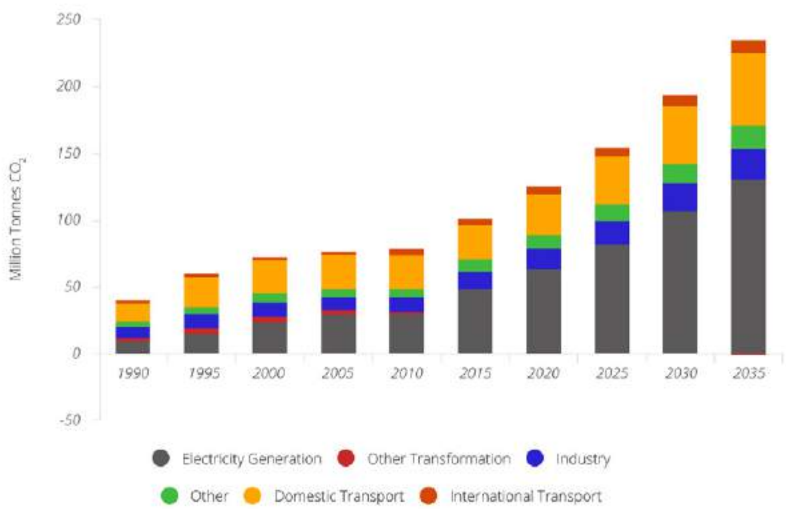
5.3.2 Asia-Pacific Energy Research Centre (APERC)

The APERC 2013[11] study reports that under business-as-usual assumptions, the Philippines projections reflect positive economic growth, matched by a corresponding growth in energy demand. The projection showed the economy's CO_2 emissions increasing 4.5% annually to Year 2035. This leads to an increase in CO_2 emission levels from 75.9 million tonnes in 2010 to 230.2 million tonnes by 2035, particularly because of the projected increase in fossil fuels consumption, especially in coal for power generation. Emissions from electricity generation grow by 6% per year and from coal-fired generation by 7.4% per year. (Table 5.14 and Figure 5.4)

10 *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, prepared by Transport and Traffic Planners Inc. in association with CPI Energy Phils., Inc.*
11 *Asian-Pacific Economic Cooperation (APEC) Energy Demand and Supply Outlook 5th Edition, Economy Reviews, February 2013, Asia Pacific Energy Research Centre (APERC) http://aperc.ieej.or.jp/file/2013/2/22/EDSO_Vol1_Full.pdf, http://aperc.ieej.or.jp/file/2013/2/22/EDSO_Vol2_Full.pdf, http://aperc.ieej.or.jp/publications/reports/outlook/5th/bau.html*

Table 5.14 BAU Scenario Projected CO_2 Emissions for the Philippines, 1990 - 2035, APERC										
in $MtCO_2$	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Electricity Generation	8.4	14.6	22.5	28.2	30.1	48.0	62.4	80.8	105.6	129.1
Other Transformation	2.2	2.8	4.2	3.7	0.2	-0.1	-0.3	-0.5	-1.1	-1.3
Industry	9.1	11.3	10.2	9.4	10.8	12.7	14.9	17.2	19.6	22.3
Other	3.5	5.2	7.1	5.6	6.3	7.6	9.5	11.8	14.3	17.4
Domestic Transport	13.8	22.0	24.7	25.3	24.7	26.2	30.3	36.0	43.7	53.8
International Transport	1.3	1.6	2.2	2.6	3.9	4.6	5.6	6.7	7.7	9.0
TOTAL	38.3	57.5	70.9	74.8	76	99	122.4	152	189.8	230.3

Figure 5.4 Philippine Carbon Emissions 1990 - 2035, APERC



Source: APERC Analysis (2012)

The resulting carbon emission per capita is projected to reach 1.7 tons by 2035. But, despite its low per capita emissions by 2035, APERC's BAU projection indicates that the growth rate of CO_2 emissions in the Philippines will be at 4.5% annually from 2010–2035, thus the need to implement intervening measures to ensure environmental sustainability. Since the electricity sector has the highest emissions growth, APERC's study proposes that improvement measures should focus on this sector, through improvement of energy efficiency in electricity generation, transmission and distribution systems, as well as in intensifying the implementation of the RE Law which would consequently reduce fossil fuels consumption.

APERC 2013 proposed three sets of alternative scenarios developed for most APEC countries and provides their impacts on carbon emission levels.

A. Low Carbon Alternative 1 - High Gas Scenario

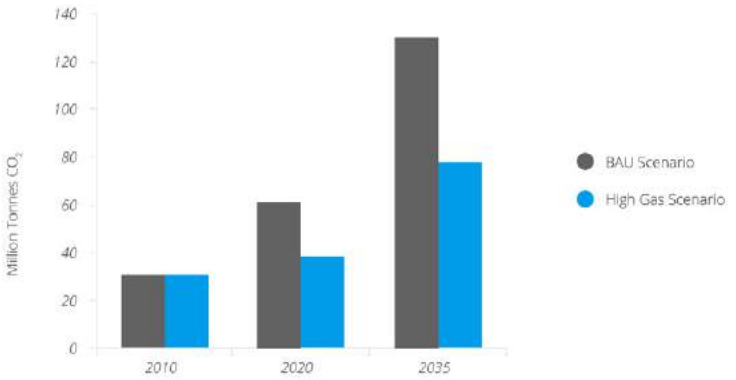
To understand the impacts higher gas production might have on the energy sector, an alternative 'High Gas Scenario' was developed. This scenario is based on the premise that the economy's natgas supply will be sufficient for its domestic requirements. The scenario was built around estimates of gas production that might be available at BAU scenario prices or below if constraints on gas production and trade could be reduced.

The High Gas Scenario in the Philippines assumed natgas production would reach 62.7 MTOE in 2035, 10 times more than the production level under BAU. This potential production scenario was taken from a joint study done in cooperation with the Japan International Cooperation Agency *(JICA, 2012)*. The increase in production will begin to take place in 2017, with production levels twice those under the BAU scenario in that year. This additional gas production will most likely come from the Malampaya gas fields. Additional gas production was assumed to replace coal in electricity generation in the Philippines from 2019, reaching 161 TWh in 2035, which is 86% of the total electricity output of the economy.

Since gas has roughly half the CO_2 emissions of coal per unit of electricity generated, this had the impact of reducing CO_2 emissions in electricity generation by 40% by 2035. This is compared to the BAU emissions level of 129 million tonnes CO_2 (see Figure 5.5).

An increase in natgas production envisions the development of additional infrastructure, such as the expansion of natgas fired power generation capacity, LNG *(liquefied natural gas)* terminals and several pipelines to extend the use of gas in other sectors, and the construction of additional CNG refueling stations for natural gas vehicles *(NGVs)*. In the High Gas Scenario, additional gas production will not be exported through gas pipelines. For gas pipeline exports to take place, the Philippines will need to commit to the Trans-ASEAN gas pipeline project requirements *(ASCOPE, 2010)*.

Figure 5.5 High Gas Scenario, CO_2 Emissions from Electricity Production in the Philippines, APERC

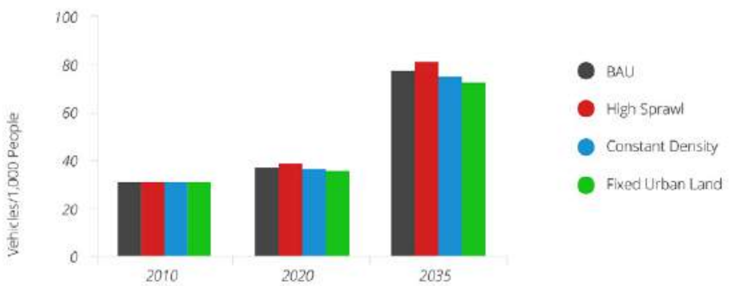


Source: APERC Analysis (2012)

B. Low Carbon Alternative 2 - Urban Development Scenarios

Three alternative urban development scenarios were developed: 'High Sprawl', 'Constant Density', and 'Fixed Urban Land' to understand the impacts of future urban development on transport in the energy sector. As urbanization increases rapidly in the next 25 years, so will vehicle ownership, estimated at 8% higher in the High Sprawl scenario compared to the BAU in 2035, but 13% lower than BAU in the Fixed Urban Land scenario. This means that significant urban planning would have a direct effect on vehicle ownership in the long run, specifically in Metro Manila. This results in changes in the oil consumption of light vehicles considerably under BAU and the three alternative urban development scenarios. Figure 5.6 shows this change in vehicle ownership under BAU and the three alternative urban development scenarios.

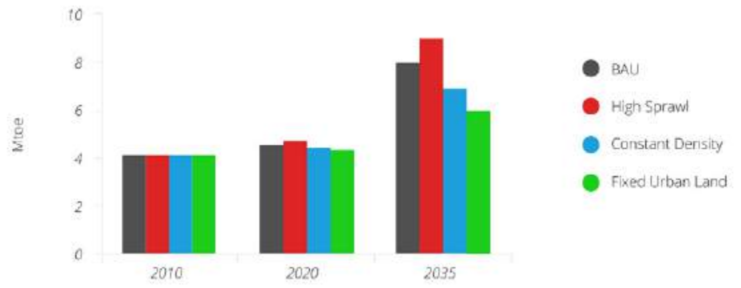
Figure 5.6 Urban Development Scenarios - Vehicle Ownership Philippines, APERC



Source: APERC Analysis (2012)

Figure 5.7 shows that light vehicle oil consumption will be noticeably higher in the High Sprawl scenario, at 16% compared to BAU in 2035. On the other hand, light vehicle oil consumption in the Fixed Urban Land scenario is 24% lower than BAU by 2035, resulting from significantly shorter travel distances per vehicle and vehicle ownership in more compact cities are significantly reduced.

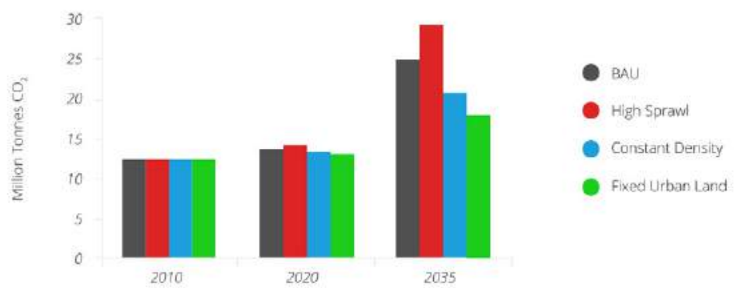
Figure 5.7 Urban Development Scenarios - Light Vehicle Oil Consumption Philippines, APERC



Source: APERC Analysis (2012)

Figure 5.8 shows the change in light vehicle CO_2 emissions under BAU and the three alternative urban development scenarios. The impact of urban planning on CO_2 emissions is similar to that of the impact of urban planning on energy use, as there is no significant change in the mix of fuels used under any of these scenarios. Light vehicle CO_2 emissions would be 16% higher in the High Sprawl scenario compared to BAU in 2035, and about 24% lower in the Fixed Urban Land scenario.

Figure 5.8 Urban Development Scenarios - Light Vehicle Tank-to- Wheel CO_2 Emissions, Philippines, APERC

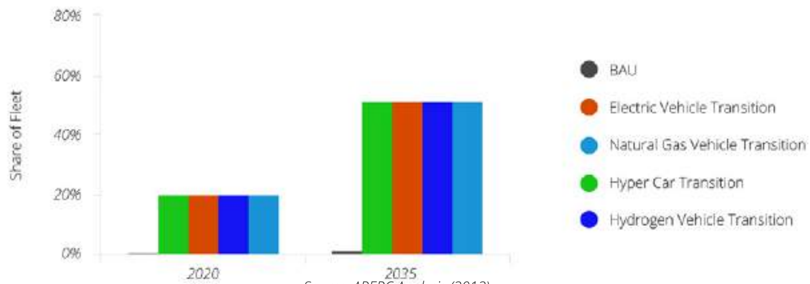


Source: APERC Analysis (2012)

C. Low Carbon Alternative 3 - Virtual Clean Car Race

Four alternative vehicle scenarios were developed to understand the impacts of vehicle technology on the energy sector given assumptions, namely: 'Hyper Car Transition' (ultra-light conventionally-powered vehicles), 'Electric Vehicle Transition', 'Hydrogen Vehicle Transition', and 'Natural Gas Vehicle Transition'. The evolution of the vehicle fleet under BAU and the four 'Virtual Clean Car Race' scenarios is shown in Figure 5.9. By 2035, the share of the alternative vehicles in the vehicle fleet is assumed to reach about 52% compared to about 1.6% in the BAU scenario. The share of conventional vehicles in the fleet is only about 48% compared to about 98.4% in the BAU scenario.

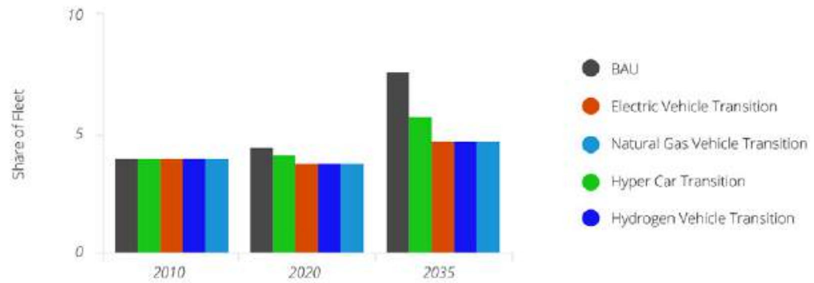
Figure 5.9 Virtual Clean Car Race - Share of Alternative Vehicles in the Light Vehicle Fleet, Philippines, APERC



Source: APERC Analysis (2012)

Figure 5.10 shows the change in light vehicle oil consumption under BAU and the four alternative vehicle scenarios, where oil consumption drops significantly by 41% in the Electric Vehicle Transition, Hydrogen Vehicle Transition, and Natural Gas Vehicle Transition scenarios compared to the BAU scenario. The large drop occurs since these alternative vehicles use no oil. Oil demand in the Hyper Car Transition scenario is also reduced significantly by 26% compared to BAU by 2035.

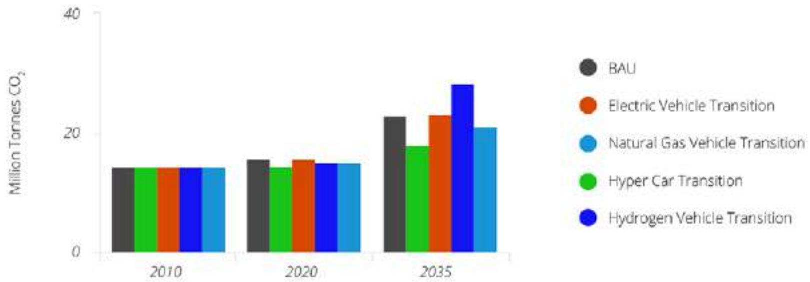
Figure 5.10 Virtual Clean Car Race - Light Vehicle Oil Consumption, Philippines, APERC



Source: APERC Analysis (2012)

Figure 5.11 shows the change in light vehicle CO_2 emissions under BAU and the four given alternative vehicle scenarios. APERC provides that to allow for consistent comparisons, in the Electric Vehicle Transition and Hydrogen Vehicle Transition scenarios, the change in CO_2 emissions is defined as the change in emissions from electricity and hydrogen generation. The emissions impacts of each scenario may differ significantly from their oil consumption impacts, since each alternative vehicle type uses a different fuel with a different level of emissions per unit of energy.

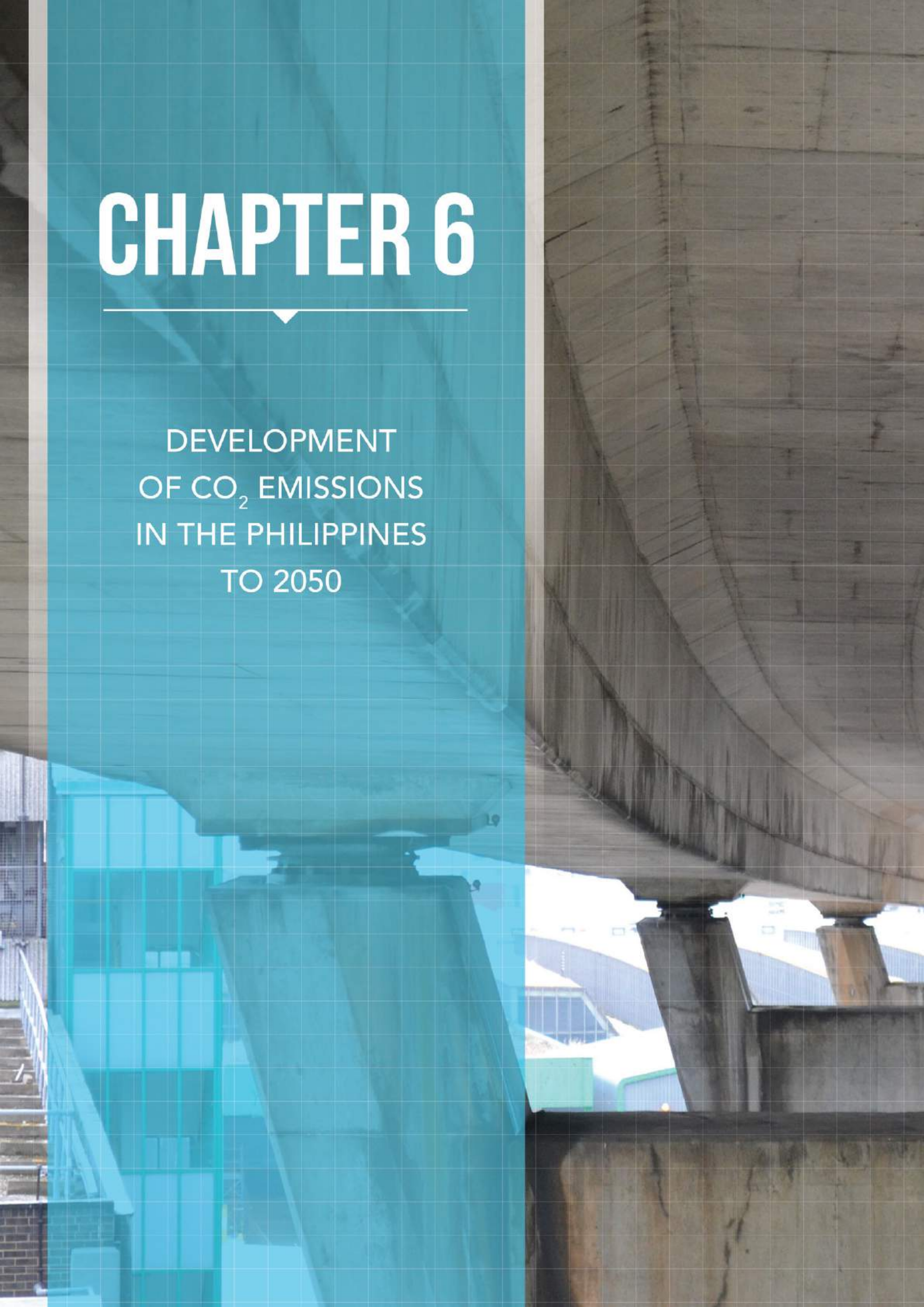
Figure 5.11 Virtual Clean Car Race - Light Vehicle CO_2 Emissions, Philippines, APERC



Source: APERC Analysis (2012)

The APERC study concludes that with given alternatives in the Virtual Clean Car Race for the Philippines, the Hyper Car Transition scenario is the clear winner in terms of CO_2 emissions reduction with emissions reduced by 26% compared to BAU in 2035. The Natural Gas Vehicle Transition scenario reduced emissions slightly, by 6% ,compared to BAU. The CO_2 emissions from the Electric Vehicle Transition scenario showed no difference compared to BAU in 2035. This may be caused by the high prevalence of coal in the electricity generation mix. The Hydrogen Vehicle Transition scenario offers no emissions reduction benefits—emissions increased by 13% compared to BAU in 2035. It is noted that to facilitate fair comparisons, the Electric Vehicle Transition and Hydrogen Vehicle Transition scenarios assumed no additional non-fossil utilization for their energy production.


e-trike



CHAPTER 6

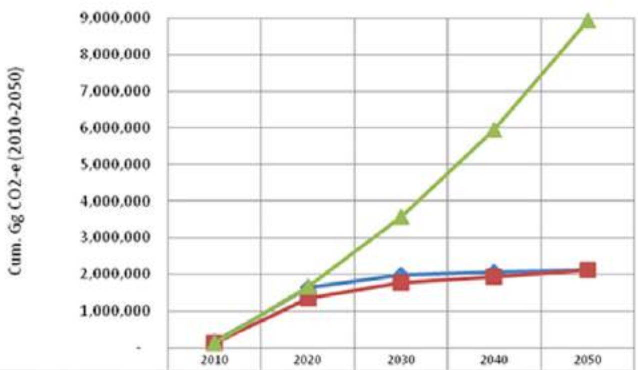
DEVELOPMENT OF CO_2 EMISSIONS IN THE PHILIPPINES TO 2050

6.1 PHILIPPINE CARBON BUDGET

Given the negative impact of rising global GHG emissions on temperature and the accompanying adverse consequences of global warming, a more stringent carbon budget that does not exceed a cumulative 600 GtCO_2e needs to be achieved to prevent global temperature from rising beyond 2°C until 2050. This cannot be achieved by developed countries alone. Developing countries like the Philippines must do their share to help keep within the given global carbon budget. For this study, the goal set for the Philippines, pro-rata to its population is to keep within a cumulative carbon budget not to exceed 2,105 Tg-CO_2e to Year 2050 defined in Chapter 1 of this study.

The development of carbon emissions under current baseline trend and given carbon budget for the Philippines is presented in Figure 6.1.

Figure 6.1 Comparative Cumulative Carbon Emissions Development, Baseline and Given Carbon Budget, Years 2010 - 2050[1]



	2010	2020	2030	2040	2050
Allowable Philippine Cum. Budget	168,339	1,637,406	1,994,434	2,051,952	2,104,572
Philippine Worldwide Relative Budget (600Gt Goal)	135,000	1,345,772	1,775,808	1,933,955	2,104,572
Philippine Real Emissions Baseline	135,000	1,663,542	3,572,297	5,955,840	8,932,270

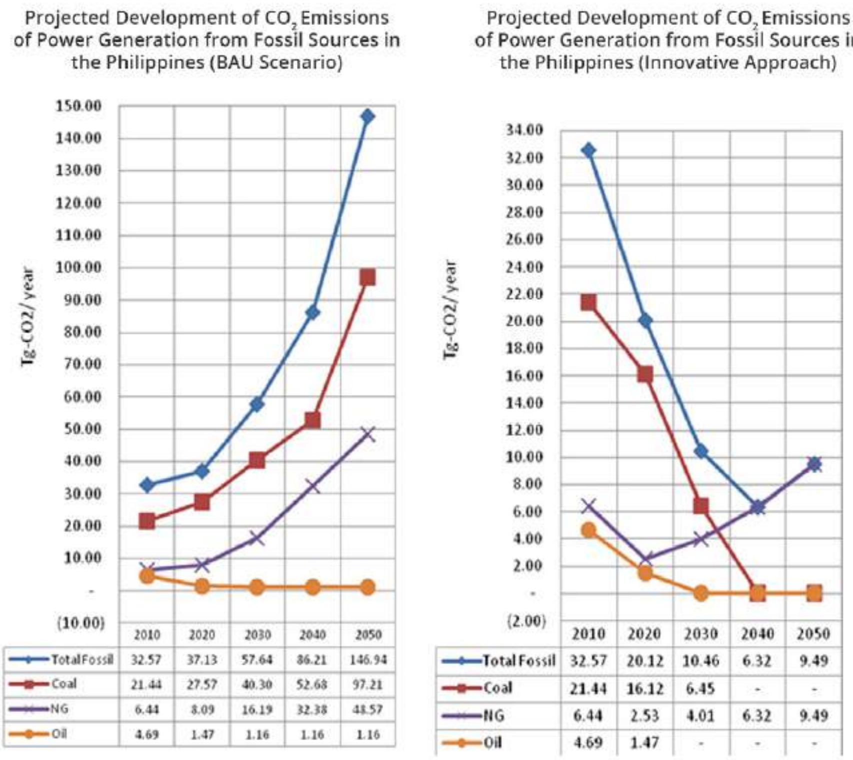
This shows that by 2050, the country's CO_2e emissions will reach almost 9,000 Tg-CO_2e, or by more than 400% of the given carbon budget following the country's current baseline trend.

1 JLBTC Model Calculation, 4-EvaluationReport.xlsx

6.2 ESTIMATED CO_2 EMISSIONS FOR ELECTRICITY GENERATION

Figure 6.2 below show the development of annual CO_2 emissions from the three different fossil energy sources: Coal, Natgas and Oil *(Diesel)* for BAU and Innovative approach. To compare, Figure 6.3 shows the development of annual CO_2 emissions for the 40-year study period. Under Innovative 3 Scenario, only emissions from natgas will increase, but emission levels are comparatively lower than emissions from natgas under the BAU 3 Scenario.

Figure 6.2 Philippine Carbon Emissions Development from Fossil Fuels, BAU 3 and Innovative 3 Scenarios, Years 2010 - 2050[2]



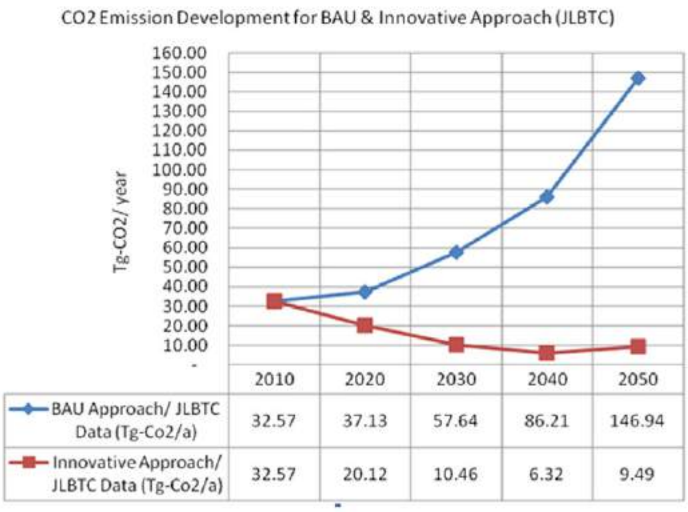
	2010	2020	2030	2040	2050
Total Fossil	32.57	37.13	57.64	86.21	146.94
Coal	21.44	27.57	40.30	52.68	97.21
NG	6.44	8.09	16.19	32.38	48.57
Oil	4.69	1.47	1.16	1.16	1.16

	2010	2020	2030	2040	2050
Total Fossil	32.57	20.12	10.46	6.32	9.49
Coal	21.44	16.12	6.45	-	-
NG	6.44	2.53	4.01	6.32	9.49
Oil	4.69	1.47	-	-	-

Results of the model calculations for the BAU 3 and proposed LCD Innovative 3 scenarios discussed in Chapter 8 are compared and presented in Figure 6.3.

2 JLBTC Model Calculation, ProjectionReferenceJL.xlsx

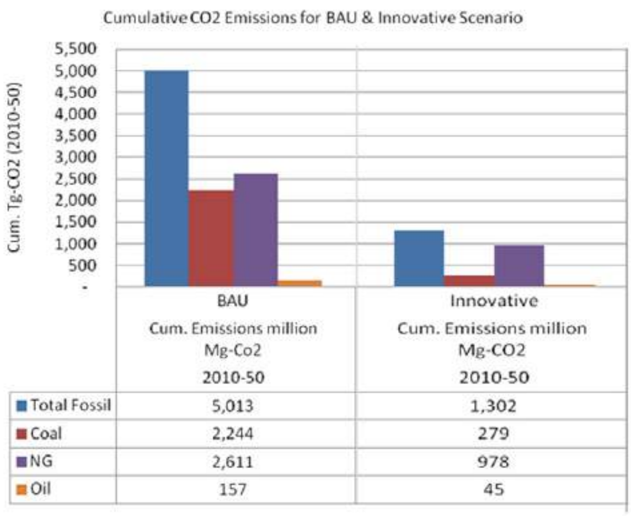
Figure 6.3 Development of Cumulative Carbon Emissions, Philippines, BAU 3 and Innovative 3 Scenarios, Years 2010 - 2050[3]



Under the BAU 3 scenario, the country's CO_2e emissions will reach about 150 Tg CO_2e. Under the Innovative 3 scenario, CO_2 emissions will continuously decrease to only 9.49 Tg CO_2e in Year 2050.

To compare the emissions from fossil fuels, under the BAU scenario, total emissions will reach up to 5,013 Tg CO_2e under the BAU Scenario compared to 1,302 Tg CO_2e under Innovative 3 (Figure 6.4).

Figure 6.4 Development of Cumulative Carbon Emissions from Fossil Fuels, Philippines, BAU 3 and Innovative 3 Scenarios, Years 2010 - 2050[4]

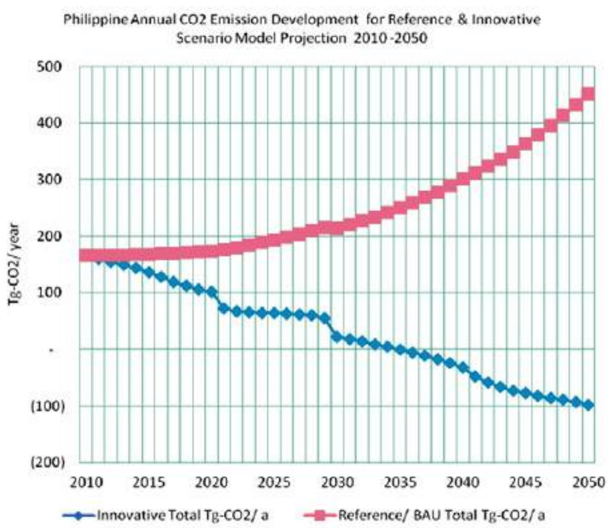


3 JLBTC Model Calculation, ProjectionReferenceJL.xlsx
4 JLBTC Model Calculation, ProjectionReferenceJL.xlsx

6.3 ESTIMATED CO_2 EMISSIONS FROM ENERGY SUB-SECTORS, WASTE AND FORESTRY

This section presents calculation results for CO_2 emissions from electricity generation with other sources in the Energy Sector *(Transport and Heat)*, Waste and LUCF, covering about 80% to 85% of all emission sources, excluding emissions from Air, Marine and Rail Transport, Agriculture and Fugitive emissions, and Land Use Change. It should be noted however, that by mainstreaming LCD and transitioning to RE with the implementation of organic farming in the Agriculture Sector, the country can achieve a zero-carbon growth. Calculations for CO_2 emission from the covered sectoral sources is presented in Table 6.1, and a graphical illustration is presented in Figure 6.5.

Figure 6.5 Development of Cumulative Carbon Emission from Selected Energy Sector Sources, Waste and Forestry, Philippines, Years 2010 - 2050[6]



Under the BAU scenario, the combined CO_2 emissions for the stated sources will escalate to about 450 Tg CO_2e at the end of the study period. On the other hand, under the Innovative Low Carbon Scenario, a negative carbon budget is achieved.

The development of carbon emissions from each of the specified sectoral sources are shown in Figure 6.6. **Under the BAU scenario**, Transportation exceeds all other sectors in total emissions in 2050, and overtakes Electricity Generation emissions in the Year 2035. Emissions from Heat and Waste will both increase to 30 Tg to 40 Tg each, while emissions from the Forestry sector with increased forest cover under the current reforestation program will continuously go down to below 20 Tg. To compare, **under the Innovative Low Carbon Development Scenarios for all specified sectors**, emissions levels will be reduced tremendously as an effect of shifting electricity generation from fossil to RE and implementing a centralized/decentralized power supply and distribution

6 *JLBTC Model Calculation, EvaluationReport.xlsx*

Table 6.1 Projected CO_2 Emissions, Philippines, Reference, BAU and Innovative Scenarios, Years 2010 - 2050[5]

Estimated Philippine CO_2 Emissions

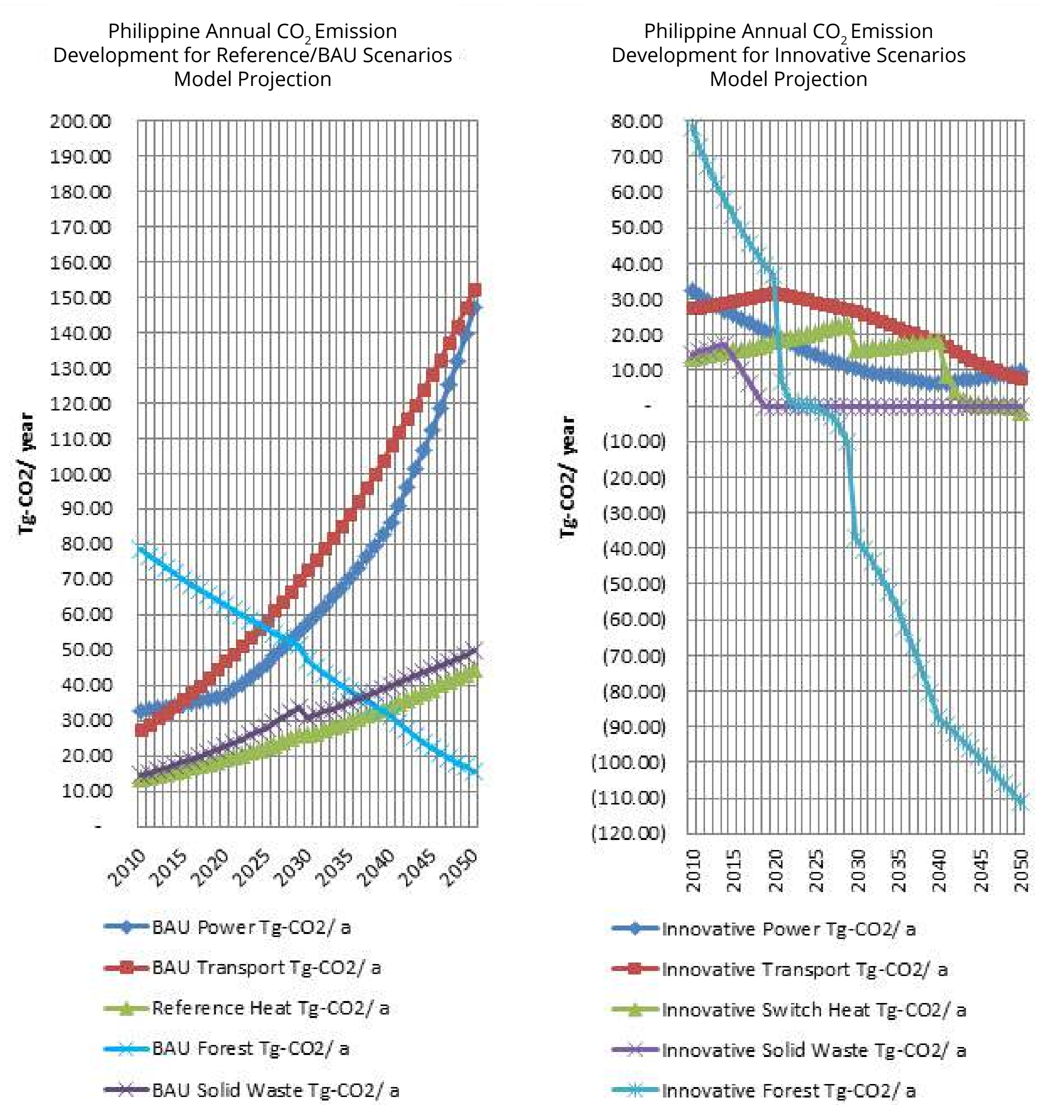
YEAR	Innovative Power $Tg\text{-}CO_2/a$	Innovative Transport $Tg\text{-}CO_2/a$	Innovative Switch Heat $Tg\text{-}CO_2/a$	Innovative Solid Waste $Tg\text{-}CO_2/a$	Innovative Forest $Tg\text{-}CO_2/a$	BAU Power $Tg\text{-}CO_2/a$	BAU Transport $Tg\text{-}CO_2/a$	Reference Heat $Tg\text{-}CO_2/a$	BAU Solid Waste $Tg\text{-}CO_2/a$	BAU Forest $Tg\text{-}CO_2/a$	Innovative Total $Tg\text{-}CO_2/a$	Reference/ BAU Total $Tg\text{-}CO_2/a$	Cumulative Innovative Total cum.$Tg\text{-}CO_2$	Cumulative Reference/ BAU Total cum.$Tg\text{-}CO_2$	Cumulative Philippine Real Emissions Baseline cum. $Tg\text{-}CO_2$	Cumulative Philippine Budget at Similar Worldwide Reduction Approach cum. $Tg\text{-}CO_2$	Philippine Budget Relative to Equal Population Share Fixed & Relative to Worldwide Budget 600Gt Goal $Tg\text{-}CO_2$
2010	**32.57**	**26.69**	**13.60**	**14.60**	**78.38**	**32.57**	**26.69**	**13.72**	**14.60**	**78.38**	**166**	**166**	**166**	**166**	**166**	**168**	**166**
2011	31.04	26.79	13.99	15.25	72.59	33.00	27.08	14.18	15.25	76.65	160	166	326	332	334	337	339
2012	29.58	26.89	14.38	15.94	67.23	33.44	27.48	14.66	15.94	74.96	154	166	480	499	504	505	521
2013	28.19	26.99	14.79	16.65	62.27	33.88	27.89	15.16	16.65	73.31	149	167	628	666	677	674	711
2014	26.86	27.09	15.21	17.40	57.67	34.32	28.30	15.68	17.40	71.69	144	167	773	833	851	835	911
2015	25.60	27.19	15.65	13.92	53.41	34.78	28.72	16.21	18.18	70.11	136	168	908	1,001	1,028	989	1,123
2016	24.39	27.29	16.09	10.28	49.47	35.24	29.14	16.76	18.99	68.56	128	169	1,036	1,170	1,208	1,136	1,344
2017	23.24	27.39	16.55	6.48	45.82	35.70	29.57	17.33	19.84	67.05	119	169	1,155	1,339	1,389	1,276	1,569
2018	22.15	27.49	17.02	2.52	42.43	36.17	30.01	17.91	20.73	65.57	112	170	1,267	1,509	1,573	1,410	1,795
2019	21.11	27.59	17.50	-	39.30	36.65	30.45	18.52	21.65	64.12	105	171	1,373	1,681	1,760	1,537	2,017
2020	**20.12**	**27.69**	**18.00**	**-**	**36.40**	**37.13**	**30.90**	**19.15**	**22.62**	**62.70**	**102**	**173**	**1,475**	**1,853**	**1,949**	**1,638**	**2,230**
2021	18.84	28.12	18.51	-	7.06	38.80	32.60	19.80	23.64	61.32	73	176	1,547	2,030	2,140	1,718	2,432
2022	17.65	28.55	19.03	-	1.37	40.55	34.39	20.47	24.69	59.97	67	180	1,614	2,210	2,334	1,782	2,620
2023	16.53	28.99	19.57	-	0.27	42.37	36.28	21.17	25.80	58.64	65	184	1,679	2,394	2,531	1,833	2,793
2024	15.48	29.44	20.13	-	0.05	44.28	38.28	21.89	26.95	57.35	65	189	1,744	2,583	2,730	1,874	2,950
2025	14.50	29.90	20.70	-	0.01	46.27	40.39	22.63	28.16	56.08	65	194	1,809	2,776	2,932	1,907	3,090
2026	13.59	30.36	21.29	-	(1.50)	48.35	42.61	23.40	29.42	54.85	64	199	1,873	2,975	3,136	1,933	3,213
2027	12.73	30.83	21.89	-	(2.84)	50.52	44.95	24.19	30.74	53.64	63	204	1,936	3,179	3,343	1,954	3,318
2028	11.92	31.31	22.52	-	(5.40)	52.79	47.42	25.01	32.11	52.45	60	210	1,996	3,389	3,553	1,971	3,408
2029	11.17	31.79	23.15	-	(10.23)	55.16	50.03	25.86	33.55	51.29	56	216	2,052	3,604	3,765	1,984	3,484
2030	**10.46**	**32.28**	**15.79**	**-**	**(36.80)**	**57.64**	**52.78**	**25.98**	**30.89**	**47.03**	**22**	**214**	**2,074**	**3,819**	**3,980**	**1,995**	**3,548**

Estimated Philippine CO_2 Emissions																	
YEAR	Innovative Power *Tg-CO_2/a*	Innovative Transport *Tg-CO_2/a*	Innovative Switch Heat *Tg-CO_2/a*	Innovative Solid Waste *Tg-CO_2/a*	Innovative Forest *Tg-CO_2/a*	BAU Power *Tg-CO_2/a*	BAU Transport *Tg-CO_2/a*	Reference Heat *Tg-CO_2/a*	BAU Solid Waste *Tg-CO_2/a*	BAU Forest *Tg-CO_2/a*	Innovative Total Tg-CO_2/a	Reference/ BAU Total Tg-CO_2/a	Cumulative Innovative Total cum.Tg-CO_2	Cumulative Reference/ BAU Total cum.Tg-CO_2	Cumulative Philippine Real Emissions Baseline *cum. Tg-CO_2*	Cumulative Philippine Budget at Similar Worldwide Reduction Approach *cum. Tg-CO_2*	Philippine Budget Relative to Equal Population Share Fixed & Relative to Worldwide Budget 600Gt Goal *Tg-CO_2*
2031	9.94	32.17	16.03	-	(40.14)	60.01	56.74	26.71	31.70	45.16	**18**	**220**	**2,092**	**4,039**	**4,198**	**2,004**	**3,603**
2032	9.46	32.06	16.27	-	(43.77)	62.48	60.99	27.46	32.54	43.36	**14**	**227**	**2,106**	**4,266**	**4,419**	**2,012**	**3,563**
2033	8.99	31.95	16.52	-	(47.73)	65.04	65.57	28.23	33.39	41.64	**10**	**234**	**2,115**	**4,500**	**4,643**	**2,019**	**3,697**
2034	8.55	31.84	16.77	-	(52.05)	67.72	70.49	29.02	34.27	39.99	**5.11**	**241**	**2,121**	**4,741**	**4,870**	**2,025**	**3,738**
2035	8.13	31.73	17.02	-	(56.76)	70.50	75.77	29.84	35.17	38.40	**0.12**	**250**	**2,121**	**4,991**	**5,100**	**2,030**	**3,777**
2036	7.73	31.62	17.28	-	(61.90)	73.39	81.45	30.67	36.10	36.87	**(5.26)**	**258**	**2,115**	**5,249**	**5,333**	**2,035**	**3,813**
2037	7.35	31.52	17.55	-	(67.50)	76.41	87.56	31.53	37.05	35.41	**(11)**	**268**	**2,104**	**5,517**	**5,569**	**2,040**	**3,849**
2038	6.99	31.41	17.81	-	(73.61)	79.54	94.13	32.42	38.03	34.00	**(17)**	**278**	**2,087**	**5,796**	**5,808**	**2,044**	**3,884**
2039	6.64	31.30	18.08	-	(80.27)	82.81	101.19	33.33	39.03	32.65	**(24)**	**289**	**2,063**	**6,085**	**6,050**	**2,049**	**3,919**
2040	**6.32**	**31.19**	**18.36**	**-**	**(87.53)**	**86.21**	**108.78**	**34.26**	**40.06**	**31.35**	**(32)**	**301**	**2,031**	**6,385**	**6,295**	**2,053**	**3,954**
2041	6.58	26.21	8.66	-	(89.63)	90.93	115.31	35.18	40.93	29.25	**(48)**	**312**	**1,983**	**6,697**	**6,543**	**2,057**	**3,989**
2042	6.85	22.02	4.08	-	(91.78)	95.91	122.22	36.11	41.82	27.29	**(59)**	**323**	**1,924**	**7,020**	**6,795**	**2,061**	**4,024**
2043	7.14	18.51	1.93	-	(93.98)	101.17	129.56	37.07	42.72	25.47	**(66)**	**336**	**1,858**	**7,356**	**7,050**	**2,065**	**4,057**
2044	7.44	15.56	0.91	-	(96.23)	106.71	137.33	38.06	43.65	23.76	**(72)**	**350**	**1,785**	**7,706**	**7,309**	**2,070**	**4,090**
2045	7.74	13.07	0.43	-	(98.54)	112.55	145.57	39.07	44.60	22.17	**(77)**	**364**	**1,708**	**8,070**	**7,570**	**2,074**	**4,121**
2046	8.07	10.99	0.20	-	(100.90)	118.72	154.31	40.11	45.57	20.68	**(82)**	**379**	**1,626**	**8,449**	**7,836**	**2,079**	**4,151**
2047	8.40	9.23	0.10	-	(103.32)	125.22	163.56	41.18	46.56	19.30	**(86)**	**396**	**1,541**	**8,845**	**8,104**	**2,085**	**4,179**
2048	8.75	7.76	0.04	-	(105.79)	132.07	173.38	42.28	47.58	18.01	**(89)**	**413**	**1,452**	**9,258**	**8,377**	**2,091**	**4,206**
2049	9.11	6.52	0.01	-	(108.33)	139.31	183.78	43.40	48.61	16.80	**(93)**	**432**	**1,359**	**9,690**	**8,653**	**2,098**	**4,231**
2050	**9.49**	**5.48**	**(1.61)**	**-**	**(110.93)**	**146.94**	**194.80**	**44.56**	**49.67**	**15.68**	**(98)**	**452**	**1,261**	**10,142**	**8,932**	**2,105**	**4,254**
Total	587	1,053	562	113	(1,054)	2,753	3,058	1,110	1,297	1,923	**1,261**	**10,142**	**1,261**	**10,142**	**8,932**	**2,105**	**4,254**
Inno/BAU	21.3%	34.4%	50.6%	8.7%	-54.8%	468.7%	290.5%	197.6%	1147.2%	-182.5%	**12.4%**	**804.1%**	**12.44%**				

5 *JLBTC Model Calculation, 4-EvaluationReport-Rev150718.xlsx*

system fueled by RE sources and natgas, as well as with the fuel shift by vehicles and improved, energy efficient mass transit system in Road Transport. In the Waste Sector, a downward trend is achieved with maximized recovery from the waste stream, and the capture of methane for electricity generation and recycling of waste materials.

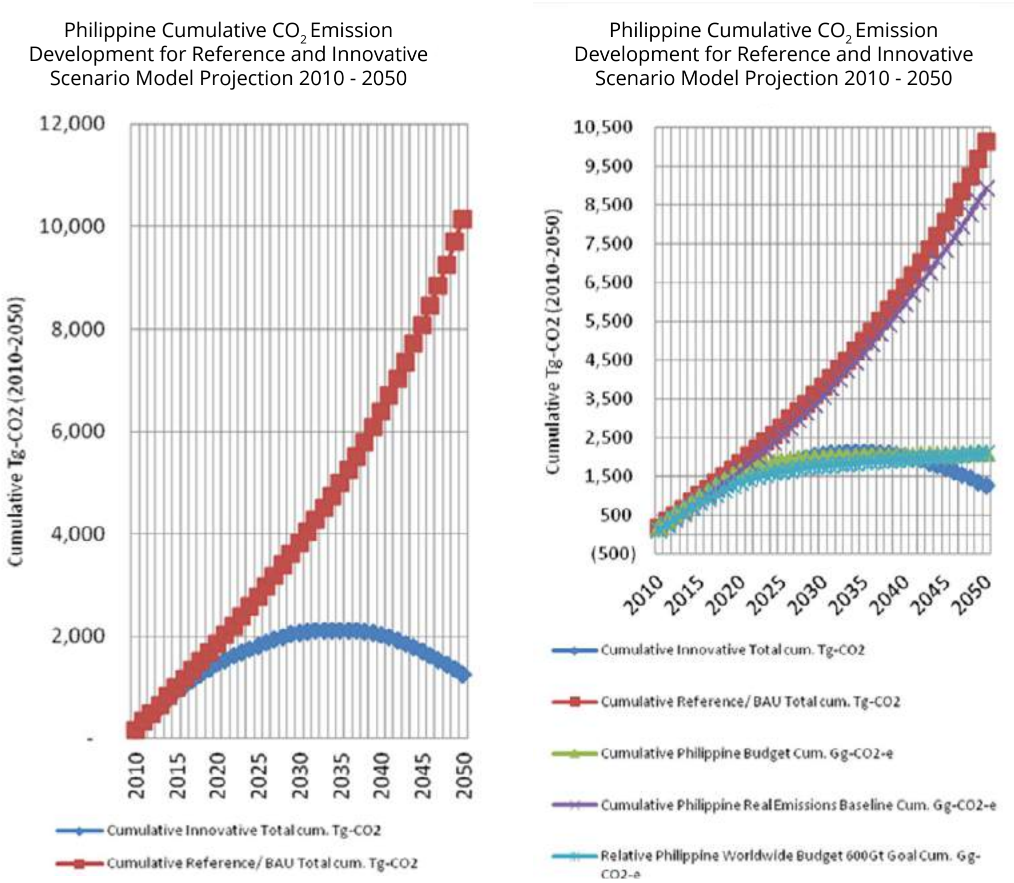
Figure 6.6 Combined Philippine Annual Carbon Emission Development, JLBTC Model Approach, (Period 2010 - 2050)[7]



7 JLBTC Model Calculation, EvaluationReport.xlsx

The Figure 6.7 shows and compares the projected cumulative CO_2 emission under the BAU and Innovative Scenarios, and also compares the cumulative emissions to the worldwide carbon model and relative Philippine carbon budget allocation under both scenarios.

Figure 6.7 Combined Cumulative Philippine Carbon Emission Development, JLBTC Model Approach, 2010 - 2050[8]



8 JLBTC Model Calculation, EvaluationReport.xlsx

6.4 CONCLUSION

The results of the calculations under the Innovative Scenario show that the allocated carbon budget for the Philippines relative to the worldwide carbon budget can not only be achieved, but also surpassed. However, implementation of recommended LCD pathways or similar low carbon strategies **must** be implemented as soon as possible. Decisive action is needed in shifting to RE.

Under the BAU Scenario, cumulative emissions levels reach more than 10,000 Tg-CO_2 in 2050 and breaches the 2,000 Tg-CO_2 allocated carbon budget by 2020. Under the Innovative Scenario, the integrated CO_2 emission calculations show that projected carbon budget can be achieved. The cumulative emission limit of around 2,000 Tg-CO_2 is reached in 2035, and considering the carbon sink potential following the proposed Marshall Plan for reforestation, the net CO_2 emission levels gradually fall below the given carbon emission budget of 2,000 Tg-CO_2, or about 1,200 Tg-CO_2. In the event carbon sink capacities from reforestation are not valued under the Innovative Scenario, the carbon emission development is still within manageable levels.

In terms of electricity generation, this study presents that the RE transition strategy is technically and financially viable and can be adapted in an emerging country like the Philippines. Cost calculations indicate total cost for a mainly RE based power generation and decentralized power distribution structure can be lower than power generation rates being charged to users today.

Despite a slightly higher cost of RE-fuel sources, compared to a predominantly fossil natgas based power generation structure, the differential cost is estimated to be less than PhP1 per kWh-e based on a constant cost base analysis, without considering socio-economic cost factors. In case of a slight cost increase for fossil natgas fuel at 1.5% p.a., the RE transition strategy yields a lower cumulative cost for the projected period and will prove to be the better strategy over the long term.

The innovative pathway to achieve carbon neutral and self sufficiency in electricity generation is hinged on the following measures:

- Energy conservation and efficiency measures must be employed, with constant monitoring of performance in all end-use sectors. This also calls for optimization of the country's current transmission and distribution system. Monitoring plays a key role to prevent and put in check the vicious cycle of unnecessary consumption when least electricity cost to end-users is achieved, which historically rebounds to higher, excessive consumptions by end-users, which then requires expansion of power generation facilities to meet excessive consumption.
- Development of RE-sources and expansion to RE must be intensified and consistent. In the transition towards 100% RE, coal must eventually be phased out. Natgas, hydro and geothermal sources fill in to replace production of coal fired plants.
- Government's leaning towards least cost expansion and preference for coal-fired plants to meet future growing demand must be rationalized.

- To boost investment, the government must provide a level playing field for investors, wherein transparency and consistency in policies and regulations allow for reasonable financial gains for investors. Power infrastructure should ensure technical viability with the provision of distribution facilities for interconnection and dispatch of variable electricity produced by RE.

The benefits of the 100% RE strategy using the RE-CH_4 technology application is that this is entirely compatible with the natgas based energy distribution network which has been established in Europe, USA and other countries worldwide, and proven highly affordable, safe and environment friendly over the decades.

This approach enables a seamless transition from natgas to RE-CH_4 without need of building untested and far more expensive network based on Hydrogen (H_2), which is not considered viable until 2030 and may be implemented at that later stage.

Other RE potentials, especially the currently unevaluated biomass sources, can additionally be used to build up RE-CH_4 buffer stock and complement the given approach in a most economical way. The evaluated 100% RE option integrating RE-power to the RE-CH_4 conversion and buffering approach can easily be expanded to the entire transport sector to close an open gap and to address the limitations in deployment and transit to purely electrical transport vehicles, such as heavy duty trucks and buses.

The strategy would establish a seamless, distributed power production, storage and usage network combining all key power demanding sectors, like Electrical, Transport and End Uses *(Residential, Commercial and Industrial)* under one integrated 100% RE based system.

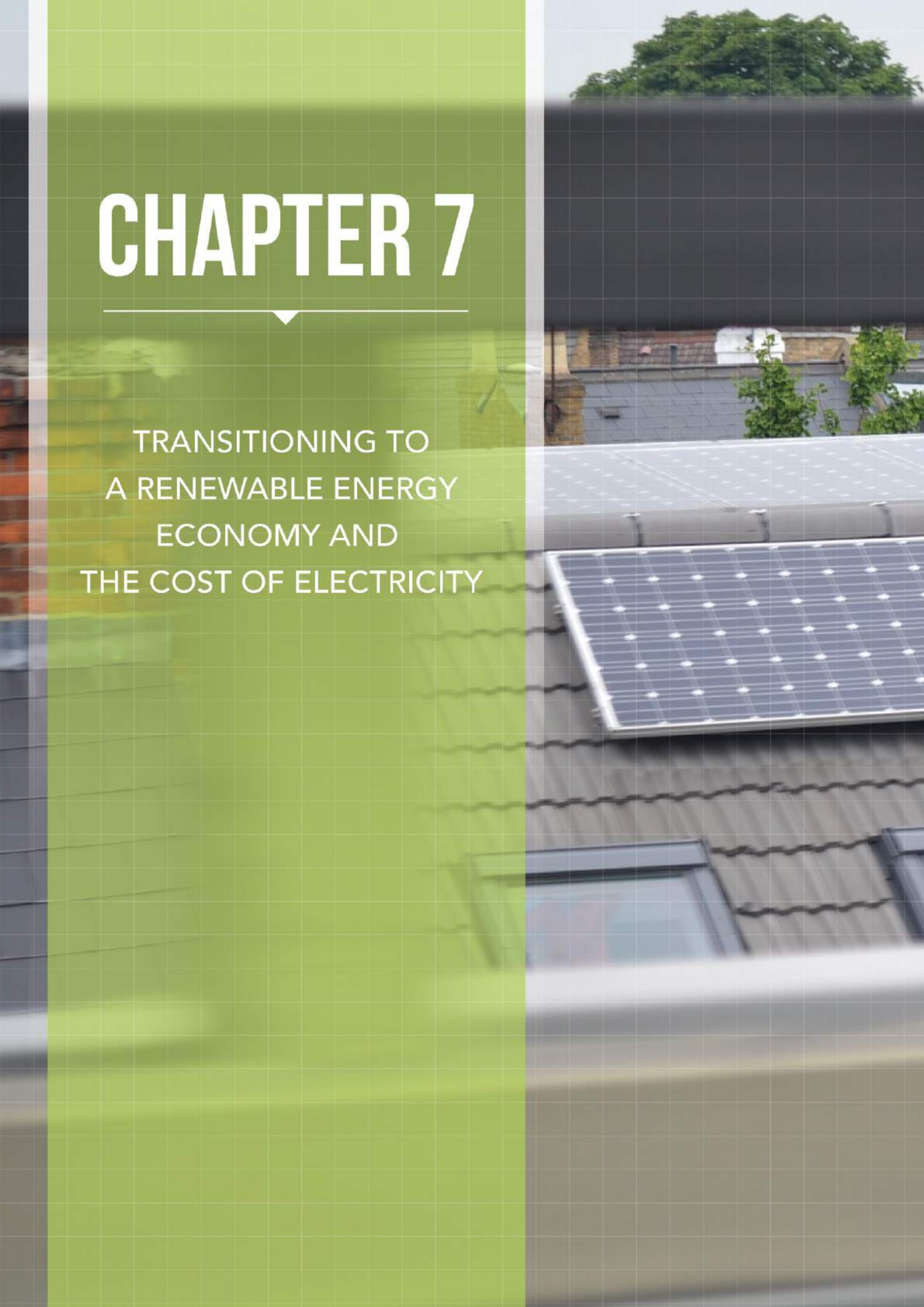
The recommended 100% RE strategy can be implemented under a gradual transition approach by initially employing natgas as a still fossil energy and replacing such with the consistent expansion of RE, towards 100% RE power capacity, but not necessarily limited to Wind and Solar sources.

The challenges facing RE project implementation should be addressed by the Philippine government, by elimination of the currently imposed red tape ridden rules, regulations and practices, as well as highly stringent caps applied on RE energy from Wind and Solar in the Philippines. Such caps are presently preventing RE developers from proceeding with large scale deployment of RE capacities from Wind and Solar in the country.

GHG emission sources from Waste and Forestry have been calculated and contained in chapters of this final report. Financially viable LCD strategies have also been presented for these two emissions sources, which could zero-out emissions from these sectors, and positive carbon sink capacities can be derived from the application of the recommended, long term reforestation and management program. In terms of the country's carbon credit potential from its forests, for example, the Philippines could maintain this as a reserve for future international carbon budget negotiations to maximize values and refrain from immediate sell down of carbon emission rights under the current REDD+ approach.

Although carbon credit trading is not viewed as a solution, early and decisive adoption of the recommended RE transition process could be a beneficial, valuable and tradable asset for the country in future negotiations for a new international climate agreement. The Philippines should not commit to disadvantageous carbon deals at the present stage, but to build up carbon reduction volumes during the next two and future decades through the recommended Innovative RE transition strategy to maximize values, thereby substantially lowering cost of the country's transition to RE.

Continued massive use of fossil energy sources worldwide may have catastrophic consequences. The low carbon strategies outlined in this study provide a clear guide for the country to transition to an RE based economy. As the results of the cost analysis show that the recommended innovative strategies are already economically viable and can be implemented today, government decision makers must take decisive action to effectively shift from a carbon intensive development, to achieving zero, if not negative GHG emissions into the coming century.



CHAPTER 7

TRANSITIONING TO A RENEWABLE ENERGY ECONOMY AND THE COST OF ELECTRICITY

7.1 INTRODUCTION

This chapter provides recommendations on how the Philippines can transition to a RE economy to reduce carbon emissions by 2050 to address concerns with regard to availability, reliability and connectivity of RE to the country's power grids. Calculations have been undertaken to determine RE's impact on electricity generation cost.

The cost of electricity from RE sources is already competitive to the cost of electricity from fossil coal and natgas, and much lower than that of oil-fired plants today. In the future, it is possible for electricity from RE sources to cost less than that sourced from coal and natgas fired plants. Therefore, it is in the interest of the Philippines to concretize policies and transition to a RE economy.

7.2 LOW CARBON DEVELOPMENT (LCD) PATHWAY FOR ELECTRICITY GENERATION

The issues for consideration for the recommended LCD pathway for electricity generation are identified and outlined as follows:

- Increase in energy saving and efficiency, through:
    A. Reduction of specific energy use in application
    B. Distributed power generation
    C. Combined power generation
    D. Energy recovering through recycling

- Fuel switch towards low emission and safer fuels like natgas (shift from coal and oil to natgas). Natgas to serve as back up and bridge energy source during transition process towards 100% RE based economy

- Replacement of fossil energy with RE based energy

- Increase RE based coverage through energy storage & -buffering systems
    A. Hydro storage
    B. Battery storage
    C. Physical phase change storage systems
    D. Conversion of surplus RE energy from wind and PV to hydrogen *(H_2)* and further into RE-methane (RE-CH_4)
    E. Thermal and cooling energy storage systems

All energy sources considered have different characteristics in terms of over-all availability and feasible capacity and time availability which depend on several factors like: time of day, season, tide, weather conditions, locality etc.

The principal choices or options for energy transformation are central or distributed, with some energy conversion systems, limited to either central and/or distributed application, depending on their type, size and source of fuel or source of energy.

7.3 ENERGY SOURCING FOR ELECTRICITY GENERATION

A. Energy Sourcing: Given the country's vast RE resources potential, the proposed LCD pathway considers a 100% RE scenario to include different types of RE sources in an optimal configuration considering the over-all availability and feasible capacity and time availability, which depend on several factors such as time of day, season, tide, weather conditions, locality, among others.

- RE Sources - a combination of solar, wind, geothermal, hydro are considered in BAU 1, BAU 2 and Innovative 1 and 2. Under Innovative 1, RE-CH_4 derived from the dialysis of RE surplus energy from RE plants converted to H_2 for storage and reforming this to CH_4 upon demand for dispatch, is included.

  To limit complexity, model calculations for all four scenarios do not include biomass and ocean energy which can complement the RE sources stated above. It should be stressed that biomass should be used as an energy source only within sustainable limits so as not to impair food security and the long term buildup of biomass *(carbon sink)* from reforested land.

- Fossil Based Energy Sources - Fossil based sources, including coal and natgas, are mainly considered in the BAU 1 and 2 scenarios, with REs employed only to the extent of the existing build-up target at the time calculation of the models for the study were undertaken. Capacities for hydro and geothermal are reduced due to DOE's current priority for build up of coal-fired plants as base source of energy. CO_2 emissions from transport of imported fuel to the country's fossil based power plants are not calculated in the national context, which will tend to zero- out when RE fuel is used.

B. Energy Sources Mix: Main fossil sources, natgas, and coal are considered in the BAU model options. Oil is basically not considered in the model as this is foreseen to be replaced by less costly and less polluting natgas.

Imported natgas is envisioned to be replaced by locally produced natgas as the local natgas industry matures and is able to meet the demand. Coal is seen as the main contender against RE, which can delay, if not jeopardize the transition towards 100% RE.

Table 7.1 below compares the energy source mix in the first four scenarios based on their dependable capacities. The costs of the coal option are presented and calculated in the two BAU scenarios where the share of natgas/Coal is 40/60% respectively for the BAU1 and 20/80% respectively for the BAU2 scenario. Natgas, the preferred option for fossil-based energy is used in BAU 1 and 2 and Innovative 2 scenarios, as well as for a limited time during the transition process in the Innovative 1 scenario; and continues to be employed under Innovative 2 scenario. Innovative 1 considers natgas as the main bridge energy until this can be fully replaced by the RE-CH_4 gas derived from RE-H_2-CH_4 conversion process.

Table 7.1 Comparison of Energy Source Mix Dependable Capacity for Electricity Generation, BAU 1 and 2, Innovative 1 and 2 , JLBTC

	BAU 1 Dependable Capacity	% to Total	BAU 2 Dependable Capacity	% to Total	Innovative 1 Dependable Capacity	% to Total	Innovative 2 Dependable Capacity	% to Total
FOSSIL								
Coal	5,229	40%	2,246	17%	0	0%	0	0%
Natural Gas	3,486	27%	7,819	60%	0	0%	6,036	53%
Oil	265	2%	284	2%	0	0%	0	0%
Sub-Total	**8,980**	**69%**	**10,349**	**80%**	**0**	**0%**	**6,036**	**53%**
RE								
Hydro	1,560	12%	1,170	9%	1,950	18%	1,950	17%
Geothermal	1,950	15%	1,170	9%	3,120	9%	2,340	20%
Solar	156	1%	78	1%	6,240	57%	390	3%
Wind	390	3%	234	2%	12,624	115%	780	7%
Biomass	0	0%	0	0%	0	0%	0	0%
Ocean	0	0%	0	0%	0	0%	0	0%
Sub-Total	**4,056**	**31%**	**2,652**	**20%**	**23,934**	**82%**	**5,460**	**47%**
RE-e-CH_4	0	0%	0	0%	5,194	18%	0	0%
Sub-Total	**0**	**0%**	**0**	**0%**	**5,194**	**18%**	**0**	**0%**
TOTAL	13,036	100%	13,001	100%	29,128	100%	11,496	100%

Given fuel mix, plant capacities, efficiencies, dependability and utilization factors is basis for determination of cost of electricity per kWh.

7.4 COST ANALYSIS ELECTRICITY PRODUCTION YEAR 2010

The cost covers calculations for the main power generation options:

- Fossil Energy Sources – Coal, natgas, natgas-CHCP
- RE-Energy Sources - RE-Gas (RE e-H_2 CH_4) + CHCP, Geothermal, Hydro, Wind, Solar

The cost analysis for electricity production shows the cost values for each of the selected power generation option. Total cost derived from different selected energy production mix configurations which shall be discussed in the Energy Transformation Model of the study.

The cost analysis draws information from a report by the US Nuclear Energy Agency[1]. However, the presented cost factors in the agency report vary in an extremely wide range and are considered on a high side, especially for power generation from Solar-PV and Wind. The suspected or seemingly high values have been adjusted accordingly to known cost levels of presently executed installations, as shown in Table 7.2.

A specifically selected power generation option in this report is natgas-CHCP[2] and RE-Gas *(REe-H_2 CH_4)* + CHCP[3]. The cost factors for RE-Gas are taken from cost levels known for electrolytic H_2 and H_2 to CH_4 reforming processes. A summarized cost value of 1,770 USD/kW-e-installed capacity has been determined. This cost value includes the cost of a 700 USD/kW-e-installed capacity for the CHCP component.

Power plant efficiencies[4] used in this evaluation range from 32% for Coal- and 48%[5] for natgas gas-power plants. Efficiency levels for bigger[6], combined and optimized cycle natgas-plants or supercritical coal fired plants[7] can be higher than 32% but are not considered in this evaluation. The efficiencies for RE power plants consider the renewable input as 100%. Plant utilization or plant factors for Wind and Solar *(35% and 17% p.a.)* are used. Other factors used in the evaluation show conversion losses due to interrupted operations and electrical transforming losses at plant level.

An important cost influence comes from the achievable plant factor for each generation type. This factor depends on the inherent technical requirement, annual availability of each plant type and usage due to the operational demand of the grid during the day and year. Two options which present the low plant factors and the maximized usage scenario considering optimal use of each plant type are apparent in an innovative scenario. The present achievable plant factor for coal fired plants in the Philippines today is around 50%. The lowest considered operable plant factor for coal plants is seen at 40% for this plant type.

Based on the assumed plant factors, the net specific annual electrical power output is calculated for each plant type. This value is then converted in a specific fix cost share derived from the annual investment cost factor[8]. The other variable cost factors are calculated based on the input values shown in the financial and cost recovery assumptions. In the CHCP options, the cost credits for the comparative value of heat and cooling sales at an average build out and given a usage factor of 50% have been considered.

The calculations show a reasonable, direct cost estimate for the main power generating types by determining both the direct fixed and variable cost factors and including one externality factor covering CO_2e cost at a relatively low value of 30 USD/Mg CO_2e.

1 *Projected Costs of Generating Electricity 2010, NEA, OECD, Iea, 2010*
2 *Natural gas used in a combined cooling, heat and electrical distributed power generation option also called as Tri-generation of power*
3 *This option is a combination of the above stated CHCP power generation by using RE methane gas generated by conversion of RE surplus power through electrolysis and following reforming process into RE-CH_4 gas.*
4 *eta power plant*
5 *CHCP electrical efficiency for small scale plants >1MW-e <5MW-e*
6 *>200 MW-e*
7 *>1200 MW-e*
8 *Annuity*

The present discussion concerning RE implementation is largely focused on the costs related to RE power generation. And costs in most discussions are reduced merely to direct costs and tend to disregard cost of externalities. Should these be internalized, cost of RE would be exceedingly lower than that of fossil fuel generated power.

The result of the cost evaluation are presented in Table 7.2. This shows that an Innovative Pathway scenario employing wind and solar energy sources will lead and given maximized utilization of 35% and 17% respectively, based on given efficiency plant factors.

Table 7.2 Cost Evaluation for Electricity Production, 2010

PROJECTED COST EVALUATION ELECTRICITY PRODUCTION 2010		Coal	NGas	NGas CHCP	RE-Gas (RE-e-H_2-CH_4) + CHCP	Geothermal	Hydro	Wind	Solar
Investment assumptions report		1,915	1,020	1,020	1,020	n.nn	n.n.	2,236	n.n.
Investment Cost Factor RE-CH_4 against NG					2.53				
Investment assumptions revised own study	USD/kW-e-inst.	1,500	600	700	1,770	3,000	3,000	1,500	1,500
Life	years	40	30	30	30	30	80	25	25
WACC	%	12%	12%	12%	12%	12%	12%	12%	12%
Annuity (25y/12%)		0.12750	0.12750	0.12750	0.12750	0.12750	0.12750	0.12750	0.12750
eta Power Plant	%	32.00%	48.00%	48.00%	48.00%	80.00%	80.00%	97.00%	97.00%
Plant Factor	%	30.00%	30.00%	30.00%	30.00%	90.00%	50.00%	35.00%	17.00%
net Spec. Annual e-power output	kWh-e/a, kW-e-inst.	2,628	2,629	2,628	2,628	7,884	4,380	3,066	1,489
Carbon Factor	kg-CO_2e/kWh-e	1.00	0.50	0.25	-	-	-	-	-
	USD/Mg-CO_2e	30	30	30	30	30	30	30	30
	PhP/kWh-e	1.23	0.62	0.31	-	-	-	-	-
CHCP Coverage (cooling+heating)	%			50.00%	50.00%				
Investment	PhP/kWh-e	2.98	1.19	1.39	3.52	1.99	3.58	2.56	5.27
Fuel	PhP/kWh-e	0.58	2.46	2.46	-	-	-	-	-
O&M	PhP/kWh-e	1.00	0.50	0.60	1.00	1.00	1.10	0.20	0.10
Carbon Cost	PhP/kWh-e	1.23	0.62	0.46	-	-	-	-	-
Credit (-) from combined heat and cooling (COP-e=4.5/COP-abs=50)	PhP/kWh-e	-	-	(1.21)	(1.21)	-	-	-	-
TOTAL Cost	**PhP/kWh-e**	**5.79**	**4.77**	**3.70**	**3.31**	**2.99**	**3.68**	**2.76**	**5.37**
Cost Factor relative to coal	PhP/kWh-e	1.00	0.82	0.84	0.57	0.52	0.64	0.48	0.93

1++ImportantRef-ProjectedCostsofGeneratingElectricity2010.pdf
PowerGenerationModel-BAU-InnovativeV3.xlsx//REmodelBAU+InnoMAX-NG//+CalcE2010

Table 7.3 shows the calculated specific power production cost for the two options with high and low plant factors. Interestingly, coal fired plants do not come out as the lowest cost plants, especially considering low plant factors arising during innovative 100% RE approach. Instead, Wind and Geothermal show the lowest cost values. Coal fired plants carry the highest cost value of PhP5.79/kWh-e particularly when they operate at a low 30% utilization factor. This high cost more or less represents the present power generation charge billed to customers, who face another pending increase of above PhP6/kWh-e.

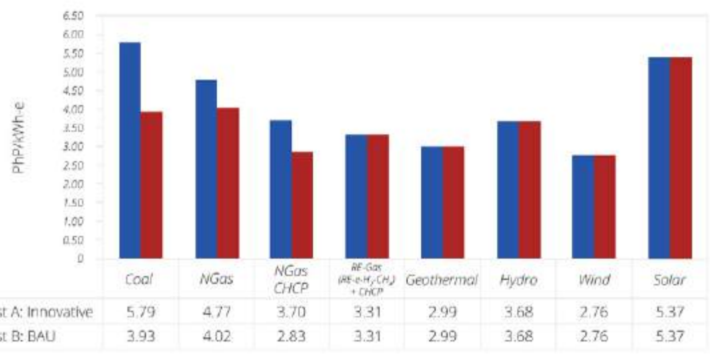
Table 7.3 Project Cost Evaluation – Electricity Production, 2010 Innovative Scenario and BAU

PROJECTED COST EVALUATION ELECTRICITY PRODUCTION 2010		Coal	NGas	NGas CHCP	RE-Gas (RE-e-H_2-CH_4) + CHCP	Geothermal	Hydro	Wind	Solar
RESULTS									
Plant factor (100% RE incl. 30 USD carbon)	%	30.00%	30.00%	30.00%	30.00%	90.00%	50.00%	35.00%	17.00%
Ranking (100% RE incl. 30 USD carbon)		8	6	5	3	2	4	1	7
TOTAL Cost A: Innovative	**PhP/kWh-e**	**5.79**	**4.77**	**3.70**	**3.31**	**2.99**	**3.68**	**2.76**	**5.37**
Plant factors for (Max-fossil & coal)	%	80.00%	80.00%	80.00%	30.00%	90.00%	50.00%	35.00%	17.00%
Ranking (Max-fossil & coal)		6	7	2	4	3	5	1	8
TOTAL Cost B: BAU	**PhP/kWh-e**	**3.93**	**4.02**	**2.83**	**3.31**	**2.99**	**3.68**	**2.76**	**5.37**

PowerGenerationModel-BAU-InnovativeV3.xlsx// Summary

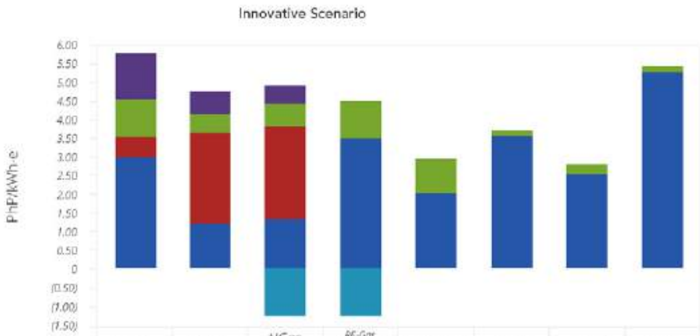
Figures 7.1 to 7.3 further illustrate this relative cost evaluation. The assumed cost benefits from combined heat, process-heat & cooling production show the advantageous application of CHCP systems, not only in reducing overall power generation cost but also in substantially reducing related carbon emissions.

Figure 7.1 Projected Electricity Generation Cost – BAU and Innovative Scenario



PowerGenerationModel-BAU-InnovativeV3.xlsx// Summary

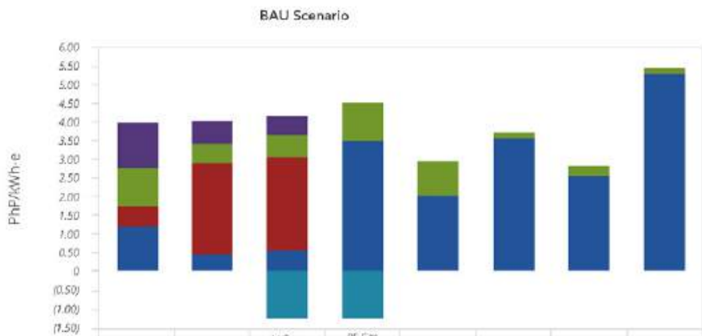
Figure 7.2 Estimated Cost for Electricity in the Philippines, 2010



	Coal	NGas	NGas CHCP	RE-Gas (RE-e-H_2-CH_4) + CHCP	Geothermal	Hydro	Wind	Solar
Credit (-) from combined Heat & Cooling (COP-e=4.5/COP-abs=50)	-	-	(1.21)	(1.21)	-	-	-	-
Carbon Cost	1.23	0.62	0.46	-	-	-	-	-
Variable O&M	1.00	0.50	0.60	1.00	1.00	0.10	0.20	0.10
Fuel	0.58	2.46	2.46	-	-	-	-	-
Investment	2.98	1.19	1.39	3.52	1.99	3.58	2.56	5.27

PowerGenerationModel-BAU-InnovativeV3.xlsx// Summary

Figure 7.3 Estimated Cost for Electricity Production, 2010 under BAU Scenario



	Coal	NGas	NGas CHCP	RE-Gas (RE-e-H_2-CH_4) + CHCP	Geothermal	Hydro	Wind	Solar
Credit (-) from combined Heat & Cooling (COP-e=4.5/COP-abs=50)	-	-	(1.21)	(1.21)	-	-	-	-
Carbon Cost	1.23	0.62	0.46	-	-	-	-	-
Variable O&M	1.00	0.50	0.60	1.00	1.00	0.10	0.20	0.10
Fuel	0.58	2.46	2.46	-	-	-	-	-
Investment	1.12	0.45	0.52	3.52	1.99	3.58	2.56	5.27

PowerGenerationModel-BAU-InnovativeV3.xlsx// Summary

7.5 RESULTS OF MODEL CALCULATIONS, BAU 1 AND 2, INNOVATIVE 1 & 2

The results of the model calculations for power demand, production and share in production of the various fuel sources in Tables 7.4 and 7.5 reveal the results for Investment and Operating Cost for the different BAU and Innovative Scenarios, which are below the present electricity rates charged for the power generation of around PhP5.9/kWh-e. Based on financial factors alone, the outcome justifies an immediate shift towards a 100% RE strategy.

Despite the possibly relatively lower mixed cost rate, considering maximized coal fired plant deployment, the difference is relatively low, especially if this is compared to the Innovative Scenario 2, RE with natgas based fuel.

For the transition phase, the calculated differences of the shown power cost of PhP0.23 to PhP0.48/kWh-e, or an additional PhP0.52/kWh-e with the application of 100% RE, is calculated at PhP4.8/kWh-e. This is still PhP1.2/kWh-e lower than the present power generation rate charged today. This cost does not justify the current government thrust towards massive build up of coal fired plants, especially the growing threat of global warming and environmental concerns.

A total conversion factor of 60% is applied which means that 40% more RE power can be generated to completely replace natgas and can be used as "filler energy" during periods when RE capacities are insufficient to cover the ongoing electrical demand. The model assumes for this strategy a RE capacity demand build up to cover the entire energy gap based on the individual achievable plant factor for each RE type.

The variable loads from Solar are based on a daily radiation schedule based on NREL solar radiation pattern for the Philippines, while Wind is on an assumed varying daily load pattern aligned with the average capacity potential for the Philippines, based on the NREL wind database.

Surplus capacity indicated as negative values due to the excess power occurring in time is considered to be converted into RE-CH_4.

Furthermore, such massive use of coal will also dramatically increase cost of coal imports in the long run. This can totally be avoided under the recommended 100% indigenous RE strategy and would not be threatened by definitely occurring fossil fuel price increases in the future.

Table 7.4 Power Demand, Production and Production Share under Various BAU and Innovative Scenarios

INNOVATIVE POWER GENERATION MIX DEVELOPMENT MODEL		Scenarios					
		BAU Scenario 1	BAU 1 Coal (sensitivity) weighed: Fix+Var. Cost	BAU Scenario 2	BAU 2 Coal (sensitivity) weighed: Fix+Var. Cost	Innovative 100% RE-Scenario	Innovative Scenario Fossil-NG max
Power Demand/Production Installed Capacity	**MW-e**	**13,036**	**13,036**	**13,001**	**13,001**	**23,934**	**11,496**
Solar	MW-e	256		78		6,240	390
Wind	MW-e	390		234		12,624	780
Geothermal	MW-e	1,950		1,170		3,120	2,340
Hydro	MW-e	1,560		1,170		1,950	1,950
RE-CH_4	MW-e					5,194	-
RE-e-CH_4 Conversion	MW-e	-	-	-	-	5,766	-
Natural Gas	MW-e	3,486		2,246		-	6,036
Coal	MW-e	5,229		7,819		-	-
Oil	MW-e	265		284		-	-
Power Production	**MWh-e/day**	**182,600**	**182,600**	**182,600**	**182,600**	**202,896**	**182,600**
Average Capacity Used	**MW-e**	**7,800**	**7,800**	**7,800**	**7,800**	**7,800**	**7,800**
PRODUCTION SHARE							
Solar		0.31%		0.30%		11.67%	0.73%
Wind		1.29%		2.70%		48.22%	2.98%
Geothermal		19.52%		7.50%		36.00%	27.00%
Hydro		10.84%		7.50%		12.50%	12.50%
RE-CH_4		-		-		12.58%	-
Natural Gas		20.41%		16.40%		0.00%	56.79%
Coal		47.63%		65.60%		0.00%	-
Oil		0.00%		0.00%		0.00%	-

PowerGenerationModel-BAU-InnovativeV3.xlsx// Summary

7.6 COMPARATIVE COST VIS-A-VIS FIT RATES AND CURRENT GENERATION CHARGES TO USERS

Generation cost comprises about 50% of the cost charged to consumers, with the remaining cost for transmission, system loss, distribution, subsidies for senior citizens and Small Power Utilities Groups *(under National Power Corporation's mandate, also known as missionary areas)* and taxes. As shown, there is a spread between the generating cost resulting from the cost calculation model, particularly that of wind and solar. Table 7.6 summarizes resulting generation cost from model calculations. To compare, Table 7.7 shows the generation cost charged to Manila Electric Company *(MERALCO)* by the power producers and power acquired from WESM as of December 2013 and January 2014. The generation charge per kW for coal-fired plants *(under A, 1-4)* range from ranged from an average of PhP3.42 to PhP6.40, and PhP4.27 to PhP6.26 in January 2014. The rate of plant gate of San Miguel Energy Corporation in May 2012 was reported at PhP4.50 as compared to PhP3.42 in December 2013, and PhP4.32 in January 2014.

Table 7.5 Investment and Operating Cost under Various BAU and Innovative Scenarios

INNOVATIVE POWER GENERATION MIX DEVELOPMENT MODEL		Scenarios					
		BAU Scenario 1	BAU 1 Coal (sensitivity) weighed: Fix+Var. Cost	BAU Scenario 2	BAU 2 Coal (sensitivity) weighed: Fix+Var. Cost	Innovative 100% RE-Scenario	Innovative Scenario Fossil-NG max
TOTAL Investment	**BUSD**	**22.91**		**21.67**		**46.63**	**18.44**
POWER GENERATION COST							
RE-CH_4 Var. Cost+Fuel						1.00	
NG Var. Cost+Fuel	PhP/kWh-e	5.00	5.00	5.00	5.00		5.00
Coal Var. Cost+Fuel	PhP/kWh-e	2.00		2.00			
Coal (sensitivity) Var. Cost+Fuel	PhP/kWh-e		3.90		2.38		
Weighed: Var. Cost	PhP/kWh-e	2.41	3.16	2.25	2.73	0.92	3.22
Weighed: Fix Cost	PhP/kWh-e	1.64	1.64	1.55	1.55	3.88	1.06
Weighed: Fix+Var. Cost	**PhP/kWh-e**	**4.05**	**4.80**	**3.80**	**4.28**	**4.80**	**4.28**
TOTAL RE Production Share		**34.28%**		**18.00%**		**100.00%**	**43.21%**
Production Share	NG	40.00%		20.00%		0.00%	100.00%
Production Share	Coal	60.00%		80.00%		0.00%	0.00%

PowerGenerationModel-BAU-InnovativeV3.xlsx// Summary

Table 7.6 Comparative Cost of Electricity per kWh, excluding Carbon Cost and Approved FIT Rates, 2013 in PhP

PLANT TYPE	Investment Cost	Fuel Cost	O&M Cost	Generation Cost	Approved FIT Rate
Coal	2.98	0.58	1.00	4.56	NA
NGas (gensets)	1.19	2.46	0.50	4.15	NA
NG-CHCP	1.39	(1.21)	0.60	0.78	NA
Geothermal	1.99	(*)	1.00	2.99	NA
Hydro	3.58	(*)	1.00	4.58	5.90
Solar	5.27	-	0.10	5.37	9.68
Wind	2.56	-	0.20	2.76	8.53
RE-Gas	3.52	(1.21)	1.00	3.31	NA

Excludes royalty due GOP, if any, for use of natural resources.
Note: Biomass and Ocean sources are excluded in cost of electricity calculations under BAU 1 and 2 and Innovative Scenario 1 and 2, but included in BAU 3 and Innovative 3 Scenarios.

Table 7.7 MERALCO Average Generation Cost from Power Producers December 2013 and January 2014		
SOURCE	Average General Cost (Jan 2014) (PhP/kWh)	Average General Cost (Dec 2013) (PhP/kWh)
A. Power Supply Agreements (PSAs)		
SEM-Calaca Power Corp. (SCPS)	4.2604	3.8880
Masinloc Power Partners Corp. (MPPC)	5.1446	6.3917
Therma Luzon Inc. (TLI)	4.2923	4.1392
San Miguel Energy Corp. (SMEC)	4.3278	3.4154
South Premiere Power Corp. (SPPC)	5.0354	5.9473
Therma Mobile Inc. (TMO)	22.1472	10.2656
Sub-TOTAL	**4.8131**	**5.0926**
B. Power Purchase Agreements (PPAs/IPPs)		
Quezon Power Phils Ltd. Co. (QPPL)	6.2644	4.6872
First Gas Power Corp. (FGPC) - Sta. Rita	6.0378	7.1503
First Gas Power Corp. (FGPC) - San Lorenzo	5.7216	6.8707
Sub-TOTAL	**5.9941**	**6.4696**
C. Wholesale Electricity Spot Market (WESM)	5.4153	36.0848
D. Renewable Energy		
Montalban Methane Power Corporation	4.1851	3.8973
Baca Valley Energy Inc. (BEI)	4.0538	3.9021
Pangea Green Energy Philippines	4.2341	3.8433
Philpodeco	5.2636	5.2919
Sub-TOTAL	**4.3065**	**4.0358**
TOTAL Generation Cost for Captive	**5.3708**	**10.0610**

The average generation charge from natgas combined cycle plants ranged per kW ranged from PhP5.95 to PhP7.15 in December 2013, and PhP5.03 to PhP6.04. Higher generation charges for the natgas plants were due to the maintenance shut-down of the Malampaya Gas Facility, the main source of fuel. South Premiere's generation charge in January 2014 was reported at PhP5.03, compared to its February 2012 rate at plant gate of only PhP4.64.[9]

For RE, the current RE-fueled electricity acquired by MERALCO are from landfill gas, with average acquisition cost per kW of PhP3.85 to PhP3.90 in December 2013, and PhP4.05 to PhP4.23 in January 2014; and from hydro at an average of generation cost per kW of PhP5.29 in December 2013, and PhP5.26 in January 2014.

Even without inclusion of the carbon cost, the cost of RE is already competitive to that of fossil sourced electricity. With spiraling cost of fossil fuels, and decreasing costs of RE technologies in the horizon, it could very well be that electricity generated from fossil fuel plants will be more expensive than that from RE.

9 *ERC Case 2012-034*

POWER PRODUCERS	TYPE OF PLANT
A. PSAs	
SEM-Calaca Power Corp. (SCPS)	Coal-Fired
Masinloc Power Partners Corp. (MPPC)	Coal-Fired
Therma Luzon Inc. (TLI)	Coal-Fired
San Miguel Energy Corp. (SMEC)	Coal-Fired
South Premiere Power Corp. (SPPC)	NG Combined Cycle
Therma Mobile Inc. (TMO)	Oil power barges
B. PSAs/IPPs	
Quezon Power Phils, Inc.	Coal-Fired
First Gas Power Corp. - Sta. Rita	NG Combined Cycle
First Gas Power Corp. - San Lorenzo	NG Combined Cycle
D. Renewable Energy	
Montalban Methane	Landfill Gas
Baca Valley Energy	Landfill Gas
Pangea Green Energy	Landfill Gas
Philpodeco	Mini Hydro

7.7 RECOMMENDATIONS

The cost analysis shows that the present cost of electrical generation to the consumer is higher than the highest determined power cost for coal despite an extremely low plant factor; and that lower cost levels are achievable with the massive employment of RE sourced power. Even under an option wherein no carbon cost is charged, the conclusion would not change.

It can be argued that under a 100% RE pathway in JLBTC's alternative model calculation that fossil fuel (natgas) is still used for a limited transition period. However, the amount of fossil energy needed will depend on how fast the transition to a 100% RE is employed by the GOP and its respective policy settings. The previous calculations assumed replacement of the remaining fossil component by RE-CH_4 conversion to minimize use of fossil fuel. The expanded calculation in this report will show that set innovative emission ceilings can be met under an Innovative approach even under limited use of fossil energy *(i.e. natgas)* can achieve set goal under viable cost conditions.

Projections to 2050 or for a long time horizon can vary substantially due to unknown development variables along the way. Variables factors that could change include: population growth rate, GDP growth, shift from rural to urban areas, poverty development, usage and kind of energy used in households, policy developments, transition rates for fuel types, transport, traveling distances per capita to name some. A slight change of growth or reduction factors used can have dramatic changes in the end result calculated and projected. However, to yield reasonable results, it is not so important to know the absolute level of i.e., in this case, of energy used, but what kind of energy is used and how this energy demand develops over time. If the country is able to transition to a 100% RE based economy, the absolute energy amount needed is secondary in regards to GHG emissions and only limited by the availability of RE.

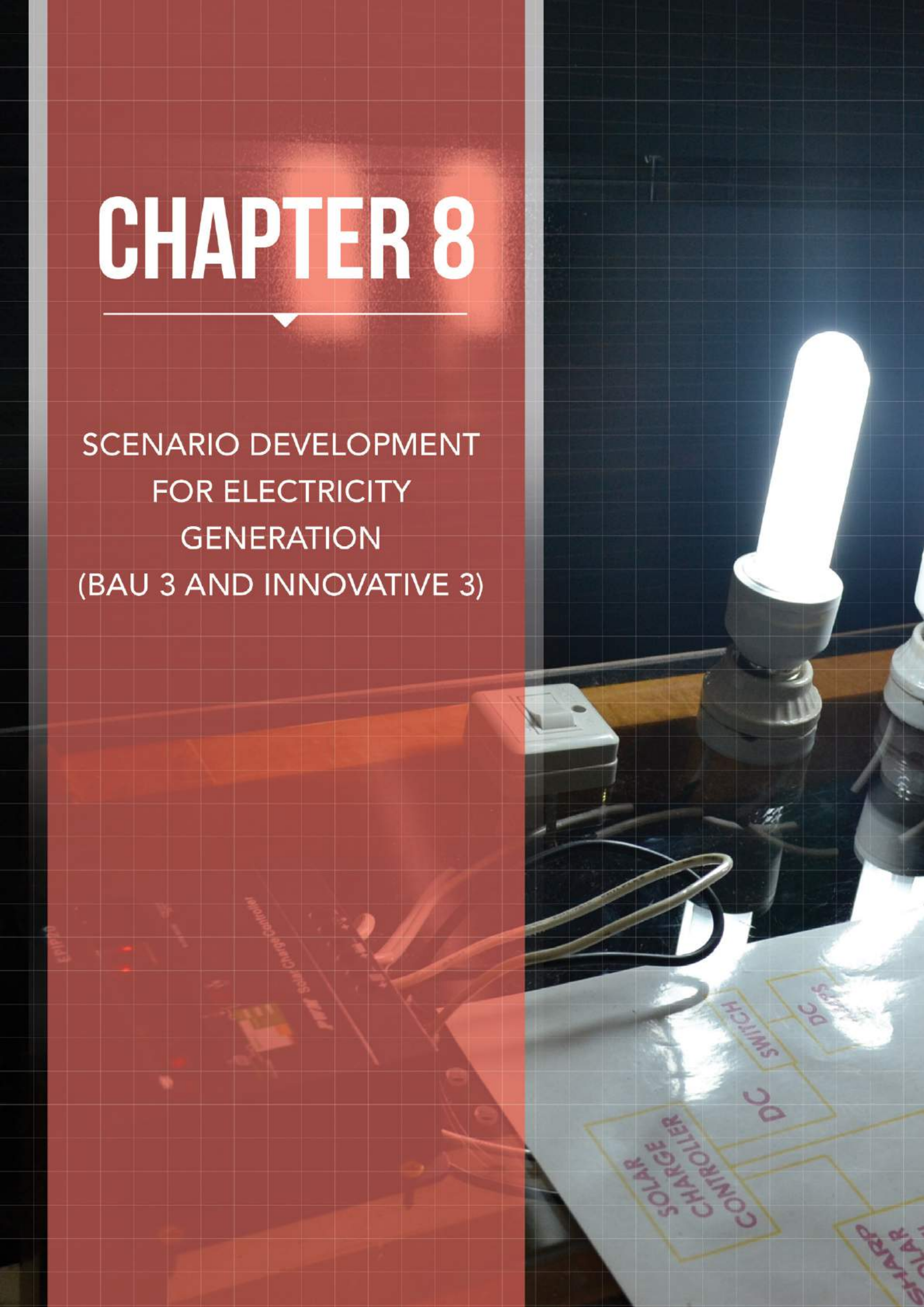
As cited in DOE and NREL reports, the country's wind, sun and probably ocean energy potential surpasses by far the probable energy demand even under extreme demand increase assumptions. Knowing such RE sources are available and can be utilized within acceptable total cost levels, it is therefore wise to work on structures which enable use of RE to its maximum extent.
To provide an effective result and to disseminate the right message towards maintaining given carbon budget, it is highly recommended to transition to 100% RE. The results of the model calculations herein illustrate that a 100% pathway is a valid and viable platform, and should be subject to further discussion and detailed calculation.

How fast and to what extent RE is employed remains open and depends on the country's response to the call for "urgent and immediate need to take decisive and internationally similar and concerted action worldwide" and its ultimate implementation strategy applied.

The implementation of a 100% RE based fuel scenario is achievable considering its vast potential of RE sources. Current Philippine energy policy needs to consider this outlook and accelerate its current RE program. This will not only drastically minimize the country's emissions, but also provide energy security for future generations.

CHAPTER 8

SCENARIO DEVELOPMENT FOR ELECTRICITY GENERATION (BAU 3 AND INNOVATIVE 3)



600W
FUSE 35A
AC LAMPS
SWITCH
AC
INVERTER
LOAD
OUTLET
SOLAR
BATTERY
PANEL

8.1 INTRODUCTION

In this section, a detailed analysis for two scenario developments for electricity generation are undertaken and compared to determine GHG emissions from the energy industries sector for the study period.

- BAU 3 Scenario - The BAU Scenario assumes a continued increase in fossil energy share, and a reduction in its projected RE targets to 2030 from 15,000 MW RE fueled share to 9,000 MW.[1] Despite strong pronouncements to fully harness the country's RE potential to significantly contribute to the country's transition towards a low carbon economy, GOP's direction is towards a larger share in deploying of fossil fueled plants to supply the increasing power demand. To support this, GOP is also aggressively pursuing to contract out its coal mine resources to private sector investors for development.

- Innovative 3 (Scenario 3) - The Innovative Scenario moves towards continuous reduction of fossil fueled plants with RE-fueled plants, and maximizes the utilization of RE depending on reasonably set potentials, availability and deployment patterns.

In both cases, the electricity to be supplied to meet the growing demand for the study period is projected to reach more than 300 TWh-e/year[2] in Year 2050, assuming an average annual growth rate of 4.01%.

All influencing factors in determining the outcome for both scenarios are reviewed, including the current supply and demand data, the country's economic and population growth, the current fuel mix and utilization of installed capacities of the various plant types, as well as the availability of fuel sources.

8.2 CO_2 EMISSIONS FROM THE ENERGY SECTOR IN 2010

The Energy Sector contributes to more than half the country's CO_2 emissions. These have risen from 49 $MtCO_2e$ from 1994 *(INC)* to almost 70 $MtCO_2e$ in 2000[3], and further to 76 $MtCO_2e$ in 2010, at an annual average growth rate of 2.81%.

In 2050, projected energy demand for transport, with the exclusion of fuel for international air and marine transport, will be at 7.92 MTOE or 20.15% of total prime energy demand. Energy demand for industry, residential, commercial and agriculture, fisheries and forestry *(AFF)* will be at 10.44 MTOE or 26.54% of total prime energy demand.

1 REECS LCD Report
2 IEA Energy statistic, EnergyStatisticIEAextractPhilData.xlsx

8.3 COST FOR ELECTRICITY GENERATION

For electricity generation, specific cost analysis is performed for:

- Plant type based Electrical Power Generation - by determining generation cost of individual power plant types and fuel use
- Electrical Power Generation mix - by projecting total power generation cost of BAU and Innovative approach. *(Power mix in this calculation is extended to cover cost for Biomass but excludes ocean sources)*
- Specific cost analysis for Electrical Drive Systems - based on equivalent prime energy demand compared to fossil fueled road transport systems.

The cost analysis presented is focused mainly on electricity generation cost from prime sources. It does not value in detail the potential substantial cost benefits from use of waste heat for process energy from combined power generation which needs a separate, new study, given availability of reliable, comprehensive statistical data.

The results of cost calculation is based on the selected mix and efficiency, availability and utilization factors provided. In as much as the energy mix is based on preference and given utilization factors, changes in input factors or assumptions will naturally result in variation in specific electricity generation cost per plant types, as well as the blended cost of electricity per kilowatt hour.

8.3.1 Cost Assumptions for Energy Electricity Generation

The following tables present cost assumptions applied in the cost calculations:

Table 8.1 provides the assumptions for investment and O&M cost and cost of fuel.

Table 8.2 presents the assumptions on lifetime, efficiency, availability and utilization of power plants.

Table 8.3 shows the resulting production share for each type of plant reflected in model calculations.

3 *The Philippine Second National Communications has not been formally submitted to the UNFCCC. Government statistics vary from statistics acquired from the World Development Indicators (WDI), sourced from the World Bank.*

Table 8.1 Assumptions for Investment and O&M Cost and Cost of Fuel in USD, Year 2010 Prices (International Industry Standards)

PLANT TYPE	Investment Cost per kW-e Installed	Cost of Capital per kW-e Installed	Fixed O&M Cost Installed kW/year	Variable O&M Cost w/o Fuel per kWh/year	Fuel Cost per kWh/year
FOSSIL					
Coal	2,000	255	62.25	0.007	0.007
Oil (Genset)	900	115	30.00	0.008	0.080
Natural Gas	900	115	20.00	0.004	0.021
Natural Gas (CHCP)	1,000	128	25.00	0.005	0.021
RE					
Biomass	2,500	319	70.00	0.008	0.004
Geothermal	3,000	383	50.00	0.006	0.000
Solar PV	1,700	217	5.00	0.001	0.000
Hydro	3,000	383	14.13	0.001	0.000
Onshore Wind	1,700	217	70.00	0.002	0.000
OCEAN OTEC (*)					
Y2010	18,600	1,488	1,110.00	(**)	0.000
Y2020	13,020	1,042	879.00	(**)	0.000
Y2030	9,114	729	717.30	(**)	0.000
Y2040	6,380	510	604.11	(**)	0.000
Y 2050	4,466	357	524.88	(**)	0.000

Notes:
Assumption for O&M Cost: Excludes cost of royalties to government for utilization of RE resources.
Assumptions for Cost of Capital: Cost of Capital for all plant types based on 20-year life with a given weighted average cost of capital of 12.75% per annum, except for Ocean OTEC technology, which is given a weighted average cost of capital of 8% per annum.
(*) OTEC is a more expensive ocean technology, and there are other existing ocean technologies (wave technologies). OTEC is used in the model calculation based on announcement of DOE that the country has three (3) Ocean Thermal Energy Conversion (OTEC) pre-development contracts, including the grid-connected 10 MW OTEC CC in Cabangan, Zambales, Philippines.
Source of cost for OTEC: Economics of Ocean Thermal Energy Conversion (OTEC): An Update, Luis A. Vega Ph.D., National Marine Renewable Energy Center at the University of Hawai'i, Copyright 2010, Offshore Technology Conference (prepared for presentation at the 2010 Offshore Technology Conference held in Houston, Texas, USA, 3–6 May 2010). The paper assumes that later generation designs are expected cost reductions of about 30%. For the model calculation a 30% cost reduction is applied every 10 years.
(**) No variable costs are applied for OTEC, these are subsumed in the Fixed O&M Cost.

Table 8.2 Assumptions on Lifetime, Efficiency, Availability and Utilization of Power Plants[4]

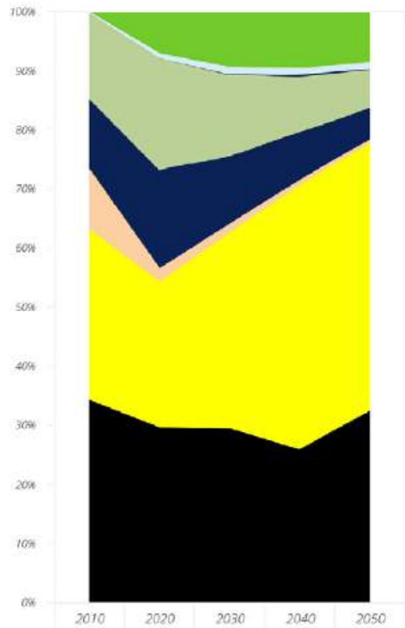
TYPE	Plant Efficiency	Plant Availability	Energy Conversion Efficiency	Effective Utilization in Phils.	Assumptions		
					Average Efficiency	*Potential Utilization Factor (*)*	
						BAU3	Inno 3/RE Trans
FOSSIL							
Coal	30-37%	85%	32%	50-60%	32%	52%	30-0%
Oil	37-48%	90%	41%	10-20%	40%	90%	30-0%
NG	43-52%	97%	43%	75%	43%	95%	30-0%
NG CHCP	43-52%	97%	43%	n.n.	43%	85%	30%
RE							
Hydro	75-85%	50%	n.a.	25-50%(**)	75%	50%	50%
Geothermal	10-15%	80%	n.a.	60-80%	25%	80%	80%
Solar	n.n.	17%	n.a.	16-17%	n.n.	17%	17%
Wind	n.n.	35%	n.a.	30-35%	n.n.	35%	35%
Biomass	15-25%	85%	32%	n.n	25%	80%	80%
Ocean	50-70%	80%	n.a.	n.a.	n.n.	0%	80%(***)

n.a. - not applicable; n.n. - not nominated
(*) Varying based on fuel mix strategy under transition to RE regime.
(**) DOE Year 2010 utilization ratio vis-a-vis installed capacity is calculated at 25.60% (Table 7.9), low utilization is attributed to the El Nino phenomenon. However, this is also caused by deforested watershed areas. In conjunction with the reforestation strategy, utilization should at least be 50%, as utilization below this level is not economical.
(***) Estimates as Ocean technology is just an emerging technology, but model calculation considers employment of ocean fuel plants starting Year 2020.

4 *JLBTC, 2013, ReviewReportJoy+Adjustments.xlsx*

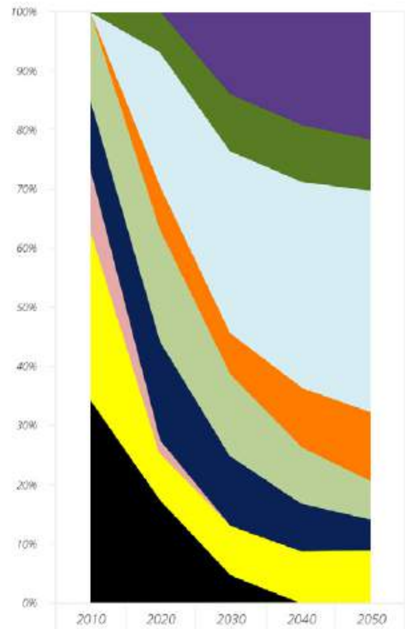
Table 8.3 Assumptions for Power Production Share per Type of Plant, for BAU 3 and Innovative 3 Scenarios, Philippines, Years 2010 - 2050

Power Production Share % of Total Production (BAU)



	2010	2020	2030	2040	2050
Ocean	0.00%	0.00%	0.00%	0.00%	0.00%
Biomass	0.04%	6.99%	9.44%	9.57%	8.62%
Wind	0.09%	0.92%	1.24%	1.26%	1.13%
Solar	0.00%	0.07%	0.10%	0.14%	0.14%
Geo	14.66%	18.87%	13.69%	9.57%	6.46%
Hydro	11.52%	16.60%	11.80%	7.97%	5.39%
Oil	10.48%	2.22%	1.18%	0.80%	0.54%
NG	28.81%	24.46%	33.04%	44.65%	45.24%
Coal	34.40%	29.88%	29.51%	26.06%	32.48%

Total Power Production Share Development Innovative Scenario (% of Total Production)



	2010	2020	2030	2040	2050
Ocean	0.00%	0.00%	14.16%	19.13%	21.54%
Biomass	0.04%	6.99%	9.44%	9.57%	8.62%
Wind	0.09%	22.80%	30.98%	34.88%	37.70%
Solar	0.00%	7.42%	7.02%	10.17%	11.45%
Geo	14.66%	18.87%	13.69%	9.57%	6.46%
Hydro	11.52%	16.60%	11.80%	7.97%	5.39%
Oil	10.48%	2.22%	0.00%	0.00%	0.00%
NG	28.81%	7.64%	8.19%	8.71%	8.84%
Coal	34.40%	17.47%	4.72%	0.00%	0.00%

8.3.2 Cost of Electricity Generation Calculations

The basic calculations in the study include projected capacities and cost for emerging ocean thermal energy conversion (OTEC) technolgy, which is still at pilot stage today. OTEC's present cost levels are still high and not competitive. Further, indications for O&M cost are scarce and hardly available. However, based on reports, capital cost for OTEC is expected to go down sharply. The assumptions used for OTEC consider "estimated default values" which are based on available data.

Calculations for several options to determine cost development were undertaken for BAU 3 and Innovative 3, as follows:

- Option considering a 0.7% p.a. increase of power generation cost for fossil plants. This scenario would increase fossil power cost by 32% within the projection period of 2010 to 2050.
- Option without the inclusion of ocean energy and replacing the production gap from wind energy sources. Ocean energy was not considered for any option under the BAU 3 scenario.

The Innovative 3 *(RE transition)* scenario calls for the eventual phase out of all coal fired plants. The assumption for the calculation is that no coal plants will be operational by Year 2040; baseload is provided by dispatch RE, with peakload provided by Natural Gas and stored RE *(RE-CH_4)*.

Table 8.4 provides specific electricity generation cost per type of power plant including ocean energy, based on assumed efficiency, availability and utilization factors.

Calculation results for the cumulative production cost for BAU 3 within the projected period are only lower under the assumption that no cost increases for fossil energy are incurred, which is quite a remote assumption. This also does not include any cost for GHG emissions, pollution and cost for other externalities. It is assumed that fossil energy is secure at all times. Based on the assumptions indicated, the resulting lower cost would not be achieved with a slight upward change in fossil fuel cost. On the other hand, under the assumption of a slight cost increase of 0.7% p.a. for fossil fuels, electricity cost under the BAU 3 scenario becomes the most expensive option over time.

Table 8.4 Results of Cost Calculation for Electricity per kWh per Power Plant Type for BAU 3 and Innovative 3 (RE Transition) Scenarios

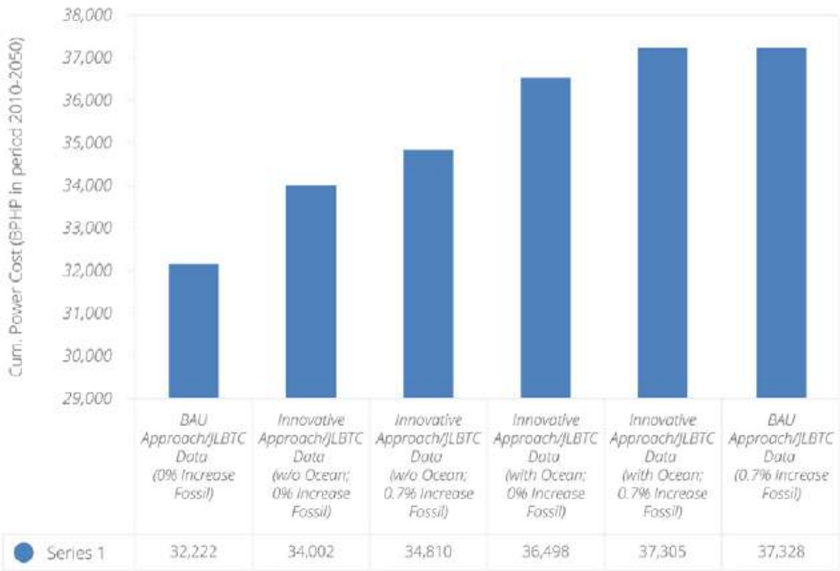
PLANT TYPE	Estimated Capital Cost	JLBTC Model Data BAU 3	JLBTC Model Data Innovative 3	Specific Cost of Electricity			
	(USD/kW)	PhP/kWh-e	PhP/kWh-e	PhP/kWh-e	PhP/kWh-e	PhP/kWh-e	PhP/kWh-e
Fossil Fuel Cost Increase				0.00%	0.00%	0.00%	0.00%
		2010	*2010*	*2020*	*2030*	*2040*	*2050*
FOSSIL							
Coal	2,000	6.51	4.31	4.31	4.31	4.31	4.31
Natural Gas	900	4.57	3.15	3.15	3.15	3.15	3.15
Natural Gas) CHCP)	1,000	3.36	1.94	1.94	1.94	1.94	1.94
Oil	900	11.45	13.81	13.81	13.81	13.81	13.81
Hydro	3,000	3.94	3.94	3.94	3.94	3.94	3.94
RE							
Geothermal	3,000	2.91	2.91	2.91	2.91	2.91	2.91
Solar	1,700	6.45	6.45	6.45	6.45	6.45	6.45
Wind	1,700	3.34	3.34	3.34	3.34	3.34	3.34
Biomass	2,500	3.27	3.27	3.27	3.27	3.27	3.27
Ocean (*)			20.00	12.00	7.00	5.50	4.50

(*) Default Values

Figure 8.1 presents the cumulative power cost projection for a 40-year study period based on the given options. Figure 8.2 illustrates the projected annual power cost per year from 2010 to 2050, comparing the BAU 3 with a 0.7% increase in cost of fossil fuels and Innovative 3 with a 0.7% increase in fossil fuels and without OTEC. This shows that annual power cost will be higher from 2020 to 2030 for the BAU option. Cost results for all options per year per decade are shown in Figure 8.3. Figure 8.4 provides the blended electricity cost for BAU 3 with 0.7% increase in cost of fossil fuels and Innovative 3, with 0.7% increase in cost of fossil fuels, excluding RE OTEC[5]; and Figure 8.5 provides the blended electricity cost for the various options presented.

5 Ocean Technology

Figure 8.1 Cumulative Power Cost Projection for Period 2010-2050
under BAU & Innovative RE Approach



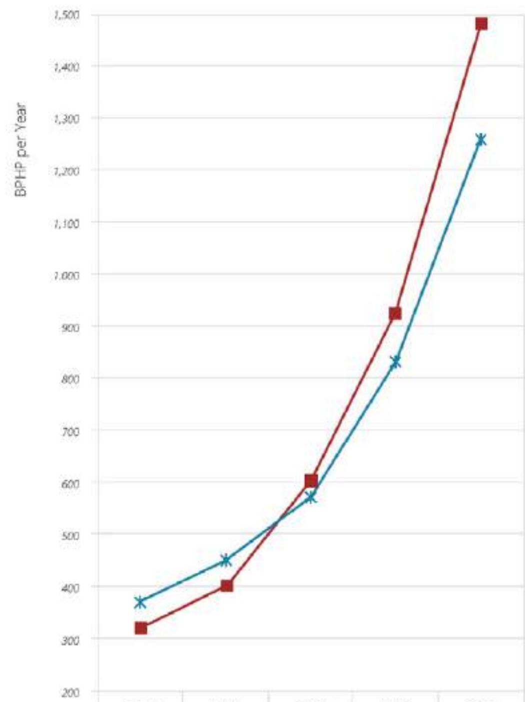
The results of the calculations confirm the viability of the recommended transition to RE under the Innovative 3 development approach, even while excluding ocean energy. However, OTEC can play a vital role after 2030 in providing a consistent RE power source once pilot stage development level has been passed, and at a reduced cost.

It can be argued that the results of the calculations *(at 2010 Prices)* are lower that what is actually charged to consumers. At present, the cost of electricity from fossil fuels is already higher than that of RE. It is important to emphasize that RE is not expensive as some lobby groups portray it to be.

The current high cost of electricity in the Philippines results from the lack of competition in the power production sector, which is now controlled by a few players. There are also the transmission losses which are passed on to consumers, contributing factor to high electricity cost. Improvement of power distribution system, implementation of smart grids and a decentralized and distributed/ combined production and usage approach will reduce losses.

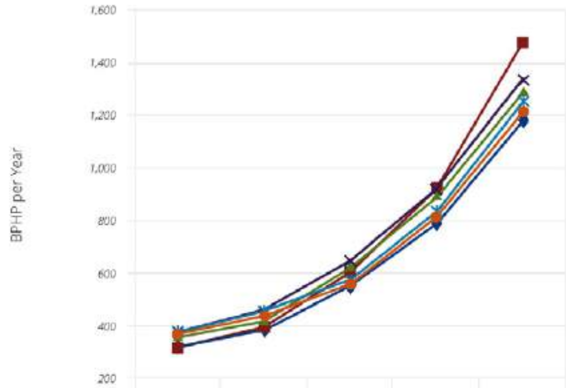
At the same time, the government should address the issues that hinder further investments in the energy sector in order to lower the cost of electricity which is among the highest in the region.

Figure 8.2 Projected Blended Power Cost for Selected Development Options, BAU 3 and Innovative 3 Scenarios (without OTEC)



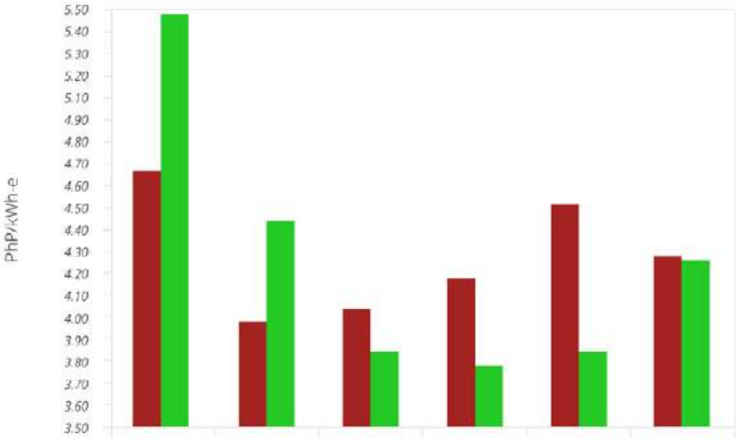
	2010	2020	2030	2040	2050
BAU Approach/JLBTC Data (0.7% increase Fossil)	320	401	603	925	1,483
Innovative Approach/JLBTC Data (w/o Ocean; 0.7% increase Fossil)	370	450	573	833	1,256

Figure 8.3 Projected Power Cost for Selected Development Options
BAU 3 and Innovative 3 Scenarios



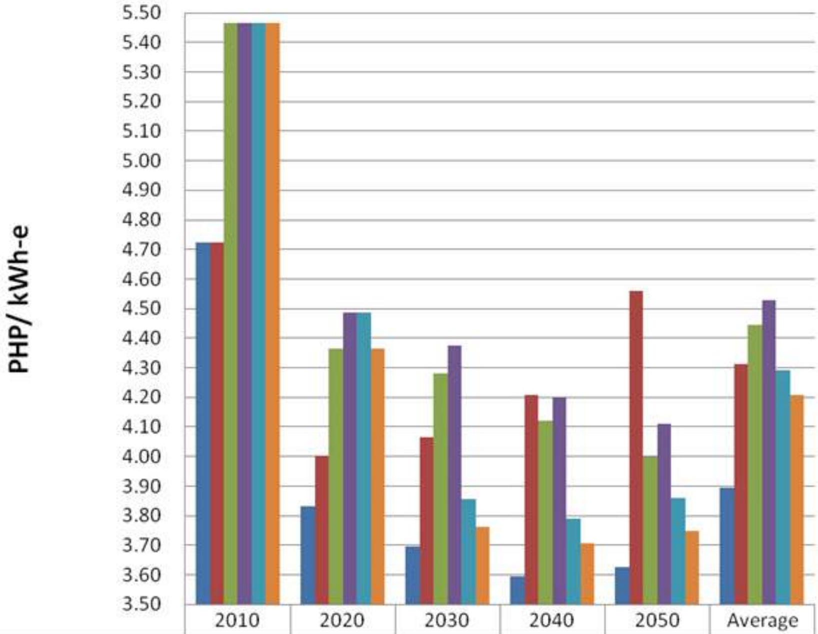
	2010	2020	2030	2040	2050
BAU Approach/JLBTC Data (0% increase Fossil)	320	384	548	790	1,180
BAU Approach/JLBTC Data (0.7% increase Fossil)	320	401	603	925	1,483
Innovative Approach/JLBTC Data (with Ocean; 0% increase Fossil)	370	438	636	906	1,300
Innovative Approach/JLBTC Data (with Ocean; 0.7% increase Fossil)	370	450	650	923	1,337
Innovative Approach/JLBTC Data (w/o Ocean; 0.7% increase Fossil)	370	450	573	833	1,256
Innovative Approach/JLBTC Data (w/o Ocean; 0% increase Fossil)	370	438	559	815	1,219

Figure 8.4 Blended Power Production Cost for Development Options
under BAU 3 and Innovative 3 Scenarios



	2010	2020	2030	2040	2050	Average
BAU Approach/JLBTC Data (0.7% increase Fossil)	4.72	4.00	4.07	4.21	4.56	4.31
Innovative Approach/JLBTC Data (w/o Ocean; 0.7% increase Fossil)	5.47	4.49	3.86	3.79	3.86	4.29

Figure 8.5 Blended Power Production Cost for All Development Options under BAU 3 and Innovative 3 Scenarios



	2010	2020	2030	2040	2050	Average
BAU Approach/ JLBTC Data (0% increase Fossil)	4.72	3.83	3.69	3.59	3.63	3.89
BAU Approach/ JLBTC Data (0.7% increase Fossil)	4.72	4.00	4.07	4.21	4.56	4.31
Innovative Approach/JLBTC Data, with Ocean; 0% increase Fossil)	5.47	4.36	4.28	4.12	4.00	4.45
Innovative Approach/JLBTC Data, with Ocean; 0.7% increase Fossil)	5.47	4.49	4.38	4.20	4.11	4.53
Innovative Approach/JLBTC Data(w/o Ocean; 0.7% increase Fossil)	5.47	4.49	3.86	3.79	3.86	4.29
Innovative Approach/JLBTC Data(w/o Ocean; 0% increase Fossil)	5.47	4.36	3.76	3.71	3.75	4.21

To meet increasing electricity demand, under BAU 3 scenario, the currently installed 16.36 GW capacity is expected to increase to more than 74 GW, while under the Innovative 3 scenario, it is expected to reach 118 GW to supply the demand in 2050. Under the BAU 3 scenario, by 2050 the production share of fossil fueled plants is calculated to reach 78% with its total installed capacity of about 62 GW, while renewables will generate the remaining 22% with its total installed capacity of 12.5 GW. On the other hand, under the Innovative 3 scenario, the production share of RE is calculated to reach 91% with its total installed capacity of 86 GW, while fossil will contribute about 9%, with its total installed capacity of 32 GW as shown in Table 8.5.

Table 8.5 Calculated Electricity Production and Installed Capacities for BAU 3 and Innovative 3, Year 2010 - 2050

Year	2010	2020	2030	2040	2050
Projected Demand in TWh-e/year	67.75	100.29	148.46	219.75	325.29
BAU 3 - PRODUCTION CAPACITY IN TWH-E/YEAR					
Fossil	49.93	56.72	94.61	157.12	254.59
RE	17.83	43.57	53.85	62.63	70.7
BAU 3 - Production in TWh-e/year	**67.76**	**100.29**	**148.46**	**219.75**	**325.29**
% Share					
Fossil	73.69%	56.56%	63.73%	71.50%	78.27%
RE	26.31%	43.44%	36.27%	28.50%	21.73%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
BAU 3 - Installed Capacity in GW					
Fossil	10.92	19.69	28.6	41.17	61.63
RE	5.44	7.85	9.6	11.1	12.5
Installed Capacity in TW	**16.36**	**27.54**	**38.2**	**52.27**	**74.13**
% Share					
Fossil	66.75%	71.50%	74.87%	78.76%	83.14%
RE	33.25%	28.50%	25.13%	21.24%	16.86%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Innovative 3 - Production Capacity in TWh-e/year					
Fossil	49.93	27.41	19.16	19.15	28.76
RE	17.83	72.88	129.3	200.6	296.53
Production in TWh-e/year	**67.76**	**100.29**	**148.46**	**219.75**	**325.29**
% Share					
Fossil	73.69%	27.33%	12.91%	8.71%	8.84%
RE	26.31%	72.67%	87.09%	91.29%	91.16%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Innovative 3 - Installed Capacity in GW					
Fossil	10.9	9.0	10.0	16.0	32.0
RE	5.4	19.7	33.9	56.0	86.0
Installed Capacity in TW	**16.4**	**28.7**	**43.9**	**72.0**	**118.0**
% Share					
Fossil	66.75%	31.36%	22.78%	22.22%	27.12%
RE	33.25%	68.64%	77.22%	77.78%	72.88%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

8.4 PROJECTED CO_2 EMISSIONS

The assumptions for CO_2 emissions applied for fossil fuels are presented in Table 8.6 below:

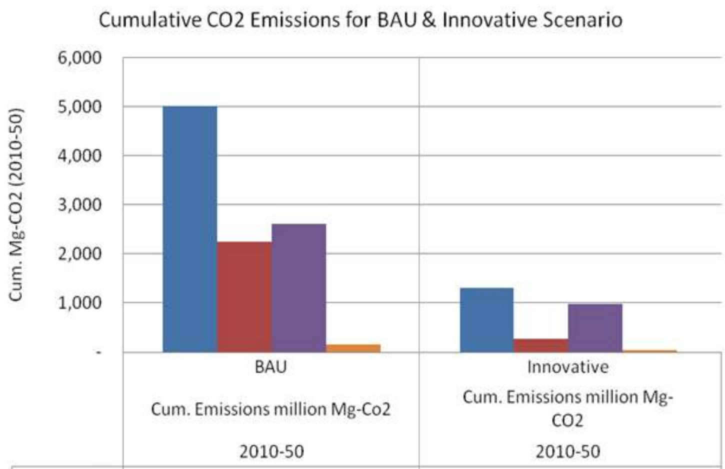
Table 8.6 CO_2 Emissions for Fossil Fuels per kWh

Fossil Fuel Type	in kilograms
Coal	0.92
Oil	0.66
Natural Gas	0.33

In Chapter 6, Figure 6.2 indicated that target emissions levels can be achieved for the Innovative 3 development option.

The results as shown in Figure 8.6 reveal that the emission levels of the Innovative Scenario fall below the earlier defined ceiling levels of 2,105 Tg CO_2e within the projection period of 2010-2050. This emission level only covers emissions from power generation. Emissions from other sources are added based on the calculations presented further below.

Figure 8.6 Projected Cumulative CO2 Emissions for BAU 3 and Innovative 3 Scenario, Philippines, Years 2010-2050



	BAU Cum. Emissions million Mg-Co2 2010-50	Innovative Cum. Emissions million Mg-CO2 2010-50
Total Fossil	5,013	1,302
Coal	2,244	279
NG	2,611	978
Oil	157	45

8.5 CONCLUSION

The country's growing population and economic growth will increase demand for electricity, with supply continuing to be dominated by fossil fuels under the BAU scenario. Harnessing and utilizing the country's huge RE sources is key to reducing its carbon emissions and to addressing energy security.

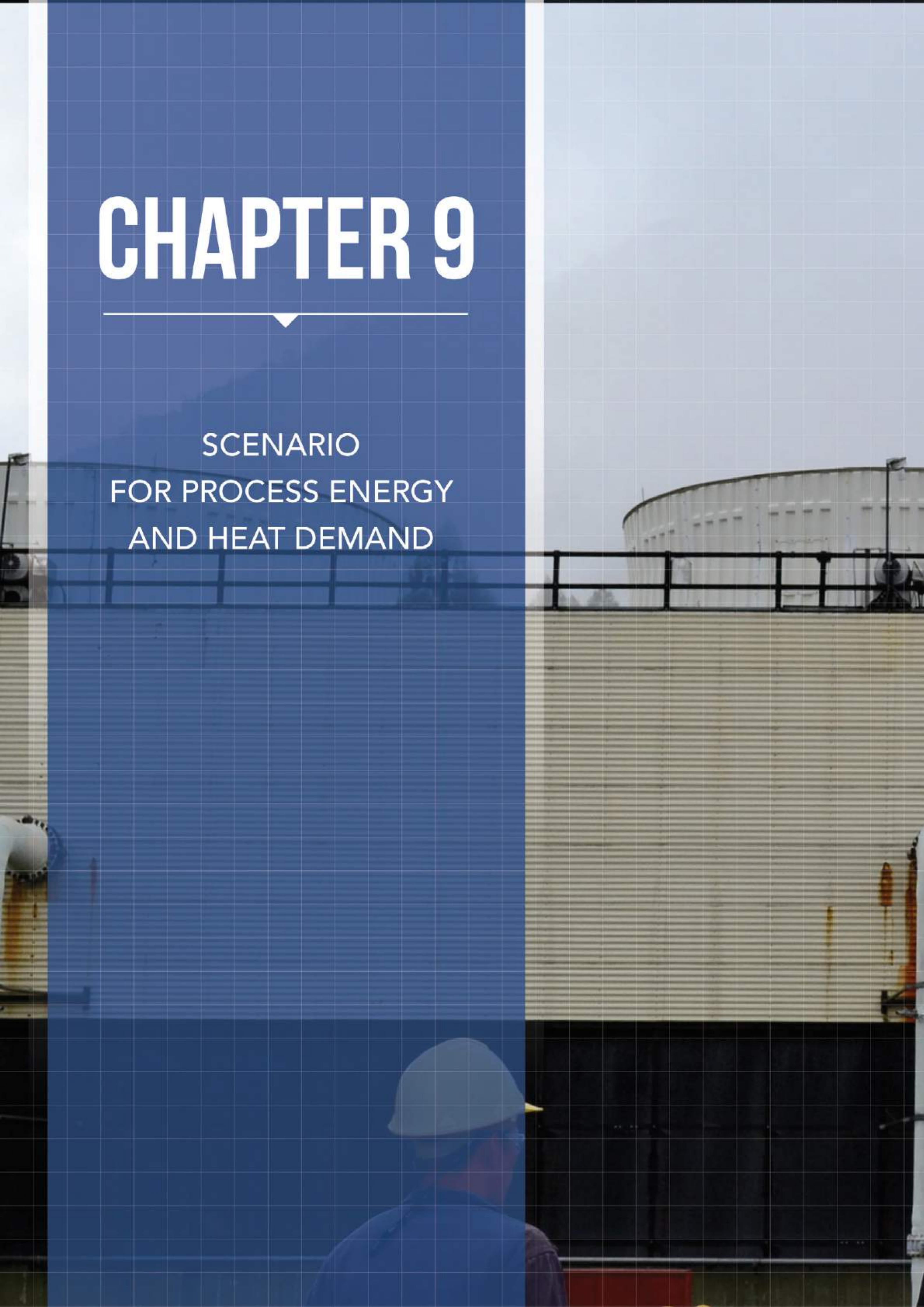
As cost of RE technologies go down, and the cost of fossil fuels spiral upward, the Philippine Government must aggressively pursue the shift to RE towards the next century. Current policies limiting deployment of RE must be revisited.

The RE transition strategy is not only financial viable, but also technically feasible and can be adapted in an emerging country like the Philippines. A central and decentralized scheme is recommended to optimize energy efficiency and minimize system losses. Utilization of intermittent RE sources such as solar and wind can be maximized with implementation of decentralized - centralized, smart grid system. To ensure maximum output from hydro sources, watershed areas for water sources must be protected from denudation. Cost calculations show that total cost for a mainly RE based power generation and decentralized power distribution structure is competitive. It can be further lowered if integrated with distributed power generation systems *(Tri-Generation or CHCP)* combined with variable RE feeds from Wind and Solar and conversion of surplus RE power into RE-CH_4 cost for power, cooling and heat generation.

When cost assumptions do not capture other project costs such as pre-development, land cost and connection to grid costs, differential costs are estimated not to exceed PhP1 per kWh-e based on constant cost base. Under the assumption of cost increases for fossil fuel source, the RE transition strategy presented under the Innovative 3 scenario, may yield lower cumulative cost for the projected period. In view of this, the RE transition strategies are recommended for implementation.

CHAPTER 9

SCENARIO
FOR PROCESS ENERGY
AND HEAT DEMAND



9.1 CO_2 EMISSIONS FROM DIRECT COMBUSTION FOR HEAT

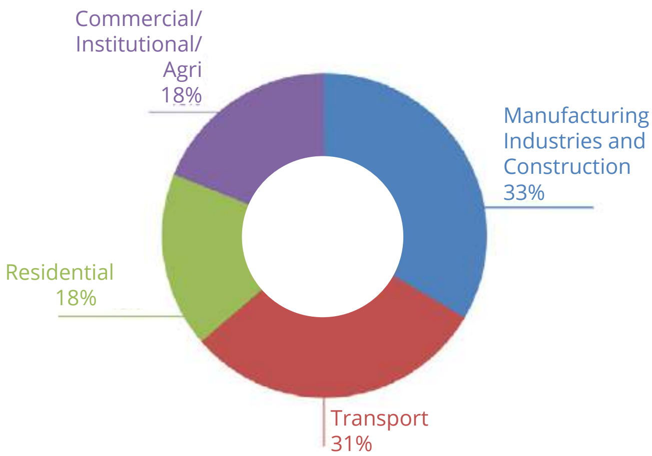
The distribution of CO_2 emissions in the energy Sector from fossil fuels is presented in Table 9.1 and in Figure 9.1 below.

Table 9.1 CO_2 Emissions from Fuel Combustion by Sector, Philippines, 2010

SECTOR	in Mt CO_2e	% Share	kg CO_2/capita
TOTAL	76.4	100%	820
Manufacturing & Construction	25.3	33%	272
Transport	23.6	31%	253
Residential	13.6	18%	146
Commercial, Institutional, & Agriculture	13.9	18%	149

Extracted from IEA, 2012 Edition CO_2 Emissions from Fuel Combustion

Figure 9.1 Share of CO_2 Emissions from Fuel Combustion, 2010[1]



Source: Extracted from IEA, 2012 Edition CO_2 Emissions from Fuel Combustion

9.2 DISTRIBUTION OF HEAT USE

The final energy demand for Heat is distributed among the end use sectors: Residential; Commercial/Institutional; Agriculture *(covers Agriculture, Fisheries and Forestry or AFF)*; Industry and Transport. To acquire a more particular view of final energy demand for heat, this is further segregated[2] into:

- High Temperature Process Energy - mainly used for high temperature heating and burning processes in industry *(i.e. cement industry)*, but also used for cooking mostly in rural areas;

1 *EnergyStatisticIEAextractPhilData.xlsx*
2 *Refer to energy allocation tables in this report's Appendix.*

- Low- and Medium Temperature Energy - mainly used in industrial sector for thermal processes; and

The distribution of high and low level thermal energy demand shown in Table 8.2 is determined based on estimates of the author as no detailed statistical surveys could be acquired from and/or provided by relevant government agencies. In this regard, there is a critical need for GOP to acquire and systematically update and collate detailed energy distribution surveys and analysis according to energy quality and type in the future.

The segregation of heat demand, supply and use in terms of quality of use would make it possible to analyze and apply alternative fuels and energy supply forms, including re-use of waste energy produced through other processes more efficiently. This could lead to a substantial reduction of energy supply needs and improvement of energy efficiency, in terms of not using high value energy for low value use.

9.3 HEAT FROM DIRECT COMBUSTION

This Section describes and calculates the Final Energy Demand and distribution and use as Process-, Medium & Low Temperature -Heat. For Process & other heating or applications, energy recovery systems are employed to minimize prime energy demand. The projection distinguishes three cases: Reference, Efficiency Increase and Fuel Shift to RE Scenarios.

9.3.1 Reference Scenario

In the Reference Scenario for Heat, it is assumed that all energy provided for the end use sectors is supplied by directly combusted prime fossil energy. RE sources are not given an allocation, considering the variations in values depend on a given specific RE source, as this will distort the analysis when evaluating GHG emissions, and since CO_2 emissions from RE sources are negligible.

Distribution and use as Process-, Medium & Low Temperature -Heat is likewise assumed based on the author’s experience as no official segregated data could be provided by DOE. Assumptions used are presented in Table 9.1. Using these assumptions, input values are derived from the Energy Balance Table for 2010 and projected until 2050 as shown in Table 9.2.

9.3.2 Efficiency Increase Scenario

Under this Efficiency Increase Scenario, energy saving measures are adapted reducing prime energy demand. High temperature heat demand is sourced from direct combustion of fossil fuel, while direct combustion of fossil fuel for low temperature heat demand is considered to be replaced by heat generated through CHCP. The results of the calculations for this scenario are presented in Table 9.3, taking off from values reflected in Table 9.1 and Table 9.2.

9.3.3 Fuel Shift to RE Sources Scenario

Under this scenario, calculation takes off from previously stated energy reduction measures that have been applied and the remaining demand is then provided under priority deployment with energy derived from biomass. Eventual gaps will be covered either by waste heat from power generation if applicable and lastly only by conventional fossil prime energy in the event no other RE source or energy recovery option is available.

Further coverage through solar thermal solutions for industry and rural areas could be additionally applied but are not calculated and thus excluded in this projection.

9.4 ASSUMPTIONS AND RESULTS OF CALCULATION MODEL FOR HEAT

The following assumptions were made by the author for non-transport direct fuel combustion: For industry-high temperature at 20%, low to medium at 80%; for the residential sector --- high temperature at 70% and low to medium at 30%; for the commercial sector-high temperature at 80% and low to medium at 20%; and other sectors *(agriculture, fisheries and forestry or AFF)* --- high temperature at 90% and low to medium at 10%.

Table 9.2 Final Energy Demand for High, Low to Medium Temperature Heat, 2010									
Remaining Prime Energy Use per Sector w/o Electricity							(kTOE-pr/a) (2010)		
PLANT TYPE	Fossil Use	RE Use	Fossil Use		RE Use		TOTAL	TOTAL	TOTAL
Energy Level Needed			High	Low	High	Low	High	Low	
TRANSPORT									**8,024**
High	100.00%	100.00%	7,841	-	183	-	8,024	-	
Low	0.00%	0.00%	-	-	-	-	-	-	
INDUSTRY	-	-	-	-	-	-	-	-	**4,341**
High	20.00%	5.00%	661	-	52	-	713	-	
Low to Medium	80.00%	95.00%	-	2,642	-	986	-	3,629	
RESIDENTIAL	-	-	-	-	-	-	-	-	**4,505**
High	70.00%	5.00%	654	-	179	-	830	-	
Low to Medium	30.00%	95.00%	-	279	-	3,396	-	3,675	
COMMERCIAL	-	-	-	-	-	-	-	-	**1,265**
High	80.00%	5.00%	754	-	16	-	770	-	
Low to Medium	20.00%	95.00%	-	188	-	307	-	496	
AGRI	-	-	-	-	-	-	-	-	**220**
High	40.00%	40.00%	86	-	2	-	88	-	
Low to Medium	60.00%	60.00%	-	129	-	2	-	132	
OTHERS	-	-	-	-	-	-	-	-	**-**
High	90.00%	90.00%	-	-	-	-	-	-	
Low to Medium	10.00%	10.00%	-	-	-	-	-	-	
TOTAL w/o Transport			2,152	3,239	248	4,692	2,400	7,932	10,332
TOTAL	13,232	5,124	9,993	3,239	432	4,692	10,424	7,932	18,356
	-	-	54%	18%	2%	26%	57%	43%	100%

High - High temperature Process-/mechanical-/or combusted Energy considered not replaceable by waste heat from CHCP
Low - Low temperature Process-/mechanical-/or combusted Energy considered replaceable by waste heat from CHCP

Take off for projections to 2050 is derived from 2010 Energy Balance Table values imputing average annual growth rates of 4.89% for industry, 1.67% for residential, 5.97% for commercial, 6.60% for other sectors *(agriculture, fisheries and forestry or AFF)* as shown in Table 9.3.

Table 9.3 Estimated Process Heat Demand & Supply Potential, Reference Scenario, Philippines, Years 2010 - 2050[3]

REFERENCE SCENARIO	2010	2020	2030	2040	2050	TOTAL 2010-50	Ave. Annual Growth (%) Assump-tion	Share %	Ave. Annual Growth Factor	Ave. Annual Growth (%) Assump-tion	Ave. Cum. Growth Factor
	MWh-pr/h					GWh-pr					
HIGH TEMPERATURE PROCESS ENERGY DEMAND											
Industry	946	1,525	2,457	3,960	6,383	974,258	4.89%	32%	6.75	4.89%	117.57
Residential	1,102	1,301	1,536	1,813	2,141	543,610	1.67%	18%	1.94	1.67%	56.32
Commercial	1,022	1,824	3,256	5,812	10,374	1,373,370	5.97%	45%	10.15	5.97%	153.41
Agri	117	221	418	792	1,501	183,808	6.60%	6%	12.87	6.60%	180.00
TOTAL High	**3,186**	**4,870**	**7,667**	**12,378**	**20,399**	**3,075,047**		**100%**			
LOW TO MEDIUM TEMPERATURE PROCESS ENERGY DEMAND											
Industry	4,818	7,765	12,515	20,170	32,508	4,961,812	4.89%	58%	6.75	4.89%	117.57
Residential	4,880	5,761	6,802	8,031	9,482	2,407,413	1.67%	28%	1.94	1.67%	56.32
Commercial	658	1,175	2,097	3,742	6,680	884,297	5.97%	10%	10.15	5.97%	153.41
Agri	175	331	627	1,188	2,251	275,713	6.60%	3%	12.87	6.60%	180.00
Total Low to Medium (reference)	**10,530**	**15,032**	**22,041**	**33,132**	**50,921**	**8,529,235**		**100%**			

With the application of stated reduction factors in Table 9.4 for estimated energy savings in the projected periods, we derive the results also shown in the same table.

Table 9.4 Estimate of Process Heat Demand and Energy Savings Potential, Efficiency Increase Scenario[4]

EFFICIENCY INCREASE SCENARIO	2010	2020	2030	2040	2050	TOTAL 2010-50	Ave. Annual Growth (%) Assump-tion	Share % (Efficiency Increase/ Refer-ence Scenario)	Ave. Growth Factor	Ave. Cum. Growth Factor	Cum. Growth Factor
HIGH TEMPERATURE PROCESS ENERGY DEMAND DECREASE											
			15%	20%	20%						
Industry	0%	5%	20%	40%	60%	-					
Residential	0%	5%	10%	15%	20%	-					
Commercial	0%	5%	20%	40%	60%	-					
Agri	0%	5%	20%	40%	60%	-					
LOW TO MEDIUM TEMPERATURE PROCESS ENERGY DEMAND											
Industry	0%	5%	20%	40%	60%	-					
Residential	0%	5%	10%	15%	20%	-					
Commercial	0%	5%	20%	40%	60%	-					
Agri	0%	5%	20%	40%	60%	-					

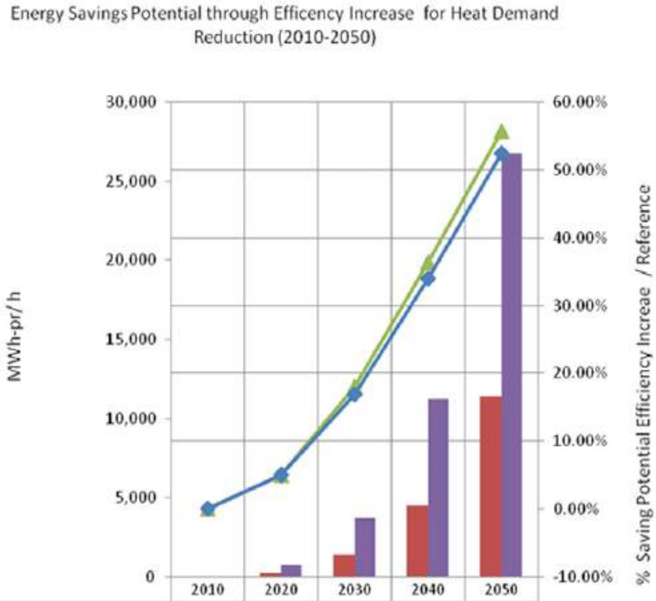
3 JLBTC Model Calculation, ProjectionReferenceJL.xlsx
4 JLBTC Model Calculation, ProjectionReferenceJL.xlsxJ

RESULTING DEMAND UNDER (EFFICIENCY INCREASE APPLICATION)	2010	2020	2030	2040	2050	TOTAL 2010-50	Ave. Annual Growth (%) Assumption	Share % (Efficiency Increase/ Reference Scenario)	Ave. Growth Factor	Ave. Cum. Growth Factor	Cum. Growth Factor
	MWh-pr/h					GWh-pr					
HIGH TEMPERATURE PROCESS ENERGY DEMAND DECREASE											
Industry	946	1,448	1,966	2,376	2,553	**560,196**	4.89%	18%	2.70	0.03	67.60
Residential	1,102	1,236	1,382	1,541	1,713	**482,620**	1.67%	16%	1.55	0.01	50.00
Commercial	1,022	1,733	2,605	3,487	4,150	**768,454**	5.97%	25%	4.06	0.04	85.84
Agri	117	210	335	475	600	**101,312**	6.60%	3%	5.15	0.04	99.21
TOTAL High	**3,186**	**4,627**	**6,288**	**7,880**	**9,016**	**1,912,583**		**62%**	**2.83**	**0.03**	**69.45**
TOTAL Saving Potential to Reference Scenario	**-**	**224**	**1,380**	**4,498**	**11,383**	**1,162,464**					
Projected Energy Savings Potential	**0%**	**5%**	**18%**	**36%**	**56%**	**38%**					
LOW TO MEDIUM TEMPERATURE PROCESS ENERGY DEMAND						**62%**					
Industry	4,818	7,377	10,012	12,102	13,003	**2,853,027**	4.89%	33%	2.70	0.03	67.60
Residential	4,880	5,473	6,122	6,826	7,586	**2,137,319**	1.67%	25%	1.55	0.01	50.00
Commercial	658	1,116	1,677	2,245	2,672	**494,798**	5.97%	6%	4.06	0.04	85.84
Agri	175	315	502	713	900	**151,969**	6.60%	2%	5.15	0.04	99.21
TOTAL High	**10,530**	**14,280**	**18,313**	**21,887**	**24,161**	**5,637,113**		**66%**			
TOTAL Saving Potential to Reference Scenario	**-**	**752**	**3,728**	**11,245**	**26,760**	**2,892,123**					
Projected Energy Savings Potential	**0%**	**5%**	**17%**	**34%**	**53%**	**34%**					

The calculations show an estimated reduction potential for year 2050 of 11,383 MWh-pr/h[5] for High level Energy demand and 26,760 MWh-pr/h for Low to Medium level Energy demand under Efficiency Increase Scenario compared to Reference Scenario. This results in a total cumulative saving potential of 34% to 38% for the period 2010 to 2050. Figure 9.2 shows the projected energy savings potential through Efficiency increase from Heat Demand.

5 MWh-pr/h - Megawatt hour prime energy per hour

Figure 9.2 Projected Energy Savings Potential through Efficiency Increase from Heat Demand, Philippines, Years 2010 - 2050[6]

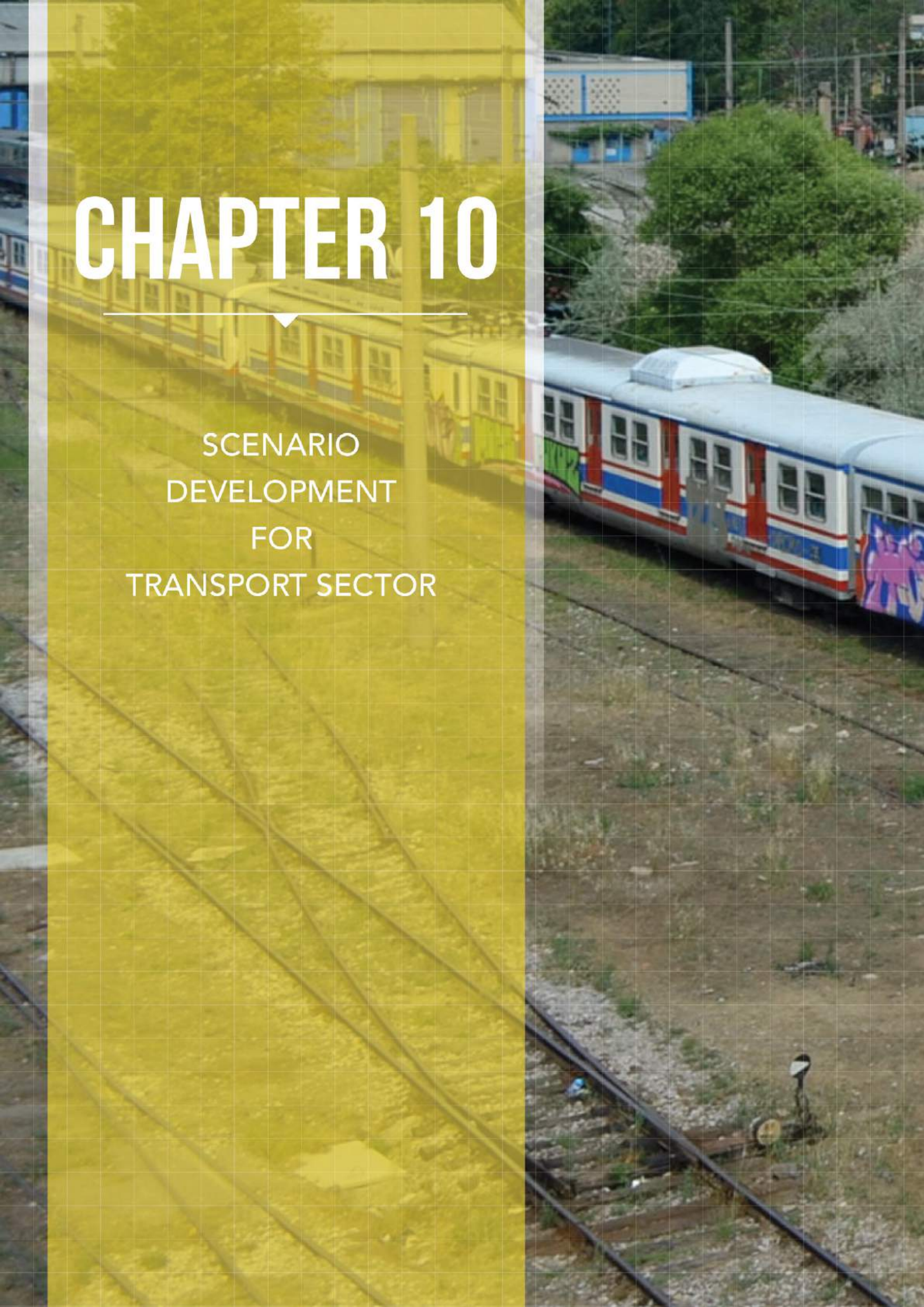


	2010	2020	2030	2040	2050
Total Saving Potential to Reference Scenario (High Heat level)	-	244	1,380	4,498	11,383
Total Saving Potential to Reference Scenario (Low to Medium Heat level)	-	752	3,728	11,245	26,760
Projected Energy Savings Potential (High Heat level)	0%	5%	18%	36%	56%
Projected Energy Savings Potential (Low to Medium Heat level)	0%	5%	17%	34%	53%

6 JLBTC Model Calculation, ProjectionReferenceJL.xlsx

CHAPTER 10

SCENARIO DEVELOPMENT FOR TRANSPORT SECTOR



10.1 INTRODUCTION

The Philippines, unfortunately, has a poor public transportation system, characterized by an inadequate road network, poor support infrastructure, and lack of connectivity.

The existing poor conditions of the country's mass transport system, its limited road network capacities and the annual increasing numbers of individual transport continue to increase CO_2 emission from the Transport Sub-Sector, which consumes the highest share of the country's total Final Energy Demand, and is dominated by fossil energy fuels. The need to make transport more efficient and shift to RE derived fuel is key to achieving GHG reduction goals.

This Section presents an evaluation for three scenarios to determine development of CO_2 emissions for Transport: the Reference (BAU) scenario, and Two *(2)* low carbon scenarios, namely

- an Optimized Approach/Efficiency Increase scenario wherein efficiency of mass transit systems are improved by replacing transport stock with intelligently networked hybrid systems (CNG+E), and the integration of energy production and usage through distributed energy generation and combined use of energy; and
- Fuel Switch to Biofuels and RE fueled e-Vehicles scenario, wherein there is an increased use of biofuels, employment of more and more e-vehicles, including hybrid-electric powered trains

In the study, only road transport is evaluated. A case study is also presented, comparing different fossil fuel based drive systems and alternative electrical powered vehicles and evaluating the effect on energy efficiency-and cost relations in use of fuel type.

10.2 CONSIDERATIONS FOR TRANSPORT SECTOR

In an analysis of the country's poor transport system, the following are noted:

- Tremendous desire for mobility
- Transport demand increases sharply with increased economic development
- Tremendous demand and desire for individual, comfortable and fast transport
- Unresolved "last mile", comfort and time lag problem in relation to mass transit systems
- Problems in shifting cargo from land transport to rail due to lack of adequate infrastructure, thereby requiring multiple handling of cargo which causes time delay and higher costs.

10.3 CALCULATIONS FOR TRANSPORT LOW CARBON MODEL

Starting from the projected energy demand and related CO_2 emissions estimated under the baseline conditions, the growth assumptions of an AAGR of 5.41% for the period 2007-2010; 5.00% for 2010-2020; 5.50% for the Years 2020-2030; 4.5% for 2030-2040; and decreases to 4.00% for Years 2040-2050 are applied to calculate CO_2 emissions to 2050 under the Reference or BAU scenario.

Taking off from the projections under the Reference (BAU) scenario, we calculate the CO_2 emissions for the Optimized Approach/Efficiency Increase by application of the efficiency ratio factors to calculate the total cumulative CO_2 emission reduction goals of 70% for Passenger Transport and 40% for Cargo Transport within the period 2010-2050.

Combining projected increase in traffic, with the given efficiency increase ratio applied, we determined the projected values for the BAU, Optimized Approach/Efficiency Increase and Fuel Switch scenarios for their respective corresponding energy demand levels and CO_2 emissions shown in Table 10.1.

Table 10.1 Road Transport Projected Energy Demand and CO_2 Emissions per Year
BAU, Optimized Approach/Efficiency Increase, Fuel Switch Scenarios, Philippines, Years 2007 - 2050[1]

ROAD TRANSPORT DEMAND ESTIMATE	$Gg\text{-}CO_2\text{-}e/year$	2007	2010	2020	2030	2040	2050
Estimated Traffic Increase (RP+RC)		4.00%	5.00%	5.50%	7.50%	6.00%	3.50%
		1.125	1.158	1.708	2.061	1.791	1.411
REDUCTION GOALS	$g\text{-}CO_2\text{-}e/km$	300					100
			0.30				0.30
Savings Goal RP 2010-2050	-70%		-2.97%	-2.97%	-2.97%	-2.97%	-2.97%
			0.914	0.740	0.740	0.740	0.740
			0.60				0.60
Savings Goal RC 2010-2050	-40%		-1.27%	-1.27%	-1.27%	-1.27%	-1.27%
			0.962	0.880	0.880%	0.880	0.880
Combined Increase & Savings Goal RP & RC 2010-2050	-70%/-40%						33%
Road/Passenger		4.00%	2.03%	2.53%	4.53%	3.03%	0.53%
Road/Cargo		4.00%	3.73%	4.23%	6.23%	4.73%	2.23%
		1.125	1.062	1.284	1.558	1.348	1.055
		1.125	1.116	1.513	1.830	1.588	1.247
FUEL SWITCH TO BIOFUEL & RE FUELED E-VEHICLES	$Gg\text{-}CO_2\text{-}e/year$						
Cum. Fuel Switch	Road/Passenger	0.00%	5.00%	15.00%	45.00%	95.00%	0.00%
Cum. Fuel Switch	Road/Cargo	0.00%	2.00%	14.00%	38.00%	81.00%	0.00%
BASELINE/REFERENCE							
TOTAL RP & RC		**23,728**	**26,691**	**30,898**	**52,778**	**108,777**	**194,804**
Road/Passenger (RP)		15,802	17,775	20,577	35,149	72,442	129,733
Road/Cargo (RC)		7,926	8,916	10,321	17,630	36,335	65,071
OPTIMIZED APPROACH/EFFICIENCY INCREASE							
TOTAL RP & RC		**23,728**	**26,691**	**28,834**	**39,315**	**65,357**	**5,477**
Road/Passenger (RP)		15,802	17,775	18,883	24,254	37,791	1,132
Road/Cargo (RC)		7,926	8,916	9,951	15,061	27,565	4,345
FUEL SWITCH TO BIOFUEL & RE FUELED E-VEHICLES		23,728	26,691	27,691	32,278	31,188	5,477
Road/Passenger (RP)		15,802	17,775	17,938	19,585	16,784	1,132
Road/Cargo (RC)		7,926	8,916	9,752	12,693	14,404	4,345

[1] *JLBTC Model Calculation, Transport-cars+Biomass.xlsx*

To estimate the projected CO_2 emissions and energy demand for Fuel Switch Scenario we apply assumed average transition rates for Passenger Transport and Cargo Transport for the study period presented in Table 10.2 below.

Table 10.2 Transition Rate for Fuel Switch Scenario, 2010 - 2050

Gg CO_2e/year	2007	2010	2020	2030	2040	2050
Road/Passenger	0.00%	5.00%	15.00%	45.00%	95.00%	0.00%
Road/Cargo	0.00%	2.00%	14.00%	38.00%	81.00%	0.00%

The Fuel Switch Scenario assumes switch solely to RE based fuel to simplify the calculations.

Biomass could play an important role to cover the projected RE energy demand for the calculated RE based Fuel Switch Scenario. Based the projected RE fuel potentials from Biomass estimated under a separate section in this report, we apply the potential RE biomass-fuel based on the defined conditions.

The Fuel Switch Scenario indicates potential biomass fuel coverage[2] of more than 100% from period 2030 onwards. However this coverage assumes a sharp transition towards RE fueled E-vehicle and hybrid drives which have to be covered from complementary RE based energy sources derived from RE-CH4 conversion and cannot be covered by biomass alone anymore as indicated under the Energy Efficiency Scenario[3]. Consequently a substantial build up of RE capacities from Wind, Solar and Ocean must cover the RE potential gap in order to stay below the projected GHG emission cap.

The results shown in the lower section of Table 10.3 indicate a full biofuel coverage potential only under the Fuel Switch Scenario step from 2030 onwards at 145% coverage. Under the Energy Efficiency Scenario, the potential coverage from biofuel remains between 68% at 2020 to 84% at 2030 and then declines to 77% in 2050. For the Reference or BAU Scenario, a 100% coverage cannot be achieved in any projection period. The potential coverage under this BAU scenario declines to around 32% in the year 2050.

Figure 10.1 shows the coverage by available Biofuel in relation to the different Scenario steps Baseline/ Reference, Efficiency and Fuel Switch step. Figure 10.2 below shows a comparative development of the annual and cumulative CO_2e emissions from the Road Transport Sector for 2010-2050 for the Reference *(BAU)*, and two proposed low carbon pathways-Optimized Approach/ Efficiency Increase and Fuel Switch scenarios. Results of the calculations indicate that in 2050 under the Reference *(BAU)* Scenario, CO_2 emissions from Road will exceed 150,000 Gg, while under the Optimized Approach/Efficiency Increase, this will reach over 63,000 Gg and this will fall 8,000 Gg under the Fuel Switch Scenario.

2 *see Table 9.13*
3 *see Table 9.13*

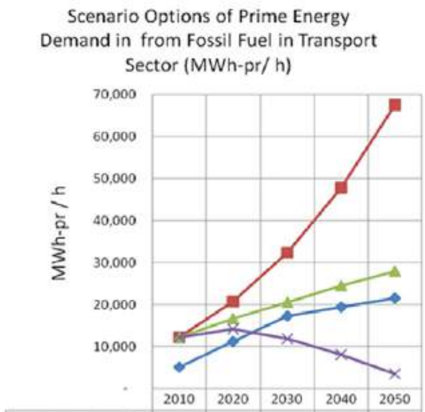
The results show a favorable energy demand development for the Fuel Switch option as this will further reduce already lowered demand from the Efficiency Increase scenario. The figures above and below indicate that efficiency increase measures alone will not achieve needed carbon emission reductions. Under fuel switch, it is assumed that all switch fuel is from RE sources -- either from Biofuel, RE-CH_4 or RE-electrical power.

Table 10.3 Road Transport Projected Energy Demand and CO_2 Emissions per Year with Application of Biomass for Fuel Switch Scenario, Philippines, Years 2007 - 2050[4]

		2007	2007-2010	2010-2020	2020-2030	2030-2040	2040-2050
Baseline	*Cum. Gg CO_2/ period*	*23,728*	*98,831*	*444,322*	*1,048,428*	*1,943,804*	*3,238,752*
Optimized Efficiency		23,728	98,831	349,989	608,812	884,211	1,154,072
Road/Passenger		15,802	65,818	187,338	287,387	369,616	419,704
Road/Cargo		7,926	33,013	162,651	321,426	514,595	734,369
Fuel Switch to Biofuel & RE Fueled E-Vehicles		23,728	98,831	313,612	467,079	568,767	615,226
Road/Passenger		15,802	65,818	169,110	224,137	244,694	247,198
Road/Cargo		7,926	33,013	144,502	242,942	324,073	368,028
Baseline	*Cum. GtCO_2/ period*	*0.02*	*0.10*	*0.44*	*1.05*	*1.94*	*3.24*
Optimized Efficiency		0.02	0.10	0.35	0.61	0.88	1.15
Fuel Switch to Biofuel & RE Fueled E-Vehicles		0.02	0.10	0.31	0.47	0.57	0.62
		2007	2010	2020	2030	2040	2050
	GWh-pr/year						
Optimized Approached/Efficiency Increase		92,147	106,671	145,174	180,377	214,819	245,231
Road/Passenger		61,367	71,040	91,247	106,261	117,784	124,239
Road/Cargo		30,780	35,632	53,927	74,116	97,035	120,992
Fuel Switch to Biofuel & RE Fueled E-Vehicles		92,147	106,671	123,937	104,395	70,201	30,410
Road/Passenger		61,367	71,040	77,560	58,443	29,446	6,212
Road/Cargo		30,780	35,632	46,377	45,952	40,755	24,198
Biofuel potential @ 100%	MWh-pr/h	N.N.	N.N.	N.N.	17,261	N.N.	21,536
Needed biofuel potential to cover fuel demand (fuel switch option)				85.79%	82.90%	77.14%	8.94%
Potential estimates		N.N.	30%	65.00%	100.00%	112.38%	124.76%
Estimated Biofuel Potential			5,178	11,220	17,261	19,398	21,536
Baseline/Reference	MWh-pr/h	10,519	12,177	20,800	32,302	47,815	67,448
Optimized Efficiency	MWh-pr/h	10,519	12,177	16,572	20,591	24,523	27,994
Fuel Switch to Biofuel & RE Fueled E-Vehicles		10,519	12,177	14,148	11,917	8,014	3,472
Potential based on Baseline			42.53%	53.94%	53.44%	40.57%	31.93%
Potential based on Optimized Efficiency			42.53%	67.70%	83.83%	79.10%	76.93%
Potential based on RE Fuel Switch			42.53%	79.30%	144.84%	242.06%	620.36%

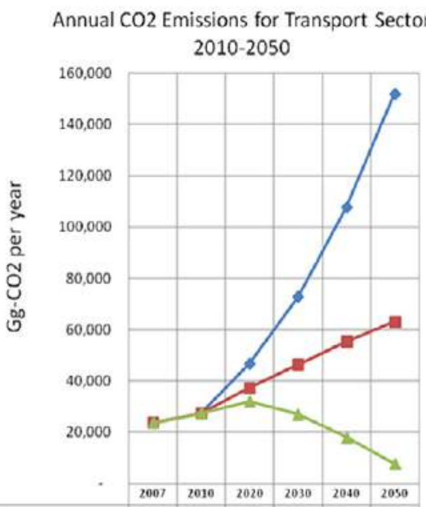
4 *JLBTC Model Calculation, Transport-cars+Biomass.xlsx*

Figure 10.1 Development of Energy Demand from Fossil Fuel in Transport Sector For 3 Scenario Options[5]

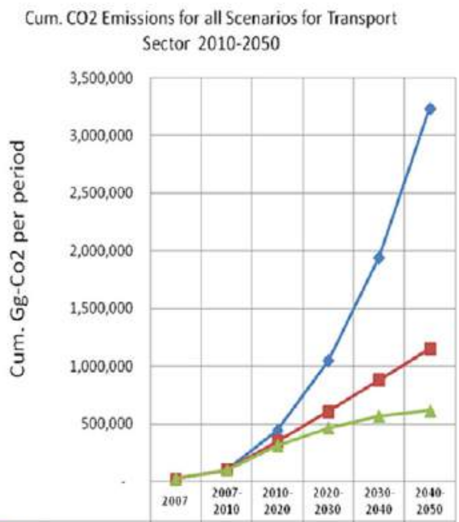


	2010	2020	2030	2040	2050
Estimated Biofuel Potential MWh-pr/h	5,178	11,220	17,261	19,398	21,536
Baseline/ Reference MWh-pr/h	12,177	20,800	32,302	47,815	67,448
Optimized Efficiency MWh-pr/h	12,177	16,572	20,591	24,523	27,994
Fuel Switch to Biofuel & RE fueled E-Vehicles MWh-pr/h	12,177	14,148	11,917	8,014	3,472

Figure 10.2 Comparative Development Of The Annual And Cumulative CO_2e Emissions From The Road Transport Sector For 2010 - 2050



	2007	2010	2020	2030	2040	2050
Baseline / Reference	23,728	27,468	46,920	72,865	107,857	152,144
Optimised Approach/ Efficiency Increase	23,728	27,468	37,383	46,447	55,317	63,148
Fuel Switch to Biofuel & RE fueled E-Vehicles	23,728	27,468	31,914	26,882	18,077	7,831



	2007	2007-2010	2010-2020	2020-2030	2030-2040	2040-2050
Baseline	23,728	98,831	444,322	1,048,428	1,943,804	3,238,752
Optimized Efficiency	23,728	98,831	349,989	608,812	884,211	1,154,072
Fuel Switch to Biofuel & RE fueled E-Vehicles	23,728	98,831	313,612	467,079	568,767	615,226

5 *JLBTC Model Calculation, Transport-cars+Biomass.xlsx*

10.4 CASE STUDY ON COST FOR HIGH EFFICIENT DIESEL AND ELECTRICAL DRIVE SYSTEMS

The following case study compares different fossil fuel based drive systems and alternative electrical powered cars using fossil or RE based energy sources and analyzes the effect on energy efficiency and cost relations in use of different fuels.

To formulate a realistic comparative case for available drive systems, we take the example of the newly presented electrical car *(BMW-i3)*, which can be delivered as mono-electric or hybrid system. The car has fully developed safety and comfort features and is therefore comparable with conventional drive systems. The electrical power demand is 12.9 kWh-e/100km which we take as the benchmark for the comparative analysis.

To derive equivalent results we calculated comparative values for different the systems, determining Prime Energy Demand *(kWh-pr), (kg-)* CO_2 emission level and fuel cost per 100 km.

Table 10.4 Comparative Cases for Alternative Drive Systems

e-Car	Fueled by electricity from a centralized Natural Gas (NG) fired powerplant
e-Car	Fueled by electricity from a centralized coal fired powerplant
DI-NG-Car	Fueled by Direct Injection (DI) Natural Gas (NG) fuelled engine
DI-Diesel Car	Fuelled by DI Diesel fuelled engine
Hybrid DI-NG-Car	Fuelled by DI NG fuelled by hybrid system
DI-Diesel Car	Fuelled by DI Diesel fuelled by hybrid system
e-Car	Fuelled by electricity from owner supplied solar PV powerplant
e-Car	Fueled by electricity from owner supplied wind power plant

For the cost analysis we use Philippine fuel and power cost except for natgas, which is not yet directly available. The price for Natural Gas was set relatively lower compared to the prevailing price for Diesel fuel considering internationally lower pricing for Natural Gas.

10.4.1 Results of Cost Analysis

The results show that the Diesel system has the highest fuel cost, close to fuel cost from electricity supplied by centralized power generation systems but shows reasonable values in terms of GHG emissions. The highest CO_2 emissions and energy demand is by electricity fuel supplied by centralized coal fired plants.

Average results in terms of energy demand, cost, and CO_2 emissions are achieved by Hybrid-Natgas fueled drive systems.

Of interest is the highly beneficial cost and emission structure, in the case of fuel supplied by decentralized solar or wind systems, which yield the best results, showing lowest values in all criteria. Beneficial cost results are achieved only through owner supplied or decentralized electricity solar-pv or wind power plants. If wind or solar power is supplied through the centralized grid system, the cost benefits will vanish as fuel cost will priced higher than electricity supplied by the grid.

The non-beneficial results for e-Cars fueled by electricity from centralized coal fired plants prove the a switch strategy to electric drive systems fueled by coal is not an option with regard to GHG emission reduction nor with regard to cost reduction. This underlines the over-all recommended strategy for a distributed and individualized, RE based power generation structure.

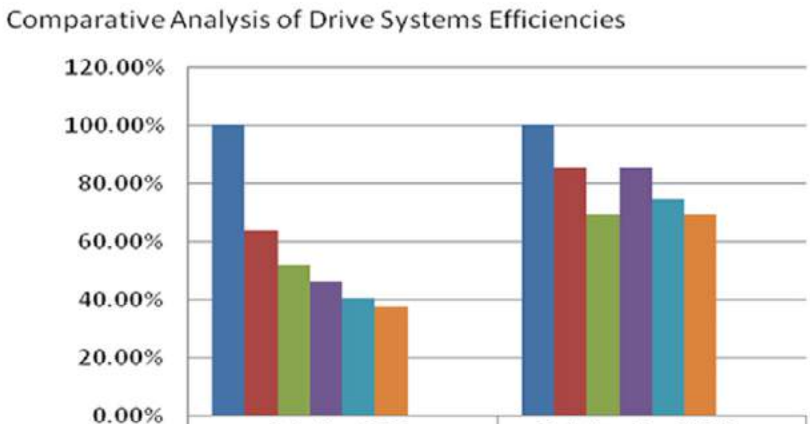
This indicates the need to reform the current inflexible and costly power supply and distribution sector in the Philippines, to be replaced with a real functioning open market structure supporting unrestricted access for distributed, individual power generation systems and giving full priority for RE based power generation systems.

Internal total cost evaluations performed by the author show that e-Car and natgas hybrid systems show most beneficial total cost relations and are financially viable under present cost conditions and if electrical power can be provided by owner supplied RE-power.

6 JLBTC Model Calculation, Transport-cars+Biomass.xlsx

The outlined approach towards hybrid and electric vehicles fuelled by RE sources is adaptable to the entire transport system and can be applied seamlessly to rail, water and *(with limitations)* also to air based drive systems.

Figure 10.3 Comparative Analysis of Efficiency & Cost Levels between Fuel-Drive, E-Drive and Hybrid Systems[6]- CO_2 Level Against Relative Fossil Prime Energy Demand



	Relative CO2-Emissions	Relative Fossil Prime Energy Demand
E-car, Coal central	100.00%	100.00%
DI-Diesel-Car	63.84%	85.25%
Hybrid DI-Diesel-car engine	51.82%	69.19%
DI-NG-car engine	46.39%	85.25%
E-car, e-NG central	40.50%	74.42%
Hybrid DI-NG car engine	37.65%	69.19%
E-car Solar powered (own supply)	0.00%	0.00%
E-car Wind powered (own supply)	0.00%	0.00%

10.5 LOW CARBON STRATEGY FOR TRANSPORT

As transport volumes and energy consumption from the transport sector continue to rise, appropriate land and urban planning is necessary to reduce transport energy consumption. This should consider the environmental ranking of transportation modes as follows: walking is preferable to cycling, cycling is preferable to public transit, and transit is preferable to private car traffic. The ground level of streets has to be designed to make it conducive for pedestrians and cyclists, including wide sidewalks, bike lanes, and crossways over the driving lanes.

Planning must avoid high carbon, transit oriented development. Due to lack of land use control and policy instituting mixed use development to allow live-work-play conditions within close proximity to each other in urban development, demand for motorized transport continues to increase. Self-sustaining community development lowers vehicular travel demand and travel distance, and encourages walking or use of non-motorized bicycles for short distance travel.

As urban sprawl development trend continues, the next best option is to provide an efficient mass transit system as early as possible. Public transport system must consider seamless multi-modal transport connectivity for commuters including properly appointed pedestrian walkways, non-polluting para-transit or shuttle transport system to primary modes such as the MRT. Additionally, park and ride solutions must be provided at economical cost to commuters.

Increase in individual road transport vehicles will further aggravate conditions in the already congested roads in urbanized areas in the country such as Metro Manila and Metro Cebu. Singapore is among the countries that has set a global example with the introduction of congestion pricing to reduce the number of kilometers driven by private vehicles and to encourage car users to switch to public transport. Pedestrian walkways in Singapore are conducive to walking, being wide with properly planned landscaping and seating.

The proposed low carbon approach involves upgrading and expanding the country's mass road transport and rail systems, to adapt seamlessly with application of hybrid and electrical strategies, along with further measures to save specific energy consumption, such as:

- Implementation of high capacity mass transit systems in all urbanized areas using cleaner fuels and greener vehicles:
- Increased pay-load (per pax or tonne) capacity per kilometer
- Utilization of lighter weight vehicles with high efficiency drive systems
- Reduction of travel distances with proper land and urban planning
- Encouragement of telecommunication based business transaction modes
- Improvement of traffic system to improve travel speed; and
- Implementation of uninterrupted flow operating travel systems

The use of alternative fuels such as natural gas, biofuels, electricity and hydrogen, in combination with improved conventional and advanced technologies provide the potential for even larger reductions.

There is a need to de-congest piling, clogging and suffocating traffic density and to resolve the "last mile problem" caused by the country's poor transportation infrastructure and mass transport system. Government must improve its mass transit system and road network to minimize travel time and idling. In Metro Manila, despite the implementation of the Uniform Vehicular Reduction Program since 1995, introduction of overpasses and underpasses, improvements in traffic systems and reduction of vehicle-pedestrian areas, traffic problems in its main thoroughfares remain unresolved. Pile-ups are also still experienced even in expressways linking Metro Manila to outlying areas.

The light rail transit system of Metro Manila comprises more than 40 kilometers, with planned expansion to about an additional 56 kilometers for a total of about 100 kilometers, with the exclusion of Lines 8 and 9. Until today, expansion of lines 7, 8, 9 of Metro Manila's elevated light rail system still have to be undertaken. To compare, Bangkok's MRT currently has a total length of 81 kilometers. The low carbon development rail transport solution expects to reduce CO_2 emissions by 45% as compared to road oriented development which results to reduction by only 22%.

Due to high cost of elevated rail systems cost at over 200 million US$/km, the alternative is to consider implementing bus rapid transit (BRT) systems which cost 1-15 million US$/km, depending upon the capacity requirements and complexity of the project. Due to many areas in Metro Manila being flood prone, it is not advisable to introduce underground metro systems which can cost 50 million US$/km, unless flooding and drainage issues in the metropolis are resolved.

As the country's economy improves, the current behavior of those that are able to afford vehicles would be to immediately turn to two or four-wheeled individual transport with the more affluent in society preferring higher-power engine and more luxurious cars, more so when public transit options are not easily highly accessible, efficient and safe. It is to be seen if this behavior will change over time as expansion of and shifting to better mass transit systems are introduced.

10.6 RECOMMENDATIONS AND CONCLUSIONS

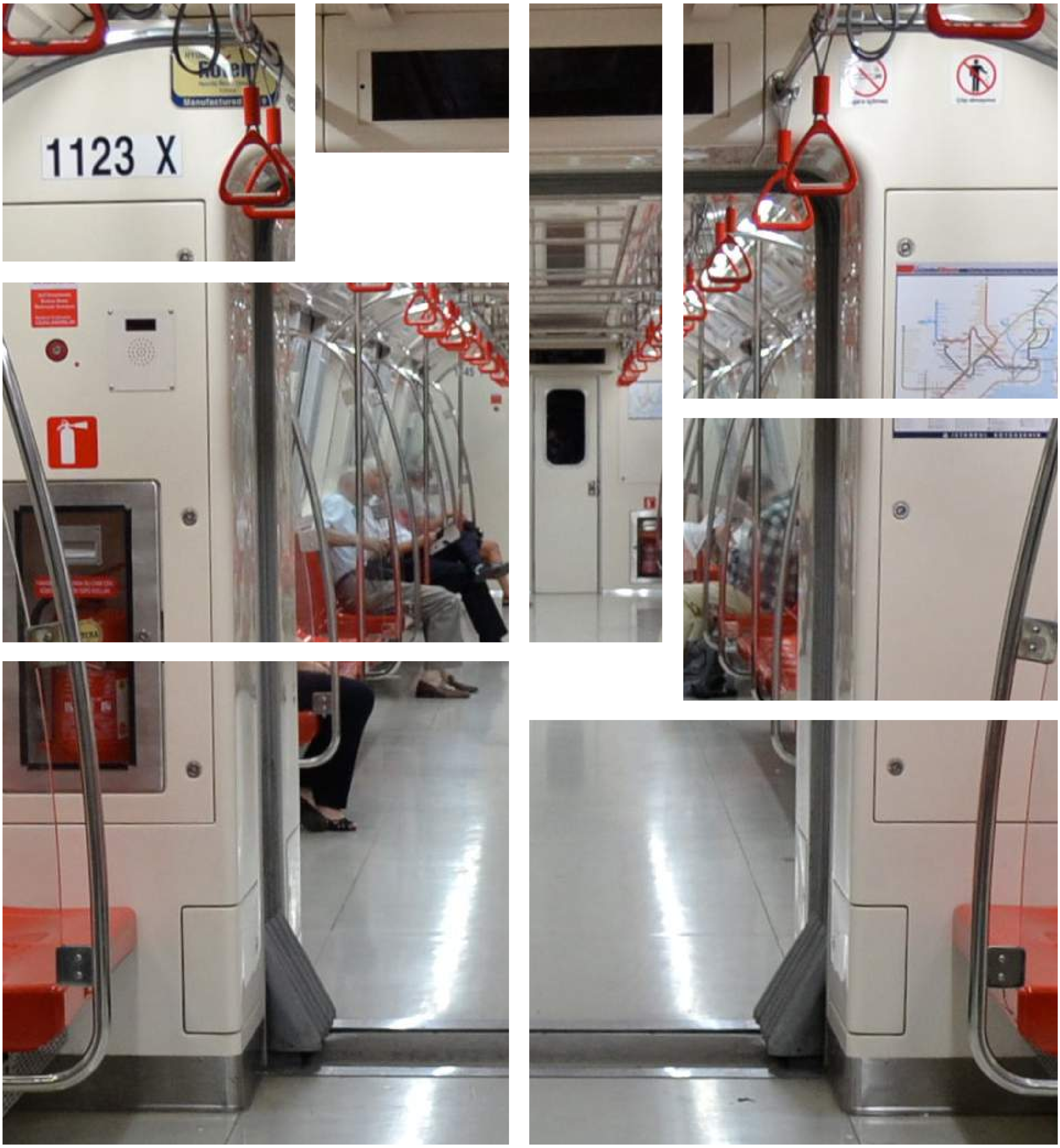
It is recommended that direction of land and urban planning be towards self-sustaining communities that ensure reduction of transport energy consumption. Providing infrastructure for a multi-modal system with high connectivity and access despite weather-related disruptions will lessen demand for individual transport, thus, lowering carbon emissions. Unless existing mass transit systems are improved, people will not be enticed to take such public transport modes. Similarly, unless pedestrian and bikeways are improved, safe and connected, the population will rely on vehicular transport even for short distances of 2 km and below.

Implementing efficiency measures in transport reduces expected CO_2 emissions to about 57,500 Mt in 2050. Under the fuel switch scenario, further reductions in emissions are achieved with maximized utilization of biofuels to 21,500 Mt. Fuel switch in combination with RE-fueled transport would further reduce CO_2 emissions to about 2,400 Mt in 2050. The sooner efficient, higher capacity, low carbon mass transit systems are implemented where necessary, the better.

Cost analysis show that electric and/or hybrid drive systems are financially viable. A shift to the e-Car and Hybrid-Natgas systems can be achieved with a market oriented but strategically regulated and directed approach.

CO_2 emissions can effectively be reduced, if adequate CNG, LPG and RE loading stations are put in place and supported by the GOP through investment incentives.

The government can likewise consider subsidy programs for installation of loading stations, for example, funded from its road tax revenues and revenues from its share of production of Malampaya gas.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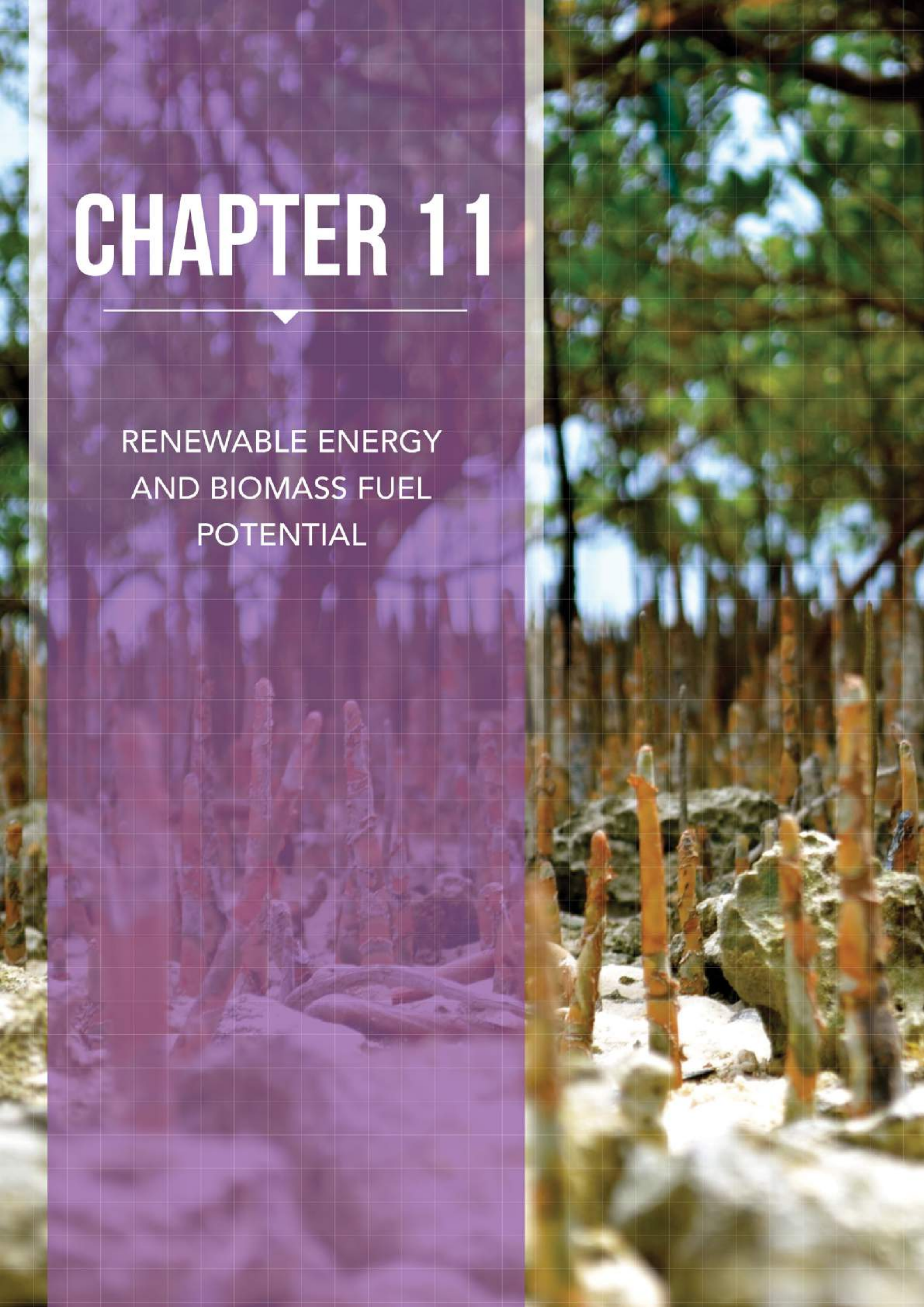
CHAPTER 11

RENEWABLE ENERGY AND BIOMASS FUEL POTENTIAL



11.1 APPLICATION OF RENEWABLE ENERGY AND BIOMASS

The different RE sources, their characteristics and uses for power and heat generation are distinguished as follows:

- Direct Electrical Power generation - from Hydro, Wind, Solar-PV and Ocean
- Indirect Electrical Power Generation and Heat from Geothermal - through low pressure steam process. Geothermal energy is primarily produced in centralized locations away from point of use.
- Multi Energy production and use from Biomass/Biofuel - Mainly from Forest and Agriculture Residuals, Fuel Crops, Livestock Manure, Solid and Liquid Waste.

  More liquid feedstock *(sewer, manure)* and dedicated fuel crops could be used to produce biofuel like ethanol or methane which can be used in the Transport sector, peak power generation or as "filler energy" to buffer gaps in RE power generation.

  Other, more solid biomass from forest and solid waste components would preferably be used in direct combustion process to generate under first priority.

  Use for electrical power and use of recoverable thermal Energy for Process-and Medium to Low Temperature Heat and/or Cooling applications can be considered.

11.2 BIOMASS FUEL

Biomass takes carbon out of the atmosphere while it is growing, and returns it as it is burned. If biomass is managed on a sustainable basis, such as biomass harvested with proper forest management, it maintains a closed carbon cycle with no net increase in atmospheric CO_2 levels. Biomass can equally apply to both animal and vegetable derived material. Sources of biomass include:

- Virgin wood, from forestry and agro-forestry activities or from wood processing
- Energy crops, high yield crops grown specifically for energy applications
- Agricultural residues, from agriculture harvesting or processing
- Food waste, from food and drink manufacture, preparation and processing, and post-consumer waste
- Industrial waste and co-products from manufacturing and industrial processes.

However economic realities limit use to where the biomass gets a higher value, such as large timber, which will not be likely used for energy generation.

Thermal and chemical conversion technologies that make optimum use of biomass, include:

A. Thermal Conversion - *combustion, gasification and pyrolysis. There are less common technologies such as hydrothermal upgrading and hydroproccessing to allow biomass with high moisture content to be converted into more convenient forms. Applications of thermal conversion include combined heat and power and co-firing.*

B. Chemical Conversion - *convert biomass into forms that can be conveniently used, transported or stored, these include anaerobic digestion, fermentation and composting; and transesterification or converting waste vegetable oil directly to biodiesel.*[1]

In the Philippines, many households burn wood for charcoal, or burn wood directly for cooking. Biomass using agricultural crop residue and methane derived from landfills are also already being converted to electricity.

Biofuels are likewise being produced in the Philippines. This comprises about 2-3% of total RE production. As of 2011, there have been no compliance issues meeting the mandated 2% biodiesel blend. There were also no problems anticipated in meeting the 5% blend. Compliance with the 10% mandated ethanol blend in gasoline, however, is hampered by the inadequate capacity of existing sugarcane distilleries, low productivity, and high production costs. Challenges to local production are compounded by commitments under regional free agreements that will open the door to Thai sugar and ethanol.[2]

1 *What is Biomass?, UK Biomass Energy Centre, http://www.biomassenergycentre.org.uk/portal/page?_pageid=76,15049&_dad=portal*
2 *Philippine Biofuels Situation and Outlook, Philippines Biofuels Annual, Gains Report, USDA Foreign Agricultural Service, July 2013, prepared by Perfecto Corpuz*

11.3 ESTIMATION OF RE AND BIOMASS FUEL POTENTIAL

In Chapter 4, Table 4.23 provides estimates for the potential RE sources in the Philippines including biomass, based on DOE estimates and expanded calculations from the study team. The total RE potential in 2030 is at 159,139 MW-e, while in 2050, this will increase to 325,819 MW-e. These figures assume complete conversion of the estimated RE potential into electrical power.

Table 11.1 projects RE potential for all sources until 2050. An optimized conversion strategy and allocation of potential prime energy, derived from biomass is applied for the conversion of this organic matter into biofuel and partially into power. The conversion of biofuel and use in the transport sector is seen more advantageous against the use of the potential prime energy for electrical power generation. Table 11.2 provides the estimated generation capacities and volumes for Prime Energy use, Electrical Power and Waste Heat recovery potential.

Table 11.1 RE Potential, Installed Capacity and Indicative Additional RE Capacity, Philippines, 2010 - 2050[3]

RE POTENTIAL	Prime Energy Potential from Biomass MWh-pr/h		Biofuel Potential MWh-pr/h		Power Generation Potential MW-e		Residual Process Heat Potential after Power Generation MW-th		Residual Process Heat Potential after Power Generation MW-th (w/o Biofuel)	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Note: All values in MWh-e per h, year if not indicated otherwise.										
Hydro (+mini, micro)					6,830	10,500	-	-		
Geothermal					2,369	4,567	-	-		
Wind					76,489	76,489	-	-		
Solar					41,667	166,667	-	-		
Ocean					17,000	51,000	-	-		
TOTAL RE w/o Biomass			**0.25**	**0.25**	**144,355**	**309,193**	**-**	**-**		
Forest Residual	7,135	7,135			1,784	1,784	4,548	4,548	4,548	4,548
Fuel Crops	43,891	65,836	10,973	16,459			27,980	41,971	-	-
Indicative Capacity										
Sugar Cane Cogen (a,b,c)	4,152	4,152	1,038	1,038			2,647	2,647	0.2%	100%
Ricehull (a)	5,024	5,024			1,256	1,256	3,203	3,203	3,203	3,203
Coconut residues (b)	80	80			20	20	51	51	51	51
Bagasse (c)	940	940			235	235	599	599	599	599
MSW/Full recycling & Energy conversion	11,551	8,885	5,250	4,038			9,467	7,282	2,544	2,544
Livestock	175	311			75	134	347	615	347	615
Sewer	348	551			150	237	688	1,090	688	1,090
TOTAL Biomass	**73,296**	**92,914**	**17,261**	**21, 536**	**3,520**	**3,665**	**49,531**	**62,006**	**11,980**	**12,650**
TOTAL (MW-e)					**147,875**	**312,858**				

Source: Department of Energy except for Landfill Gas estimates and targets made by Study team
1GOODImportantPH_Low_Carbon_Transport_and_Power copy.pdf
Table 4.1-2:RE Potential, Installed Capacity and Indicative Additions

3 *JLBTC Model Calculation, Transport-cars+Biomass.xlsx*

Table 11.2 Energy and Power Potential from Biomass, Philippines 2010 - 2050[4]												
ENERGY & POWER POTENTIAL FROM BIOMASS		2010	2020	2030	2040	2050	TOTAL 2010-50					
Estimated Potential based on 2030 figure		*10%*	*30%*				*GWh-pr*					
TOTAL Prime Energy Potential from Biomass Reference	**MWh-pr/h**	**2,199**	**21,989**	**73,296**	**83,105**	**92,914**	**8,099,519**			**42.26**	**0.10**	**420.49**
POTENTIAL BIOFUEL FOR TRANSPORT SECTOR												
Biofuel Potential (share)	MWh-pr/h	1,726	5,178	17,261	19,398	21,536	2,664,427			12.48	0.07	176.21
Energy Demand for Reference Scenario	MWh-pr/h	11,833	13,698	23,398	48,223	86,360	12,814,484			7.30	0.05	123.63
Energy Demand for Optimized Efficiency Scenario	MWh-pr/h	11,833	12,783	17,429	28,974	41,993	8,212,077			3.55	0.03	79.23
Energy Demand for Fuel Switch to Biofuel & RE fueled e-Vehicles Scenario	MWh-pr/h	11,833	12,276	14,310	13,826	1,926	1,955,896			0.16	(0.04)	18.87
Potential Biofuel Surplus for Fuel Switch Scenario (Potential use for High Temp. Process Heat)	**MWh-pr/h**	**(10,106)**	**(7,097)**	**2,952**	**5,572**	**19,609**						
POTENTIAL BIOFUEL FOR POWER GENERATION												
Biomass Power Generation Potential (share)	MWh-e/h	106	1,056	3,520	3,593	3,665	336,300			34.71	0.09	363.56
WASTE HEAT POTENTIAL FROM BIOMASS (MWh-th use/h)												
A. Potential from Biomass (incl. Biofuel to Power)	(MWh-th use/h)	1,486	14,859	49,531	55,768	62,006	5,422,528			41.73	0.10	416.58
B. Potential from Biomass (Biofuel for Transport) (excl. Biofuel to Power) Low to medium	(MWh-th use/h)	359	3,594	11,980	12,315	12,650	1,156,354			35.20	0.09	367.28
Temperature Process Energy Demand	(MWh-th use/h)	10,530	14,280	18,313	21,887	24,161						
Potential Waste Heat Surplus (Option B)		**(10,171)**	**(10,686)**	**(6,332)**	**(9,572)**	**(11,511)**						
Potential Waste Heat Surplus (Option B plus Surplus Biofuel reserved for High Temp. Process Energy)		**(20,277)**	**(17,783)**	**(3,381)**	**(3,999)**	**8,098**						
WASTE HEAT POTENTIAL FROM ELECTRICITY PRODUCTION												
Waste Heat Potential from Electricity Production (Reference Scenario)	MWh-th use/ h	5,066	7,500	11,101	16,432	24,324	4,217,388	4.00%	1.48	4.80	0.04	95.03

The result of the calculations indicate an ample amount of total energy supply potential through RE-sources, which surpasses the energy demand under Reference Scenario applications, if these RE resources including biomass are developed.

The estimated volumes of energy and power production potentials from Biofuels is shown in Table 11.3. This considers application of the conversion priority regime for utilization of energy derived from biofuels.

4 *JLBTC Model Calculation, Transport-cars+Biomass.xlsx*

Table 11.3 Summary of Energy and Power Potential for Biofuels, Philippines, Years 2010 -2050[5]

ENERGY & POWER POTENTIAL FROM BIOMASS		2010	2020	2030	2040	2050	TOTAL 2010-50
Estimated Potential based on 2030 figure		*10%*	*30%*				*GWh-pr*
TOTAL Prime Energy Potential from Biomass Reference	**MWh-pr/h**	**2,199**	**21,989**	**73,296**	**83,105**	**92,914**	**8,099,519**
POTENTIAL BIOFUEL FOR TRANSPORT SECTOR							
Biofuel Potential (share)	MWh-pr/h	1,726	5,178	17,261	19,398	21,536	2,664,427
Energy Demand for Reference Scenario	MWh-pr/h	11,833	13,698	23,398	48,223	86,360	12,814,484
Energy Demand for Optimized Efficiency Scenario	MWh-pr/h	11,833	12,783	17,429	28,974	41,993	8,212,077
Energy Demand for Fuel Switch to Biofuel & RE fueled e-Vehicles Scenario	MWh-pr/h	11,833	12,276	14,310	13,826	1,926	1,955,896
Remaining Potential Biofuel Surplus under Reference Scenario (Potential use for High Temp. Process Heat)	**MWh-pr/h**	**(10,106)**	**(8,519)**	**(6,136)**	**(28,825)**	**(64,825)**	
Remaining Potential Biofuel Surplus under Optimized Efficiency Scenario (Potential use for High Temp. Process Heat)	**MWh-pr/h**	**(10,106)**	**(7,604)**	**(168)**	**(9,575)**	**(20,458)**	
Remaining Potential Biofuel Surplus under Fuel Switch Scenario (Potential use for High Temp. Process Heat)	**MWh-pr/h**	**(10,106)**	**(7,097)**	**2,952**	**5,572**	**19,609**	

Highest priority is given to biofuel production derived from fuel crops or methane production from anaerobic digestion processes converting biodegradable organics. Other solid biomass is preferably converted through combustion and steam process into power and process heat. Waste heat recovered is preferably distributed for co-processing and used for high to low level heat and cooling applications.

Additional waste heat can be recovered from electrical power generation using fossil or RE-fuels. The potential is indicated in the Table 11.3. The recoverable Energy is not calculated in the Energy Balances due to the projected diminishing share of fossil power in the RE transition scenario and the assumption under Reference Scenario that centralized power production prevails, thus no waste heat can be recovered.

The calculations indicate that biomass is able to cover an important function by bridging and buffering energy demand for power, heat and transport functions provided that planted land area of at least 2 million hectares[6] is given and sustained build up and supply of consistently needed feedstock is secured.

It is stressed that implementation of a long-term and sustainable build up and professionally managed and operated reforestation program is critical for the success of this low carbon strategy.

5 *JLBTC Model Calculation, ProjectionReferenceJL.xlsx*
6 *Area of 2Million hectares targeted by the Philippine Agricultural Development and Commercial Corporation of the Department of Agriculture. http://www.coa.gov.ph/phocadownloadpap/userupload/annual_audit_report/GOCCs/2011/Corporate-Government-Sector/Human-Settlements-Development-Corporation/PADCC_ES2010-2011.pdf*

Lack of land availability, and unwillingness of farmers/suppliers of feedstock and plant operators to agree on prices for the bio-feedstock under financially viable conditions, are barriers which could hinder widespread conversion to and use of RE biomass for energy.

11.4 PRIORITY APPLICATION REGIME FOR BIOMASS

The priority regime for eligible biomass potential from fuel crops is for biofuel. The biofuel produced should prioritize the energy needs of the transport sector. Any surplus can then be used for peak power generation or as variable "filler load" to buffer variable RE power supply. Other combustible biomass is likewise first used to serve High Temperature *(Process)*- Energy.

Waste heat recovery can be derived from all applications for biofuel production used in the transport sector provided the location of power production is similar or close to the location where the waste heat will be used.

Cement plants as a main user of the highest level thermal energy is dependent on direct combustible fuel. Energy savings is limited to reducing internal energy demand and losses in the kiln.

Since there are no detailed statistical data available on the present energy demand and available level of supply, it is not possible to prepare a reasonably exact estimate on how high surplus potential is or use of biomass and heat energy recovery for the projected period.

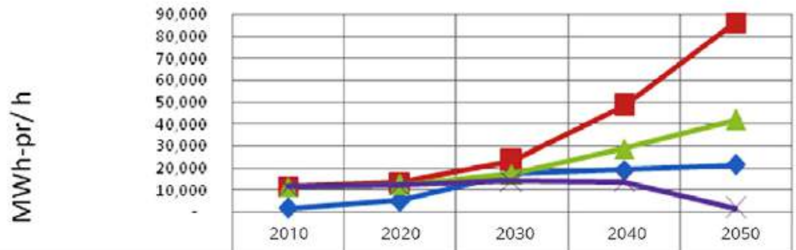
International research & development and pilot projects have demonstrated that 60%-70% of the presently used energy during cement production can be reduced or recovered, which could substantially reduce the high level thermal energy demand in this sector in the near future.

11.5 PRIORITY APPLICATION OF BIOMASS FOR TRANSPORT

The calculated potential supply of biofuel in the transport sector shown in Table 11.4 and Figure 11.1, shows a high deficit for Reference and Efficiency Increase Scenario but an increasing surplus of biofuel supply potential and a biofuel surplus over demand under the "Fuel Switch Scenario". This underlines the need to support the transition towards RE based drive systems through additional RE-based fuel and power sourcing from wind, solar and ocean.

This integrated transition process must be supported by energy extraction from fuel crops. By applying combined processing and use of the potential energy source together with products manufactured energy can be recovered in several stages by largely increasing energy efficiencies and reducing prime energy demand. During biofuel production, energy produced in the process can be used for biofuel and product (cement, food industry) output simultaneously. Such combined processes could be developed and reviewed in the future to integrate and combine potential biofuel production with manufacturing processes (wherein biomass is supplied in a close loop and high, medium and low temperature energy is recovered at site. Such approach could further reduce all over prime energy demand.

Figure 11.1 Energy and Power Potential, Prime Energy Demand and Supply from Biofuel Production in the Transport Sector, Philippines, Years 2010 - 2050[7]



	2010	2020	2030	2040	2050
Biofuel potential (share) MWh-pr/h	1,726	5,178	17,261	19,398	21,536
Energy Demand for Reference Scenario MWh-pr/h	11,833	13,698	23,398	48,223	86,360
Energy Demand for Optimized Efficiency Scenario MWh-pr/h	11,833	12,783	17,429	28,974	41,993
Energy Demand for Fuel Switch to Biofuel & RE fueled E-Vehicles Scenario MWh-pr/h	11,833	12,276	14,310	13,826	1,926

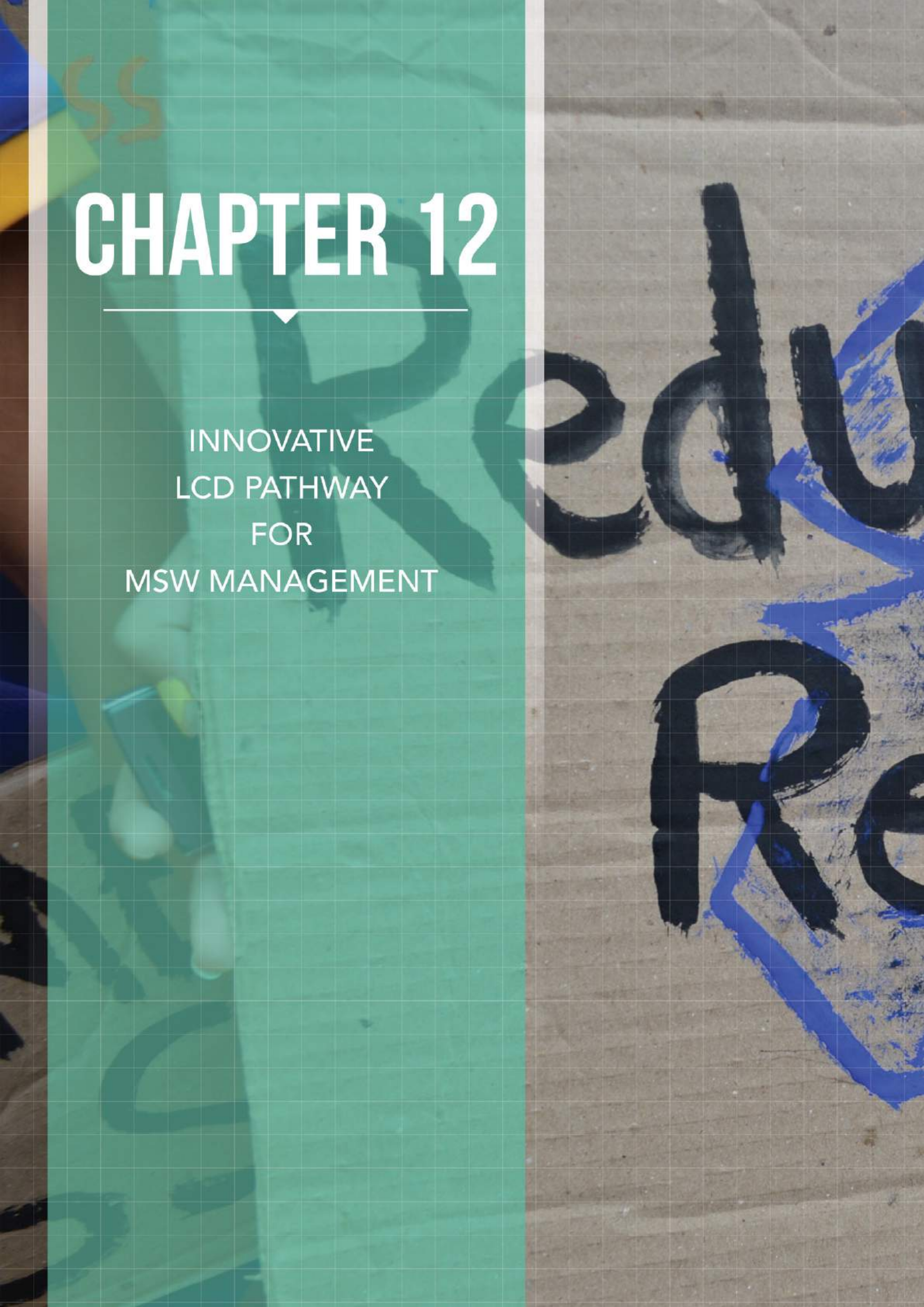
In the foregoing analysis, RE potential is partly considered for application in the Fuel Switch Scenario. The over-all potential, however, will depend on the extent it would be possible to transfer and integrate production processes to the locations where the biomass can be sourced and processed. The feasible supply range for biomass is seen not to exceed a radius of 50 km. Since labor and land cost are becoming a more important cost factor, industry should focus on integrated production and location transfer strategies in the coming decades taking these factors into account.

In the event of surplus in biofuel production required by the transport sector, further evaluation may be carried out to determine if the surplus can be stored as “buffer energy” for electricity production to meet peak power demand; or to directly combusted to produce high temperature process energy.

7 JLBTC Model Calculation, ProjectionReferenceJL.xlsx

CHAPTER 12

INNOVATIVE LCD PATHWAY FOR MSW MANAGEMENT




ce
euse
Recycle

12.1 INTRODUCTION

Aside from environmental and health risks associated with the improper treatment and disposal of solid waste, decomposition of waste emits significant levels of methane. Unabated methane emissions from degrading waste continue to pose a major burden in efforts to reduce GHG emissions in the Philippines.

This section provides values for CO_2e emissions particularly from municipal solid waste *(MSW or domestic waste)* generated in the Philippines. The model calculation presented in this section does not consider the current recovery volume from the waste stream as recycling efforts are limited in the Philippines. Recovery and recycling is generally on an informal basis by scavengers and junk shop dealers for highly saleable recyclable plastics, paper, glass and metals. Organic fertilizer production is also achieved on a very limited scale. Further, it is assumed that all MSW are disposed in "controlled" landfills, which represent the general practice in the Philippines. Such "controlled" landfills do not provide adequate lining and capture systems for leachate and methane.

Alternatively, a low carbon strategy was formulated as the most efficient and feasible option to contain methane emissions based on a maximized recovery and recycling approach, with conversion of residual, sorted organic waste for power generation. Such options to avoid negative effects of methane emissions from solid waste have long been available, but are not widely implemented due to social and political barriers, despite the evident financial and socio-economic advantages.

12.2 MUNICIPAL WASTE DISPOSAL TREATMENT IN THE PHILIPPINES

The Ecological Solid Waste Management Act of 2000 *(Republic Act 9003)* mandates waste reduction, segregation of MSW at source, segregated collection, recovery and diversion of at least 25% from the waste stream *(which should be increased)*, and disposal in an engineered sanitary landfill *(which requires a lining system, methane collection and flare system, and a leachate collection and treatment system.)* It prohibits informal scavenging in landfills, as well as open burning and incineration of MSW.

Under this law, local government units were required to upgrade their existing open dumpsites to "controlled" disposal sites. Upgrade of open dumpsites to "controlled" disposal sites was only to serve as as a stop gap measure. The law required that these be further upgraded to fully engineered sanitary landfills. A "controlled" disposal site required covering active waste with a soil layer, which is not sufficient to prevent migration of methane and leachate in comparison to engineered sanitary landfills.

Waste minimization and recycling/reuse practices to reduce methane emissions are limited, with landfill gas recovery undertaken at a minimal scale in the Philippines, but slowly gaining ground with CDM. Currently, there are three *(3)* landfill gas to energy facilities in the Philippines, capturing methane from "controlled" dumpsites which supply electricity to MERALCO:

- 1.2 MW Payatas, Quezon City - *This was formerly an open dumpsite, wherein a garbage landslide killed more than 200 people living in the adjacent area, belonging to families engaged in scavenging activities in the surrounding area, which prompted the government to rehabilitate the dumpsite.*

  In 2007, Pangea Green Energy undertook the development of a 700 MW landfill gas plant under a 10-year contract, capturing an estimated 116,339 tons CO_2e annually, and with electricity production of 42 MWh over the 10 year period. Investment cost is reported at EU1,386,000, with O&M cost at EU95,670 for the first two years, and EU180,670 from the third year *(exchange rate EU/PhP0.01618)*, with an electricity price of PhP4.87 per kWh.[1] The project is the first CDM project approved under the Kyoto Protocol in the country. The plant supplied MERALCO 0.32 GWh for the month of December 2013, with an average generation cost charge of PhP3.84 per kWh.[2]

- 15 MW Rodriguez, Rizal - *The landfill gas plant has an installed capacity of 15 MW and is operated by the Montalban Methane Power Corporation. The annual average reduction of CO_2e is reported at 582,269 tons annually under a 10-year contract.*[3] *This project is reported to account for half of the CDM credits from the Philippines.*[4] *The plant supplied MERALCO 1.99 GWh for the month December 2013, with an average generation cost charge of PhP3.90 per kWh.*[5]

- 4 MW San Pedro, Laguna - *The landfill gas plant has an installed capacity of 4MW and is operated by Bacavalley Energy, Inc. The project cost is PhP798 Million (USD16.61 Million). It is estimated to have an annual output of 35 million kWh a year. Electricity cost is based on ERC approved time-of-use (TOU) rate.*[6] *The annual average reduction of CO_2e is reported at 136,733 tons for a 10-year period.*[7] *The plant supplied MERALCO 0.31 GWh for the month December 2013, with an average generation cost charge of PhP3.90 per kWh.*[8]

Volume of methane capture is poor since these landfills are not engineered appropriately and are only "upgraded open landfills".

Additionally the following landfill gas projects are proposed: the Cebu-Inawayan in Cebu City *(750 kW pilot, 10 MW projected capacity)*[9]; 6.5 MW Metro Clark, Tarlac[10]; and 4 MW Consolacion, Cebu by Asianenergy Systems Corporation *(DOE)*.

1 CDM PDD, Quezon City Controlled Disposal Facility Biogas Emission Reduction Project.
2 Meralco Electricity Generation Rates - Dec. 2013/Jan 2014
3 CDM PDD, Montalban Landfill Methane Recovery and Power Generation Project
4 Philippines: Deforestation through mining subsidized by CDM Project, World Rainforest Movement, December 30, 2010, http://wrm.org.uy/articles-from-the-wrm-bulletin/section2/philippines-deforestation-through-mining-subsidized-by-cdm-project/
5 Meralco Electricity Generation Rates - Dec. 2013/Jan 2014
6 ERC
7 CDM PDD, San Pedro Landfill Methane Recovery and Electricity Generation
8 Meralco Electricity Generation Rates - Dec. 2013/Jan 2014
9 CDM PDD, Cebu City Landfill Gas and Waste to Energy Project.
10 CDM PDD, Metro Clark Landfill Gas Capture System

12.3 SOLID WASTE MANAGEMENT OPTIONS

In principle, the available options for government for solid waste management are:

- Do nothing and proceed with waste dumping/landfilling;
- Convert existing open dumpsites into sanitary landfills;
- Implement a mixed strategy with limited waste recovery and landfilling;
- Implement mixed waste incineration;
- Apply a maximized recycling technologies including organic fertilizer production and integrate waste to energy from methane generation and residual RDF production from pre-sorted, non-toxic and selected dry organic components.

12.3.1 Disposal in a Sanitary Landfill

Disposal in a sanitary landfill is the least desired pathway for MSW management, but it is the most common practice.

Even if upgrade of all open and “controlled” disposal sites to engineered sanitary landfills is effected, there are still substantial amounts of harmful emissions of gases such as CH_4, as well as heavy metals such as mercury, etc. CH_4 emissions sharply increase the greenhouse effect.

Once degradation of waste in landfills begins in the following decades, even with use of CH_4 capture mechanisms, harmful GHGs will continue to be emitted into the atmosphere. Further, landfills cannot be totally secured against leakage of leach which pollutes groundwater. Landfills also require substantial aftercare cost, lasting as long as 50 years with CO_2-e emissions continuing through those years.

At present it is estimated that only 15% of the daily produced waste is recovered or recycled mostly by informal waste-pickers and recyclers which are not equipped with appropriate tools to protect them from health hazards.

12.3.2 Incineration

Mixed waste incineration is expensive and creates serious health hazards caused by emission of dioxin, furans and other toxic emissions, despite application of major cleaning agents prior to release of fumes to the atmosphere.

Mixed waste incineration also restricts recovery and recycling solutions for paper, plastic and prevents the production of organic fertilizer, which is needed by the agriculture sector.

Further, efficiency in energy recovery is low and ranks behind full recycling approaches due to high moisture and low heat value of the wet, mixed waste when incinerated.

The Ecological Solid Waste Management Act (Republic Act 9003) and Philippine Clean Air Act (Republic Act 8749) explicitly prohibits incineration. However, a ruling of Supreme Court,[11] states that incineration is allowed, "if such does not emit toxic fumes" – which is impossible since all forms of incineration, which include pyrolysis or gasification processes emit substantial volumes of toxic fumes even with the application of the best available cleaning devices and stages.

12.3.3 Integrated Solid Waste Management with Full Recycling

The best solid waste management solution is implementation of maximized recycling. By immediately mandating a full recycling approach as pre-requisite, as already practiced in many European countries,[12] substantial amounts of resources from the waste stream is diverted from landfill, thus avoiding emissions.

A fully integrated recycling solution can prove as the most environment friendly solution, but also can achieve higher investment returns as compared to the landfill and mixed waste incineration solution. Financial and socio-economic analyses provided for a major, long-term waste management project for Metro Manila[13] clearly showed the benefits of recycling against both the landfill solution and mixed waste incineration. Maximizing recovery and recycling of waste also provides the most number of badly needed jobs for informal waste-pickers still living in dumpsite areas in sub-human conditions and exposed to health hazards.

Waste to energy clearly ranks behind a full recycling approach and should only be applied after extensive and professionally performed mechanical-biological pre-treatment of waste and to make use of by-products where they are most valuable, with methane generation from anaerobic digestion or percolation, utilized for power generation.

11 *MMDA vs. Jancom Environmental Corporation, Supreme Court Case No. GR-147465*
12 *The mechanical-biological pre-treatment of raw waste is mandatory before any residuals is allowed for incineration*
13 *Metropolitan Manila Solid Waste Management Project, tendered by the Philippine government under a build-operate-own scheme, 2000,*

Despite the clear advantages of the fully integrated solution to MWS management, it has not been implemented. One reason is the higher investment cost as compared to that of the landfill solution. Though there is interest for private sector investment, this is hindered by the weak enforcement of the Ecological Solid Waste Management Act, and bureaucratic red tape. Government must ensure investors of a level playing field and insulate the projects from changes in the political sphere. Further, MSW input volume guarantees must be provided to satisfy volumes required for its viable operations technically as well as financially.

12.4 COMPARATIVE EVALUATION OF MSW MANAGEMENT SOLUTIONS AND RE POTENTIAL

To compare the different waste conversion options in relation to diversion rates from landfilling and potential power generation capacity, Table 12.1 below demonstrates the advantages derived from the preferred full recycling option and previously proposed as the solution to MWS disposal problems for Metro Manila in 2000[14].

Table 12.1 Energy Extraction Efficiencies of Different Waste Incineration Technologies[15]

	Min	Max	Average			
WASTE TO ENERGY OPTION	kWh-el/Mg-MSW	kWh-el/Mg-MSW	kWh-el/Mg-MSW	Efficiency in relation to best option	Proven Technology?	Diversion Rate from Landfilling (% by Volume)
Landfill Gas extraction	41	84	63	5.76%	yes	0%
Combustion	470	930	700	64.52%	yes	90%
Pyrolysis	450	530	490	45.16%	no	83%
Gasification	400	650	525	48.39%	no	97%
Plasma Arc Gasification	400	1,250	825	76.04%	no	97%
Full Recycling+RDF+Methane Power	**920**	**1,250**	**1,085**	**100.00%**	**yes**	**95%**

By implementing properly clustered, full recycling solutions countrywide, substantial, mostly RE-power generation potential would become available, wherein such RE capacity is proven cost efficient and competitive against present fossil dominated energy production. A total potential and sizable capacity of 1,716 MW-e, *(2010)* and 3,859 MW-e *(2050)* could be harnessed.

The all over combustible, fossil carbon share, mostly based on fossil plastic components is calculated at 6.18% according to IPCC guidelines. The relevant fossil based CO_2e share under applying waste to energy is calculated at 14.94% of the dry MSW input basis. Due to a substantially higher recovery

14 *Metropolitan Manila Solid Waste Management Project – MWS management concept developed by Pro-Environment Consortium (PEC), a partnership together with REMONDIS ®, Germany, Australia; JLBTC et.al. The project was awarded to PEC by the Metropolitan Development Authority (MMDA) in cooperation with the Office of the President in 2001. The project is held in abeyance due to a legal case filed against MMDA by a BOT proponent using incineration technology which prevents MMDA from implementing the contract award to PEC.*

15 *Table based on data from: Reconsidering Municipal Solid waste as a Renewable Energy Feedstock, EESI, July 2009, eesi_msw_issuebrief_072109.pdf //addition of "Full recycling+" and formatting by JLBTC, 2013*

and therefore carbon-preservation or-sink ratio, the full recycling option also leads to a better carbon balance. Internationally and locally moving toward RE-based plastics could further lead to a 100% shift of a RE-based carbon cycle in this sector.

Table 12.2 below, shows a qualitative evaluation matrix for the given MSW management options. As shown, the full recycling solution provides most beneficial conditions not only regarding minimizing CO_2e emission potential but also towards all other stated goals.

Table 12.2 Evaluation Matrix for MSW Management Options

PRINCIPLE WASTE MANAGEMENT OPTION	MRF/Recycling	Methane Recovery	Power Generation Efficiency for RDF	Power Generation Efficiency for Methane Component	Qualitative Advantages and Disadvantages
Do nothing/Proceed with waste dumping	15%	0%	N.A.	N.A.	Extreme CH_4 emissions and environmental hazards
SLF w/o Methane Capture	15%	0%	N.A.	N.A.	Extreme CH_4 emissions and reduced environmental hazards
SLF with methane capture & flaring	15%	35%	N.A.	N.A.	Reduced CH_4 emissions & reduced environmental hazards
SLF with methane capture & power generation	15%	35%	N.A.	N.A.	Reduced CH_4 emissions & reduced environmental hazards & RE use for component converted to power
Mixed Waste to Energy	15%	95%	20-25%	N.A.	Avoided CH_4 emissions but hazardous waste burning with low energy recovery efficiency and high investment cost, Marginal Labor Employment Rate
MRF + Mixed Waste to Energy	25%	95%	20-25%	N.A.	Avoided CH_4 emissions but hazardous (Dioxins/Furans emissions) waste burning with low energy recovery efficiency and high investment cost, Low Labor Employment Rate
Full Recycling+organic waste digester+selective residual Waste to Energy	95%	95%	33-36%	48-52%	Maximized material recovery and quality upgrade + organic fertilizer production + maximized RE power generation + 100% Methane gas generation potential, High Labor Employment Rate

12.5 CONCLUSION AND RECOMMENDATIONS

The over-all carbon balance with reference to MSW in the Philippine scenario depends on the speed and extent to which the proposed full recycling option is implemented. This relies heavily in enforcing political will and creating the necessary public awareness of its necessity, as well as benefits for fast track and successful implementation.

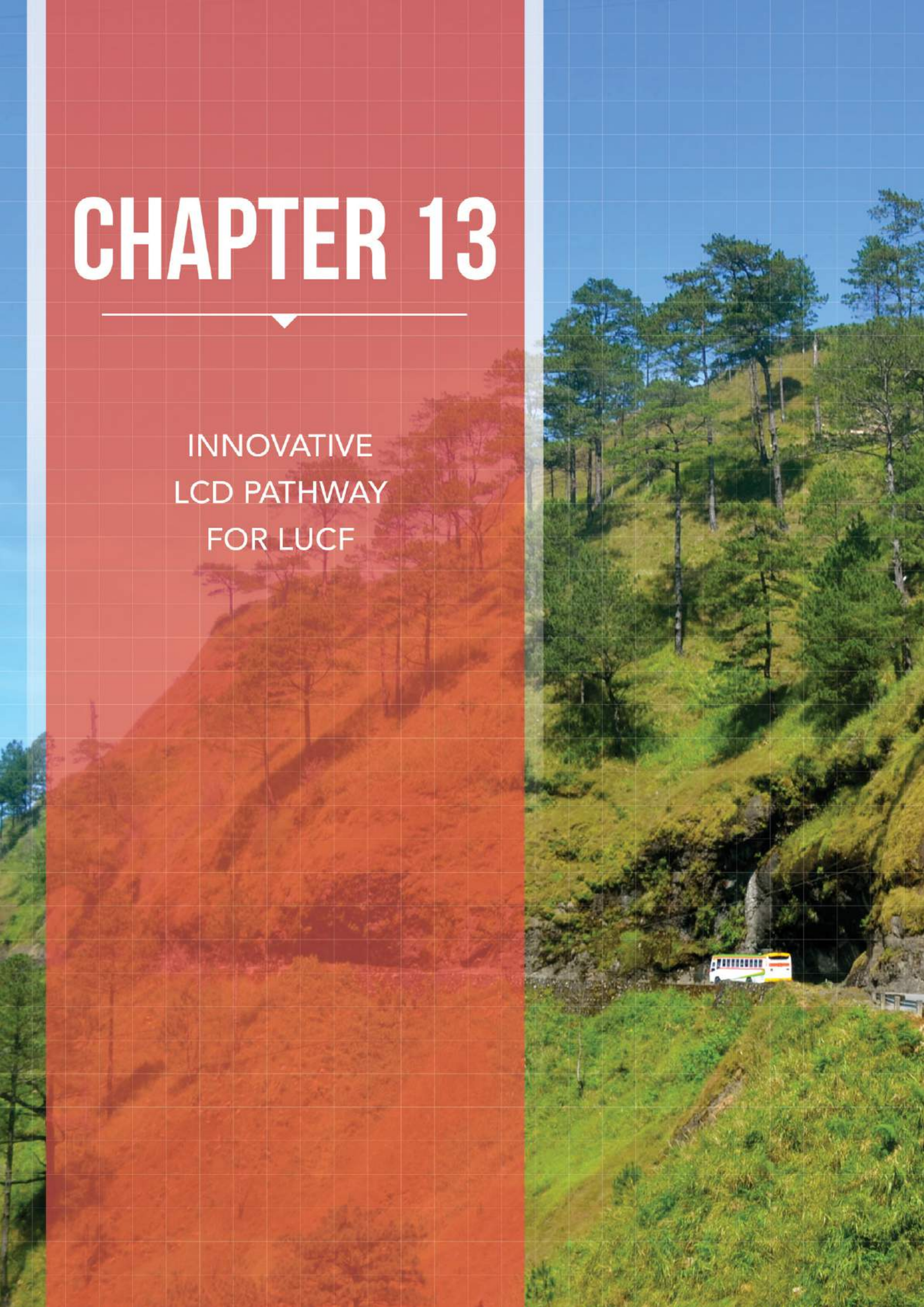
The recommended solution prioritizes the build up of professionally designed and operated, clustered recycling plants which can undertake fine-segregation and recycling of the pre-segregated waste collected from origin sources. Additionally these plants should be able to convert biodegradable matter into methane gas for conversion to power and to produce organic fertilizer in commercial quantities. Dry, organic, non-toxic portions which cannot be directly recycled are converted into environment friendly RDF as an additional source for power.

The full recycling solution provides most beneficial conditions not only in terms of minimizing CO_2e emission potential, but also realizes the highest direct operational financial returns in view of life-cycle cost compared to the landfill and mixed waste incineration solution. In terms of socio-economic benefits, it can also prove the most advantageous in terms of public health and job generation, among others.

Maximizing recovery from MWS stream of fractions for conversion to power can prove economically viable especially when comparative cost for fossil fuel keeps getting higher or oil prices stay above the current USD30/barrel.

CHAPTER 13

INNOVATIVE LCD PATHWAY FOR LUCF



13.1 INTRODUCTION

Land use and forests play an important role in relation to the atmosphere. Consequently, sustainable use of land and forests is key to limiting global warming.

In determining the CO_2 emissions and carbon sink values in the LUCF Sector, input data regarding land use and forest are necessary. In the Philippines, official statistical data for conditions, composition and coverage area of the different forested and other land areas are fragmented, inconsistent and contradictory, preventing a complete and accurate calculation of CO_2 emissions and carbon sink values from these areas. The lack of a systematic reporting system and collation at the local, regional and national levels prevents an over-all assessment of their current status.

To provide a good estimate for CO_2 emissions for forested and other land areas, it was necessary to develop a template for a simplified CO_2 calculation emission model to contribute towards a further detailed analysis of the country's over-all CO_2 emission from all sectors. It aims to provide values of CO_2 emission and carbon sink for the Philippines based on its forest and other land uses and classification.

The recommended innovative low carbon strategy aims to improve the carbon sink potential of the Philippines through a sustainable reforestation program, or the Philippine "Reforestation Marshall Plan" proposed by JLBTC earlier in 2011[1].

13.2 CURRENT STATUS OF FOREST COVER IN THE PHILIPPINES

In 2011, pursuant to Executive Order 23, the government embarked on a national greening program *(1.5 billion trees covering 1.5 million hectares for a period of six years from 2011 to 2016)* to revitalize denuded areas to improve forest conditions as a greenhouse abatement strategy. It likewise imposed a ban on logging, with the exception of plantation forests, but despite this, illegal logging remains rampant.

The Forest Management Bureau *(FMB)* reports that in 2011, the total area reforested covered 128,588 hectares, and in 2012, a total area of 221,763 was covered, for a total of 350,321 hectares. The government's forest management plan provides for strengthening forest management through community based forest management strategies in critical watershed areas.[2]

1 *Sustainable Reforestation and Poverty Elimination through Socially Responsible Private Finance and Development Mechanism (Marshall Plan for Forestry in the Philippines), a program formulated by Juergen Lorenz, JLBTC and presented at the Haribon Foundation Forum held on May 2, 2011.*

2 *State of Philippine Watersheds by Director Ricardo L. Calderon, Director of the Forest Management Bureau, State of the Nature Address, Green Convergence Forum, Miriam College, August 6, 2013.*

13.3 PHILIPPINE REDD+ STRATEGY

Noting the potential of reducing emissions from deforestation and forest degradation, and to conserve forest carbon stock (REDD+) in the Philippines and the need for domestic climate change mitigation action, several NGOs spearheaded consultation and workshops, mapping and capacity building throughout the country, in early 2009. At that time, the GOP had not yet commenced REDD+ planning. Through these efforts, the Code REDD was formed to ensure that national REDD+ developments yield co-benefits for biodiversity conservation and community development.

After increased interest from GOP, CoDe REDD partners identified the need to develop a multi-stakeholder REDD+ strategy in order to facilitate, guide, inform and provide initial resource for institutions interested in REDD+ development in the Philippines, and for continued, broadened stakeholder engagement, for a future, targeted action plan. The involvement of the Climate Change Commission led to the integration of REDD+ into Section 8.5 of the National Framework Strategy on Climate Change and to Executive Order 881 on REDD+ planning and development.

The Philippine National REDD+[3] Strategy or (PNRPS) presents a broad range of strategies and corresponding activities over a 10-year time horizon *(2010-2020)* to prepare forestlands managers throughout the country to assume responsibility in implementing REDD+ programs, research, projects and activities with the support of international, national and local agencies, NGOs and other support groups.

Due to lack of financial support to enforce significant reductions in forestry sector emissions, the Philippines looks forward to financing mechanisms through REDD+, or in combination with other financial mechanisms capable of financing long-term, large-scale conservation efforts, funds from which the PNRPS suggests can be managed through the proposed national and sub-national structures.

To date, financing strategies generally involve *(1)* voluntary financing from international grants and the voluntary carbon market, and *(2)* funds from proposed future compliance carbon markets.

The PNRPS proposes a staged adoption of both strategies. During the Readiness Phase, the PNRPS proposes to maximize limited domestic resources to catalyze initial readiness, while seeking immediate voluntary donor funding in the form of grants. As pilot/demonstration projects mature, the PNRPS proposes their engagement with voluntary carbon markets. Scaling up to the Engagement Phase, the PNRPS proposes to explore a range of funding sources, including potentially with compliance markets and market linked mechanisms, and possibly by bundling carbon with other ecosystem services. The PNRPS also addresses unanticipated consequences and proposes strategies

3 *REDD+ is a broad term that describes a range of actions to reduce emissions from deforestation and forest degradation and the role of conservation of carbons stocks, sustainable management of forests and enhancement of forest carbon stocks in developing countries, supported by financing from industrialized nations.*

to ensure financial resilience within REDD+. These include exploring potential for a national REDD+ reserve fund, use of conservative buffers, and opportunities to generate self-sustaining low-emissions rural livelihoods.

The PNRPS finally addresses the importance of equitable benefit sharing as a mechanism to ensure local compliance with REDD+ and to ensure continued funding.

13.4 PHILIPPINE REFORESTATION MARSHALL PLAN

The innovative strategy presented for the LUCF Sector focuses on an aggressive, but sustainable reforestation program under the proposed "Marshall Plan" concept. This calls for the recovery and maintenance of at least 30% of the country's total land area as bio-diverse, indigenous forest system within a span of 25 years. Counting the country's forestland which comprises only of about 500,000 "healthy and resilient" forest remaining, the area for reforestation is 9.5 Million, requiring the velocity of reforestation at an average of 380,000 hectares per year. To compare, the velocity of the proposed Marshall Plan for reforestation is twice that of the current achievement of the National Greening Program (NGP), which reforested a total of 350,321 hectares for the Year 2011 and 2012.[4]

Clearly, the country's reliance on financing through REDD+, CDM, allocation from the national budget, voluntary contributions and international grants is not sustainable over the longer term. The plan involves private sector investment in partnership with IPs and upland communities of illegal dwellers, wherein the given denuded areas for reforestation and management by the private sector and community will be zoned, partly used for dwelling, crop growing, and sustainable harvest purposes. A portion of at least 30%-35% of the area will be "no touch zone" or a protected zone. The other zones for sustainable harvest will provide steady source of livelihood and improve the quality of the lives of the indigenous people and/or upland communities.

A point to consider is that pride of ownership and provision of sustainable income levels to IPs and upland community partners will prevent unsustainable harvesting and illegal logging, slash and burn farming. As, in this way, the IPs and upland community members themselves will protect the "no touch zones."

13.5 BASIS FOR INNOVATIVE LUCF STRATEGY MODEL CALCULATIONS

The tables contained in this section provide estimates for historical, present and future CO_2 emissions from land areas performed using this model. The factors for each land category are established are as follows:

- Land area;
- Number and mix of plant species in each area;

4 *National Greening Program in 2011-Forest Management Bureau reported that in 2011, the total area reforested covered 128,588 hectares, and in 2012, a total area of 221,763 was covered, for a total of 350,321 hectares-State of Philippine Watersheds by Director Ricardo L. Calderon, Director of the Forest*

- Density of each plant species in each area;
- Components of plant species and related carbon density;

The calculation is limited to estimating stored biomass above ground only. However, build up of carbon stock and emission development from below ground biomass may be added in a later stage.

Published data gathered with regard to valuations in the LUCF sector have disparities, and variances in estimations for values of carbon stock. In 1990 this was at -48,654 Gg. And for 1994, this was at -68,323 for 1994 *(as presented in the 1999 Initial National Communications)*. A 1998 report presents this at -190,522.

The DENR commissioned the Philippine Rural Reconstruction Movement *(PRRM)* and the Manila Observatory to prepare the LUCF report. Fr. Jett Villarin, team leader of the inventory report, provides that the basis of the increase in carbon sink given were underestimation in the initial communication for agro-forestry, upland farms, as well as grassland areas that had been replanted with coconut trees and other trees in 2000, resulting in a higher absorption of carbon dioxide emissions. Isagani Serrano, president of PRRM, described the results as "counter-intuitive" for bucking the trend in other developing nations, where carbon emissions are increasing along with economic growth.[5]

Government data available relating to CO_2e emissions from LUCF requires further verification with regard to composition and valuations. It is plausible that forestland comprising of closed forest, residual/denuded forest, pine forest, mossy forest, mangrove forest, tree plantations, managed forest, agro-forest and grassland dwindled from 13.165 Million hectares in 1990 to 6.960 Million hectares in 2010. Therefore, increase in net carbon balance for LUCF from 70,753 Gg in 1994 to 143,898 Gg for 1998 may be in question.

13.6 FOREST CARBON MODEL

Table 13.1 shows historical, present and future values for land area established using statistical values provided by Tonie Balangue[6] which are used as baseline for the forestland carbon model.

To provide a projection for all given years and estimated future values based on a development path, land area and carbon density have been applied using a linear interpolation between the beginning value *(1934)* and the ending value *(2012)* for each bracket.

For conformity, we have selected 5-year period increments values for 1934 and 2012 and have applied this to Year 1935 and 2010 respectively. Initial carbon stock values for key forested areas are based on calculations by Tonie Balangue for certain years from 1934 to 2012, and default values have been added *(as shown in Table 13.2)* for other undetermined carbon storing and emission areas.

5 *Study: Philippines is a Carbon sink, GMA News.TV, – Pia Faustino and Yasmin Arquiza, December 7, 2009 http://www.climatemediapartnership.org/reporting/stories/study-philippines-is-a-carbon-sink/*
6 *Source by: Tonie Balangue (Reference file: Carbon forest to soil Feb18 Tonie Balangue RevJL-latest)*

Table 13.1 Distribution of Forestland 1935 – 2020

YEAR	1935 Mha	2010 Mha	1945 %	2020 %
Old Closed Forest	11.10	0.29	37.0%	1.0%
Residual / Denuded Forest	2.50	2.25	8.3%	7.5%
Pine Forest	2.83	1.24	9.4%	4.1%
Mangrove	0.30	0.12	1.0%	0.4%
Unproductive Scrub	0.70	1.75	2.3%	5.8%
Grassland	-	2.21	0.0%	7.4%
Plantations	-	0.35	0.0%	1.2%
Managed Forest	-	0.15	0.0%	0.5%
Agro-forest	-	0.35	0.0%	1.2%
Forest to Upland Agriculture	-	0.30	0.0%	1.0%
Unclassified Forest Land	2.57	6.00	8.6%	20.0%
Original Area of Forest Land w/o urban land development	20.00	15.00	66.7%	50.0%
Urban Land / Built-up Area	10.00	15.00	33.3%	50.0%
TOTAL	**30.00**	**30.00**	**100%**	**100%**

Source: Tonie Balangue

Table 13.2 Estimated Development of Carbon Density for Selected Forestland Categories, 1935-2010

YEAR	1935	2010	1935	2010	1935	2010
Land Type	Mg-C/ha		Average Share of Mg-C/ha		Weight	
Old Closed Forest	221.38	126.51	81.91	1.22	74.4%	6.6%
Residual / Denuded Forest	141.05	34.42	11.75	2.58	10.7%	13.9%
Pine Forest	125.36	62.68	11.83	2.58	10.7%	13.9%
Mangrove	63.39	63.39	0.63	0.24	0.6%	1.3%
Unproductive Scrub	24.63	24.63	0.57	1.44	0.5%	7.8%
*Grassland	2.00	2.00	0.00	0.15	0.0%	0.8%
*Plantations	50.00	150.00	0.00	1.75	0.0%	9.4%
*Managed Forest	50.00	150.00	0.00	0.75	0.0%	4.0%
*Agro-Forest	50.00	100.00	0.00	1.17	0.0%	6.3%
*Forest to Upland Agriculture	20.00	20.00	0.00	0.20	0.0%	1.1%
*Unclassified Forest Land	20.00	20.00	1.71	4.00	1.6%	21.5%
Original Forest Land before Urban Development			108.41	16.08	98.5%	86.5%
*Urban Land	5.00	5.00	1.67	2.50	1.5%	13.5%
TOTAL Average Carbon Density			**110.08**	**18.58**	**100.0%**	**100.0%**

(*) Own estimate (default values)
Mg-C/ha = metric ton Carbon per hectare

Table 13.3 presents the factors applied in the calculation for carbon density for forested areas.

Table 13.3 Factors Used for Estimation of Carbon Density

Land Type	Period (Year)	Logging Damage Factor (1)	Crown Volume Factor (2)	Stump & Roots Volume Factor (2)	Bole Volume/ Ha (3)	Wood Density (Ton/cu.m.) (4)	Carbon Factor (5)	Land Use Conversion Factor (Mha/Year)
Old Closed Forest	1934	0.15	0.25	0.25	350	0.767	0.5	
	1988				254			
	1997				246			
	2000				230			0.085
	2012				200			
Pine & Mossy Forest	1934	0.15	0.25	0.25	300	0.54	0.469	
	1988				250			
	1997				200			
	2000				180			
	2012				150			
Residual/Denuded Forest	1934	0.15	0.25	0.25	250	0.767	0.446	
	1988				200			
	1997				150			
	2000				100			
	2012				61			
Mangrove						0.66	0.44	
Grassland								
Unproductive scrub	1934-2012		0.25	0.25	101.15	0.325	0.454	
Plantations								
Managed Forest								
Agro-Forest								
Forest Converted to Upland Agriculture								
Other/balance								
Urban land								

Notes/References:

Old Growth Forest Volume Reduction (1834-2012)

1 - Logging damage based on the Forest Accounting Study by Dr. Tonie O. Balangue under ENRAP 1.
2 - Based on the ENRA study in Siargao by Dr. Antonio Carandang.
3 - Average timber volume based on forestry statistics except for the 1934 volume estimate.
4 - Average wood density based on the following:

700-910 kg/cu m – apitong group or dipterocarpus, by Newman et al, 1996
800-1200 kg/cu m yakal group, hopea and shorea, Newman et al, 1996, Lomibao, 1973
400-590 kg/cu m Philippines Mahogany group, red lauan, tanguile, bagtikan, white lauan

	700	*910*	*805*
	800	*1200*	*1000*
	400	*590*	*495*
Average:			*767*

5 - Equivalent carbon content of old growth forest, Lasco, R. F. Pulhin, Philippine Forest Ecosystems and Climate Change: Carbon stocks, Rate of Sequestration and the Kyoto Protocol Annals of Tropical Research 25(2): 37-51 (2003)
6 - 3.66 is the equivalent CO_2 per carbon based on IPCC guideline.

Notes/References:

Pine and Mossy Forest Volume Reduction (1934-2012)

7 - FAO: Estimating biomass and biomass change in tropical forests
WOOD DENSITIES (G/CM^3 OR T/M^3) OF TREE SPECIES FOR TROPICAL REGIONS OF THREE CONTINENTS
Carbon content of Mossy forest = 45%, and Pine forest = 48.8%

5 - equivalent carbon content of Pine and Mossy forest, Lasco, R. F. Pulhin, Philippine Forest Ecosystems and Climate Change: Carbon stocks, Rate of Sequestration and the Kyoto Protocol Annals of Tropical Research 25(2): 37-51 (2003)
Average carbon content = 45%+48.8%=46.9%

Residual Forest Area Reduction (1934-2012)

Note: The DENR recorded 157 illegal logging hotspots municipalities nationwide. About 50 cum/week/mun most likely is illegally logged. Working backward applying 40% lumbering waste and 50% for crown, branches and stumps and roots. This is equal to 31,651 hectares logged annually. This is applied in 2000 up to 2012
Note: Figures were extrapolated from annual change in previous years.
4 - same in the old growth forest
5 - Carbon content of Residual forest = 44.6% equivalent carbon content of Residual Forest, Lasco, R. F. Pulhin, Philippine Forest Ecosystems and Climate Change: Carbon stocks, Rate of Sequestration and the Kyoto Protocol Annals of Tropical Research 25(2): 37-51 (2003)

Mangrove Forest Carbon Reduction (1934-2012)

8 - Interpreted from the graphs of wood density of mangroves in New Zealand from 0.57 to 75 g/cubic centimeter, Nadia S. Santini • Nele Schmitz • Catherine E. Lovelock. Variation in Wood Density and Anatomy in a Widespread Mangrove Species. Trees DOI 10.1007/s00468-012-0729-0:
Ave. wood density = 0.57 + 0.75g/cubic centimeter = 0.66 ton/cubic meter.
5 - Carbon content of Mangrove = 44% equivalent carbon content of Mangrove, Lasco, R. F. Pulhin, Philippine Forest Ecosystems and Climate Change: Carbon stocks, Rate of Sequestration and the Kyoto Protocol Annals of Tropical Research 25(2): 37-51 (2003)
Average carbon content = 45%+48.8%=46.9%
Note: Figures were extrapolated from annual change in previous years with data.

Unproductive Brushland Forest Carbon Reduction (1934-2012)

Note: Volume per hectares is based on the RP German Inventory Project for Region 10 and Region 11, 1986.
5 - Carbon content of Brushland = 45.4% equivalent carbon content of Brushland forest, Lasco, R. F. Pulhin, Philippine Forest Ecosystems and Climate Change: Carbon stocks, Rate of Sequestration and the Kyoto Protocol Annals of Tropical Research 25(2): 37-51 (2003)
7 - Species in brushlands are generally softwood and miscellaneous species. The wood density is assumed from the density of ficus spp at at 39%, Endospermum peltatum at 31%, Eucalyptus deglupta at 34%, and Albizzia falcataria at 25%.
FAO: Estimating biomass and biomass change in tropical forests...
WOOD DENSITIES (G/CM^3 OR T/M^3) OF TREE SPECIES FOR TROPICAL REGIONS OF THREE CONTINENTS
Average wood density = 39%+31%+34%+25%=32.5%

Carbon and CO_2 Emission of Grasslands (1970-2011)

Note: Grazing area data based on the 2011 statistics on FLGA. It is assumed that all grazing areas are burned annually. Since there is no data on actual kaingin area, it is further assumed that the remaining grassland area not covered by any grazing permit or license is kaingined by the 3.18 million households yearly where they also burned the area. Carbon density of grassland is based on the study of R. Lasco, J. Lales, I. Guillermo, R. Sales, 2000, published in the Grassland Society of the Philippines Journal, Vol 4, July-December 2000, No.2.

Carbon and CO_2 Emission of Soil (1970-2011)

1 - Carbon density of grassland soil, R. Lasco, J. Lales, I. Guillermo, R. Sales, 2000, published in the Grassland Society of the Philippines Journal, Vol 4, July-December 2000, No.2

Source: Tonie Balangue

Table 13.4 presents the results for stored carbon from estimated values for each land area bracket. The entire calculation summarizes all land area in the Philippines at a rounded value of 30 million ha.

Differential values for areas not covered under the defined forest areas are categorized and calculated as urban land at a rounded and fixed value of 15 million ha and under *(other/balance)* to compensate for not determined areas. As previously mentioned, this approach is necessary since no conclusive and complete statistical data was available. Effective values can be introduced at a later stage upon acquiring confirmed values for those areas.

The summary total value of stored carbon over time shown in Table 13.4 is further converted into CO_2 emission values for the period between 1935 until 2010.

Table 13.4 Estimated Stored Carbon Value for each Land Use Category, 1935 - 2010

Estimated total stored C-mass based on estimated (reported) area and carbon densities for classified original or converted (degraded) Forest or other land of the Philippine Archipelago

LAND TYPE			1935	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
Old Closed	Stored-C	Mt-C	2,457	2,232	2,016	1,809	1,611	1,423	1,243	1,072	911	759	616	482	357	241	134	37
Residual/ Denuded	Stored-C	Mt-C	353	333	313	293	274	255	236	217	199	181	163	145	128	111	94	77
Pine	Stored-C	Mt-C	355	330	306	283	261	240	220	200	182	164	148	132	117	103	90	77
Mangrove	Stored-C	Mt-C	19	18	17	17	16	15	14	14	13	12	11	10	10	9	8	7
Unproductive Scrub	Stored-C	Mt-C	17	19	21	22	24	26	28	29	31	33	35	36	38	40	41	43
Grassland	Stored-C	Mt-C	-	0	1	1	1	1	2	2	2	3	3	3	4	4	4	4
Plantations	Stored-C	Mt-C	-	1	2	5	7	10	13	16	19	23	27	32	36	41	47	53
Managed Forest	Stored-C	Mt-C	-	1	1	2	3	4	5	7	8	10	12	14	16	18	20	23
Agri Forestry	Stored-C	Mt-C	-	1	3	4	6	8	10	12	14	17	19	22	25	28	32	35
Forest to Upland Agriculture	Stored-C	Mt-C	-	0	1	1	2	2	2	3	3	4	4	4	5	5	6	6
Other /balance	Stored-C	Mt-C	51	56	61	65	70	74	79	83	88	93	97	102	106	111	115	120
Urban land	Stored-C	Mt-C	50	52	53	55	57	58	60	62	63	65	67	68	70	72	73	75

To arrive at estimates for the future years, it is assumed that a sustainable reforestation management is implemented to reforest and manage a minimum of 10 million ha of denuded, degraded forest, grass-and unproductive land in line with a proposed reforestation "Marshall Plan"[7].

The proposed reforestation "Marshall Plan" applies an optimized, mixed forest build up and usage strategy by carefully selecting the forest and plant species and biodiversity mix with the integration of a controlled and limited agro-forestry application for suitable areas. The strategy is guided by the mandatory establishment of continued over-all growth of biomass and biodiversity combined with maximized but limited harvesting and usage of biomass for i.e.: building, furniture and RE-power, among others.

Economic and financial calculations prove that this strategy will be able to reverse the ongoing degradation process. This will be beneficial for both the private and government sectors since large parts of the Philippine population living under very marginal, extremely poor conditions will be given sustained livelihood opportunities. Investors in this endeavor will enjoy acceptable returns on their investment, and at the same time the strategy fulfills the targets of Philippine Government's National Greening Program and its promise to create "inclusive growth."

The estimate for reforested land area applied under this proposed reforestation scheme is reflected in Figure 13.1 *(Total Projected Land Area Applied under Sustainable Reforest9ation Management Marshall Plan in the Philippines, 2010-2035).*

7 *Sustainable Reforestation and Poverty Elimination Through Socially Responsible Private Finance and Development Mechanism (Marshall Plan for Forestry in the Philippines), a program formulated by Juergen Lorenz, JLBTC and presented at the Haribon Foundation Forum held on May 2, 2011.*

The assumed average growth rate for the proposed mixed forest scheme could vary depending on the effectively planted forest stock and its mix. The annual projected carbon emission balance is thus derived from the estimation for the carbon stock sink.

Figure 13.1 Total Projected Land Area Applied under Sustainable Reforestation Management Marshall Plan for the Philippines, 2010 - 2035

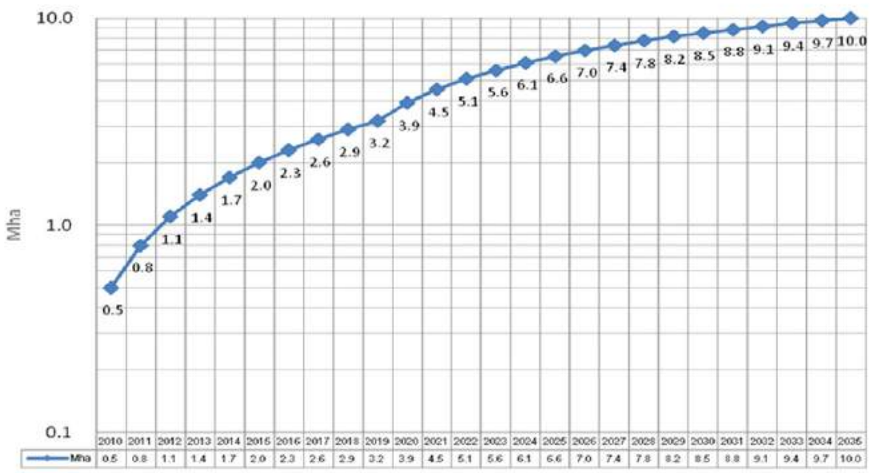


Table 13.5 Projected Carbon Emission Balance under Marshall Plan for Reforestation, 2010 – 2055 (in Gg CO_2/Year)										
	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055
Historical – Present Average Carbon Sink Loss	78,382	70,542	62,704	54,866	47,028	39,190	31,352	23,514	15,676	7,838
Carbon Sink Development "Marshall Plan"	-	9,287	26,305	55,805	83,833	107,438	118,883	123,032	126,602	129,733
Carbon Balance	(78,382)	(61,255)	(36,399)	939	36,805	68,248	87,531	99,518	110,926	121,895
Cumulative Carbon Balance	(2,009,438)	(2,070,693)	(2,107,092)	(2,106,153)	(2,069,349)	(2,001,101)	(1,913,570)	(1,814,052)	(1,703,127)	(1,581,231)

Under this model, the resulting projected values are then balanced against a cumulative carbon emission value build up from the past carbon emissions in the earlier periods from 1935 to 2010.

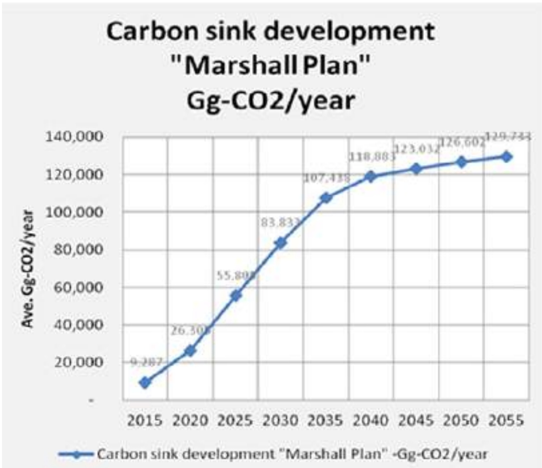
Using the selected and given assumptions for input factors for growth, emissions as presented above, resulting values show that the projected reforestation in accordance with the proposed "Marshall Plan" could offset CO_2 emissions to 2050 substantially.

From a maximum accumulated CO_2 emission value of more or less 2,100,000 Gg until 2010, this value could be reduced to more or less 1,600,000 Gg CO_2.

With the implementation of the proposed reforestation "Marshall Plan", an annual increase in CO_2 sink capacity is substantial.

Based on the preliminary calculations presented in this study the carbon-sink potential from the defined emission components will develop from initially average 9,287 Gg-CO_2/year *(between 2012 and 2015)* to 126,602 Gg-CO_2/year *(between 2045 and 2050)* under the Reforestation Marshall Plan is shown in Figure 13.2.

Figure 13.2 Carbon Sink Development in the Philippines under the Reforestation Marshall Plan



13.7 CONCLUSION AND RECOMMENDATIONS

Old closed forest in the Philippines have dwindled due to logging and conversion to agricultural and other use. Unabated urbanization has caused environmental, social, economic and political pressures, especially since government has failed to shape urban growth according to a pre-determined concept, with most development led by the private sector. Urban decay is evident in some areas.

Past developments in land use have led to major carbon-sink loss higher than the present combined carbon emissions in the Philippines. The carbon sink capacity of the Philippines must be maximized with an aggressive reforestation and protection program.

The results determined by the given model template show that a substantial carbon-sink capacity lies in proper build up and management of forest and related land areas. This carbon sink potential will prove higher than shown in this initial model calculation when values for other carbon-sink capacities like soil, production of long lived natural products containing RE-carbon mass etc. are integrated.

The proposed reforestation strategy is financially feasible and it is possible to implement this without need for long term subsidies or foreign donations, provided revenue generation for stakeholders on a sustainable level is applied.

The inclusion and fast track implementation of the proposed reforestation "Marshall Plan" and replication in other countries suffering similar losses of carbon-sink capacities through deforestation will be crucial to achieve future goals for carbon budgets worldwide.

The government's policy to rely on coal-fired plants is evident with the aggressive pursuit in exploration and development of its coal and natgas resources. In 2010, DOE had over thirty *(30)* coal mine sites in the development and operating stages; and DOE has put on the table investment opportunities for exploration and development of twelve *(12)* oil and gas sites, and an additional thirty *(30)* coal mine sites for exploration.[8] This means that additional development and operation of coal mine sites will have a negative impact on the carbon sink when these sites fall within forested areas. The current policy on mining must be tempered to ensure sustainability. If not, the country's carbon sink potential cannot be maximized.

The conflicting land use issues in this sector have to be resolved and delineated proclaimed protected and reforested "no touch" forestland must be secured.

8 *Energy Sector Investment Opportunities presented by DOE Sec. Jose D. Almendras, Finance Asia, Infrastructure Philippines 2010, Investing and Financing in Public-Private Partnership Projects.*

CHAPTER 14

SUMMARY AND CONCLUSIONS

14.1 ACHIEVING THE GLOBAL CARBON BUDGET

UN nations have adopted the formal decision to hold the increase in global average temperature below 2°C above pre-industrial levels to avert catastrophic and irreversible climate change impacts. Cumulative global CO_2 emissions must stay below 600 Gt CO_2 within 2010-2050 to achieve this.

Developed and developing countries alike should work towards the same goal. Under present BAU development of global emissions, the share of emerging countries is already higher than 50% today. If unabated, this is expected to increase to more than 80% in 2050.

The maximum previously determined allowable threshold of cumulative emission ceiling of 600 Gt-CO_2-e until 2050 bears implications for the Philippines' own emissions ceiling The Philippines' average allowable emissions budget share is 0.35% of worldwide emission levels, or about a cumulative 2.104 Gt-CO_2-e *(or 2,105 Tg-CO_2-e or 2,104 Mt-CO_2-e)* until 2050.

In order to successfully attain the allowable global GHG emissions budget in the coming decades, the country must review its development trend and current CO_2 reduction program to determine if these are sufficient to maintain a cumulative 2,105 Tg CO_2e until 2050. If not, there is a need to institute more drastic measures to enable the country to live within its budget.

14.2 ENERGY SECTOR DEVELOPMENT TO 2050 UNDER BAU AND LOW CARBON DEVELOPMENT

14.2.1 Energy Supply and Demand

As the Philippine economy and population grows, so will its energy demand rise. GOP's latest projections show that primary energy demand is expected to grow at an annual average of 3.4%, reaching 77.5 MTOE in 2030 under the BAU. It is expected to increase to 5.4% under the low carbon scenario due to utilization of more RE resources such as hydro, geothermal, wind and solar, contributing about 37.3 percent average share to the total energy supply *(Philippine Energy Plan 2012 - 2030)*. Oil will continue to dominate the country's energy mix at 30% of total, with the transport sector consuming more than 60% of the economy's total oil supply to 2030.

The domestic production of energy resources is projected to increase at an average annual rate of 2.7%, reaching 7 MTOE by 2035, and to contribute to about 50% of the country's energy requirement. Coal is expected to significantly contribute to the economy's energy mix, accounting for about 70% of total electricity generation or 28 MTOE of coal by 2035. RE is likely to account for about 20% of the mix.

14.2.2 Electricity Supply and Demand

In 2010, the total annual average demand of 7,800 MW was supplied by power generation plants with a total installed capacity of about 16,000 MW, with a given dependable capacity of 85% or 13,000 MW. The distribution of installed capacity in 2010 is 67% fossil and 33% RE. Dependable capacity of fossil based plants averaged 68%, while that of RE averaged 32%.

DOE provides that peak demand for power will grow at an annual average growth rate of over 4.44% up to Year 2030, equivalent to 23,158 MW *(or 23.16 GW)*. The country will require an additional 13,000 MW of new installed capacity to meet energy demand and reserve margin. Of this, additional needed capacity of 1,766.7 MW will be provided by committed power projects, while the remaining 11,400 MW will be available for private sector investment. Of the uncommitted 11,400 MW requirement, 8,400 MW will be baseload plants, 2,100 MW mid-range plants, and 900 MW peaking plants.

Based on the given data by DOE, total production of total installed capacity is 258.86 TWh, based on a peak demand of 202.86 TWh. The resulting reserve factor is about 78%. Considering successful implementation of NREP to triple its RE sourced generation capacity by 2030, the ratio of installed capacity of RE to fossil will be 52% RE- 48% fossil, as compared to 2010 installed capacity of about 33% RE and 67% fossil.

DOE's higher projected supply ratio from RE hinges on the deployment of RE based on given caps up to 2030. Capacities from deployment of more coal fired plants will naturally block the entry of RE.

Given the annual average growth assumption in energy demand over a 40-year period of 4.01%, it is expected to reach about 325.26 TWh-e/year.

To compare with its neighbors, the 2011 per capita electricity consumption of the Philippines is at the same level as that of Indonesia and India; while it is much lower than that of Vietnam, Thailand, Malaysia, and Singapore.

To meet the energy demand in 2050, under the BAU 3 Scenario, the production share of fossil is 78.27% and RE is 21.73%, with a total installed capacity of 74.13 GW, with fossil sharing 61.63 GW or 83.14% and RE at 12.5 GW or 16.86%. On the other hand, under the Innovative 3 Scenario, the production share of fossil is at 8.84% and RE at 91.16%. The total installed capacity required is 118 GW, with 32 GW for natgas and 86 GW for RE.

14.2.3 Final Energy Demand - Heat and Transport

Final energy demand in 2010 was 12.88 MTOE, with Transport accounting for 7.90 MTOE or 61%. .

DOE expects final energy consumptions to reach 39.1 MTOE based on an annual average growth rate of 2.8% *(PEP 2012 - 2030)*. The transport sector is expected to account for a 35.5% share at an annual average growth rate of 2.9% *(or 13.88 MTOE)*; the industry sector will have a share of 34.1% with the fastest growth rate of 5.1% *(or 13.33 MTOE)*; and the Commercial, Residential and Agricultural Sectors share the remaining balance of 30.40% or 11.89 MTOE, with average growth rates of 2.7%, 0.8% and -0.6% respectively.

DOE's projected final energy demand for Transport is at 13.88 MTOE, while heat demand is expected at 25.22 MTOE by 2030 at an annual average growth rate of 2.8%.

For projections to 2050, demand for heat is segregated by sector and each sector is segregated into low, medium and high temperature heat demand *(for energy efficiency, such as use of prime energy for high temperature heat demand, rather than waste such prime energy for low temperature heat demand)*.

Based on the 2010 Energy Balance Table, the average annual growth factors provided for each sector are 4.89% for industry, 1.67% for residential, 5.97% for commercial, 6.60% for other sectors *(agriculture, fisheries and forestry or AFF)*.

Under the BAU 3 Scenario, the model calculation for the 40-year study period results in a final energy demand for heat at 16.87 MTOE in 2030, lower than DOE's projection of 25.22 MTOE for the same period; and 38.35 MTOE in 2050 *(or from 10,530 MWh-pr/h to 50,921 MWh-pr/h)*[1].

On the other hand, under the Innovative 3 Scenario, the estimated reduction potential for year 2050 is at 11,383 MWh-pr/h[2] for High Temperature Energy Demand and 26,887 MWh-pr/h for Low to Medium Temperature Energy Demand under Efficiency Increase strategy compared to the Reference/BAU Scenario. This results in total cumulative saving potential of 34% to 38% for the period 2010 to 2050.

For the Transport Sector, under the Baseline/Reference *(BAU)* 3 Scenario, the Transport Sector's energy demand from fossil sources in 2050 is projected at 86,360 MWh-pr/h. Under the Optimized Efficiency Strategy, energy demand from fossil sources is lower at 57,513 MWh-pr/h while energy demand from fossil sources drops to 2,428 MWh-pr/h under the Fuel Switch and RE-fueled E-vehicles strategy.

14.2.4 Development of CO_2e Emissions to 2050 - Energy Sector

Development of CO_2e emissions to 2050 for electricity generated from fossil fuels, under the BAU Scenario, reaches a cumulative CO_2e emissions of 5,013 Tg, already exceeding the target carbon budget of 2,105 Tg or by 281%. On the other hand, under the Innovative 3 scenario, cumulative emissions are expected reach 1,302 Tg.

For the transport sector, under the BAU 3 scenario, the cumulative CO_2e emissions in 2050 is projected to reach 3,010 Tg. Under the Optimized Efficiency Strategy, cumulative CO_2 emissions falls to 1,850 Tg, while under the Fuel Switch and RE fueled E-vehicles strategy, emissions are further reduced to 826 Tg.

14.2.5 Impact of RE on Cost of Electricity

Cost analysis shows that generation cost of RE sources is already competitive with that of fossil sourced electricity. With the spiraling cost of fossil fuels, and continued decreasing costs of RE technologies in the horizon, it could very well be that electricity generated from fossil fuel plants will be more expensive than that from RE. Even under an option wherein no carbon cost is charged, the conclusion would not change.

1 *For the projections to 2050, to make energy stream analysis easier to understand and to compare, all appearing values including TOE, barrel oil-equivalent, etc. are converted to Wh-pr (Prime Energy Watt-hours) or equivalents. Thermal Energy is shown as Wh-th-use and Thermal Energy losses as Wh-th-loss. Electrical and mechanical energy values are shown in Wh-e or Wh-mech. For the calculating the respective Prime Energy Input or Demand, to simplify calculation, a unified conversion factor of 11.63 MWpr per 1 ton oil equivalent is applied.*

2 *MWh-pr/h - Megawatt hour prime energy per hour*

14.3 SOLID WASTE

The average waste per capita generation for urban and rural areas is at 0.49 tons per day, and is estimated to increase at an annual average rate of 0.97% over the 40 year study period. From a total volume of 30,521 tons of 30,521 per day or 11,140,176 tons per year in 2010, this is expected to reach 100,930 tons per day or 36,839,477 tons per year in 2050.

CO_2e emissions from the Waste Sector in 2010 is estimated at 14,601 Gg and is expected to increase to 49,667 Gg in 2050. Resulting cumulative emissions from 2010 to 2050 total 157,834 Gg or 157.83 Tg.

The projected carbon emissions from waste will practically be eliminated with the systematic application of the proposed Innovated Strategy for Waste involving an integrated solid waste management solution[3], wherein 95% of the waste stream is recovered and recycled, and only 5% residual inert waste is left for disposal.

The energy potential from the waste stream based on composition of waste and energy values from such recoverable factions, including extraction of landfill gas in a span of 2 decades, is calculated to reach 18,398 MW electrical power.

For organic fertilizer potential, based on the volume of input bio-waste, organic fertilizer output potential is projected to increase from 1,608,208 m^3 in 2010 to 13,507,388 m^3 in 2050.

14.4 FORESTRY

Rapid urbanization and continued economic expansion have caused deforestation and indiscriminate conversion of agriculture land for residential, industrial and commercial uses, which could undermine the economy's food security and forest resources. Old closed forest in the Philippines have dwindled from 11.1 Million hectares in 1935 to 0.290 Million hectares in 2010 due to logging and conversion to agricultural and other uses.

Under the BAU 3 Scenario, the cumulative CO_2e emissions from Forestry is estimated to reach a 1,923 Tg in 2050, while under the Innovative 3 Scenario, the cumulative carbon sink potential is expected to reach 1,054 Tg. The recommended innovative low carbon strategy is to implement a Philippine "Reforestation Marshall Plan"[4] to improve the carbon sink potential of the Philippines.

The reforestation "Marshall Plan" calls for the recovery and maintenance of at least 30% of the country's total land area *(or 10 Million Hectares)* as bio-diverse, indigenous forest system within a span of 25 years. This applies an optimized, mixed forest build up and usage, with careful selection of forest and plant species to ensure biodiversity.

3 Pro-Environment Consortium proposal for MMDA's Metropolitan Manila Solid Waste Management Project, Rethmann GmbH (now Remondis AG), JLBTC, EDC, MPI and ERAIC, 2000
4 Sustainable Reforestation and Poverty Elimination through Socially Responsible Private Finance and Development Mechanism (Marshall Plan for Forestry in the Philippines), a program formulated by Juergen Lorenz, JLBTC and presented at the Haribon Foundation Forum held on May 2, 2011, and likewise presented to DENR Secretary Ramon Paje thereafter under the Green Convergence umbrella.

The plan involves private sector investment in partnership with IPs and upland communities of illegal dwellers.

14.5 GHG EMISSIONS - ENERGY, SOLID WASTE AND FORESTRY

Under the BAU 3 Scenario, carbon emissions from Power, Transport, Heat, Solid Waste and Forestry are expected to reach a cumulative 10,412 Tg CO_2e, exceeding the given carbon budget of 2,105 Tg by 495%. Under the Innovative 3 scenario, the cumulative CO_2e emissions are expected to reach only 1,261 Tg in 2050, or 40% lower than the given carbon budget.

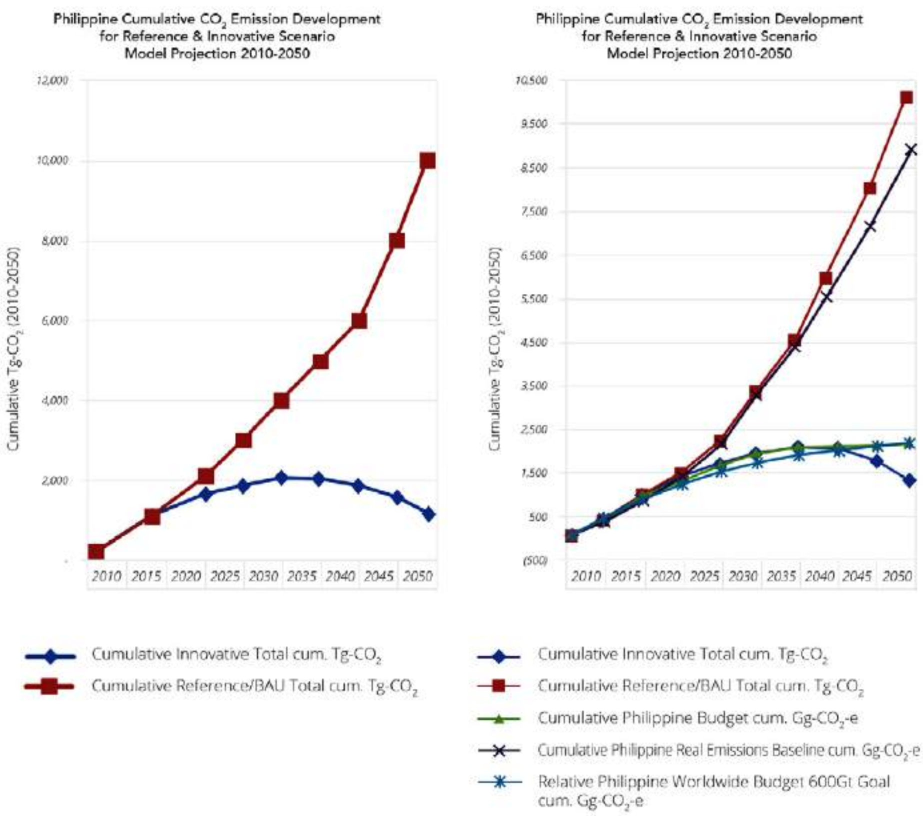
Emissions from Air and Marine Transport, Liquid Waste, Industry, Agriculture other LUCF, fugitive emissions and use of halo-carbons are excluded in the study for lack of available and verifiable source data. However, low carbon strategies can be applied in Agriculture, for example, by mainstreaming a low carbon strategy such as shifting to organic farming and biogas capture, for emissions from this sector to reduce substantially from current values. All sewerage *(liquid waste)* can also be collected through a sewerage system, to eliminate methane through anaerobic process for conversion to electricity.

Figure 14.1 shows and compares the projected cumulative CO_2 emission projections under the BAU 3 and Innovative 3 Scenarios to the Global Carbon Model the relative Philippine Carbon Budget.

Under the Innovative 3 Scenario, results of the calculations show that the country can comply with the probable future carbon budget allocation. Considering the country's carbon sink potential with the implementation of the recommended reforestation program, the cumulative carbon emission which is expected to peak in 2035 will gradually be reduced to a negative carbon balance in the following years.

Even if carbon sink capacities from reforestation are not valued in the equation, the total remaining carbon emission developments will be manageable under the recommended RE transition strategy. In this context it is also recommended to keep prospective carbon credit potentials as a strategic negotiation reserve in regards to future international carbon budget negotiations. Therefore, the Philippine Government should also refrain from selling down carbon emission rights under the ongoing REDD+ approaches.

Figure 14.1 Philippine Carbon Emission Development vis-a-vis Global Carbon Budget, JLBTC Model Approach, Years 2010 - 2050[5]



14.6 TRANSITION TO RE BASED ECONOMY

To provide an effective result and to disseminate the right message towards maintaining its given carbon budget, it is highly recommended to transition to 100% RE. The results of the model calculations herein illustrate that a 100% pathway is a valid and viable platform, and should be subject to further discussion and detailed calculation.

How fast and to what extent RE is employed remains open and depends on the country's response to the call for "urgent and immediate need to take decisive and internationally similar and concerted action worldwide."

The implementation of a 100% RE based fuel scenario is achievable considering the country's vast potential of RE sources. Current Philippine energy policy needs to consider this outlook and accelerate its current RE program. This will not only drastically minimize the country's emissions, but also provide energy security for future generations.

5 *JLBTC Model Calculation, EvaluationReport.xlsx*

LIST OF ACRONYMS

AAGR	Average Annual Growth Rate
BAU	Business-as-Usual
BOI	Bureau of Investments
BRT	Bus Rapid Transit
CDM	Clean Development Mechanism
CCC	Climate Change Commission
CH4	Methane
CHCP	Combined Heating, Cooling and Power
CME	Coco Methyl Ester
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
DENR	Department of Environment and Natural Resources
DOE	Department of Energy
DOST	Department of Science and Technology
DOT	Department of Tourism
DOTC	Department of Transportation and Communication
DPWH	Department of Public Works and Highways
DTI	Department of Trade and Industry
DU	Distribution Utility
EMB	Environmental Management Bureau
ERC	Energy Regulatory Commission
EV	Electric Vehicle
FIT	Feed-in Tariff
FMB	Forest Management Bureau
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GNP	Gross National Product
GOP	Government of the Philippines
HOA	Homeowners Association
ICC	Indigenous Cultural Communities
IEA	International Energy Agency
INC	Initial National Communications
IP/IPCs	Indigenous Peoples/Indigenous Peoples, Communities
IRENA	International Renewable Energy Agency
LCD	Low Carbon Development
LNG	Liquefied Natural Gas

LUCF	Land Use Change and Forestry
MMDA	Metro Manila Development Authority
MSW	Municipal Solid Waste
N_2O	Nitrogen Oxide
Natgas	Natural Gas
NSCB	National Statistics and Coordinating Board
NEDA	National Economic and Development Authority
NGP	National Greening Program
NREB	National Renewable Energy Board
NREL	National Renewable Energy Laboratory
NREP	National Renewable Energy Program
OTEC	Ocean Thermal Energy Conversion
PDP	Philippine Development Plan
PV	Photovoltaic
RDF	Refuse-Derived Fuel
RE	Renewable Energy
REDD	Reducing Emissions from Deforestation and forest Degradation
REDD+	Reducing Emissions from Deforestation and forest Degradation, and to conserve forest carbon stock
SATMP	Society for the Advancement of Technology Management in the Philippines
SNC	Second National Communications
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
USAID	United Stated Agency for International Development

UNITS USED

Gg	Gigagram
Gt-CO_2e	Gigatonnes of carbon dioxide equivalent
GW	Gigawatt
kWe	kilowatt-electric
MMBFOE	Million Barrels of Fuel Oil Equivalent
MMT	Million Metric Tonnes
MTOE	Million Tonnes of Oil Equivalent
MtCO_2e	Million Metric Tonnes of Carbon Dioxide Equivalent
MW	Megawatt
MWh-pr/h	Megawatt hour prime energy per hour
TEU	Twenty-foot equivalent unit
Tg	Teragram 1 Tg (teragram) = 1000 Gg (gigagram) = 1,000,000,000 kg
Tg-CO_2e	Teragrams of carbon dioxide equivalent
TWh	Terawatt-hours 1 terawatt-hour per year = 114 megawatts

LIST OF TABLES

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WE ARE AT THE FRONTLINE OF CLIMATE CHANGE.
NOW IS THE TIME TO ACT.

LOW-CARBON DEVELOPMENT

The Philippines can achieve development the low-carbon way by leapfrogging into the use of clean technologies and renewable energy, enhanced energy conservation plus improved carbon sink potential. This contributes to a better climate future without sacrificing economic progress.

RENEWABLE ENERGY

Tremendous abundance of indigenous renewable energy sources tapped to meet current and future power needs. Along with increased energy efficiency, these resources symbolize the country's contribution to global climate change mitigation and guarantee the Filipino's energy independence.

SUSTAINABILITY

Clear strategies to realise economic and environmental sustainability. Low-carbon development anchored on 100% renewables will secure Filipinos' energy needs well into the future, achieving global competitiveness.

TRANSITION

Transition into a low-carbon economy employing specific solutions and policies to sectors such as power, waste, transport and agriculture—over time, integrating the country's development objectives with the world's 100% renewable energy future.

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To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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