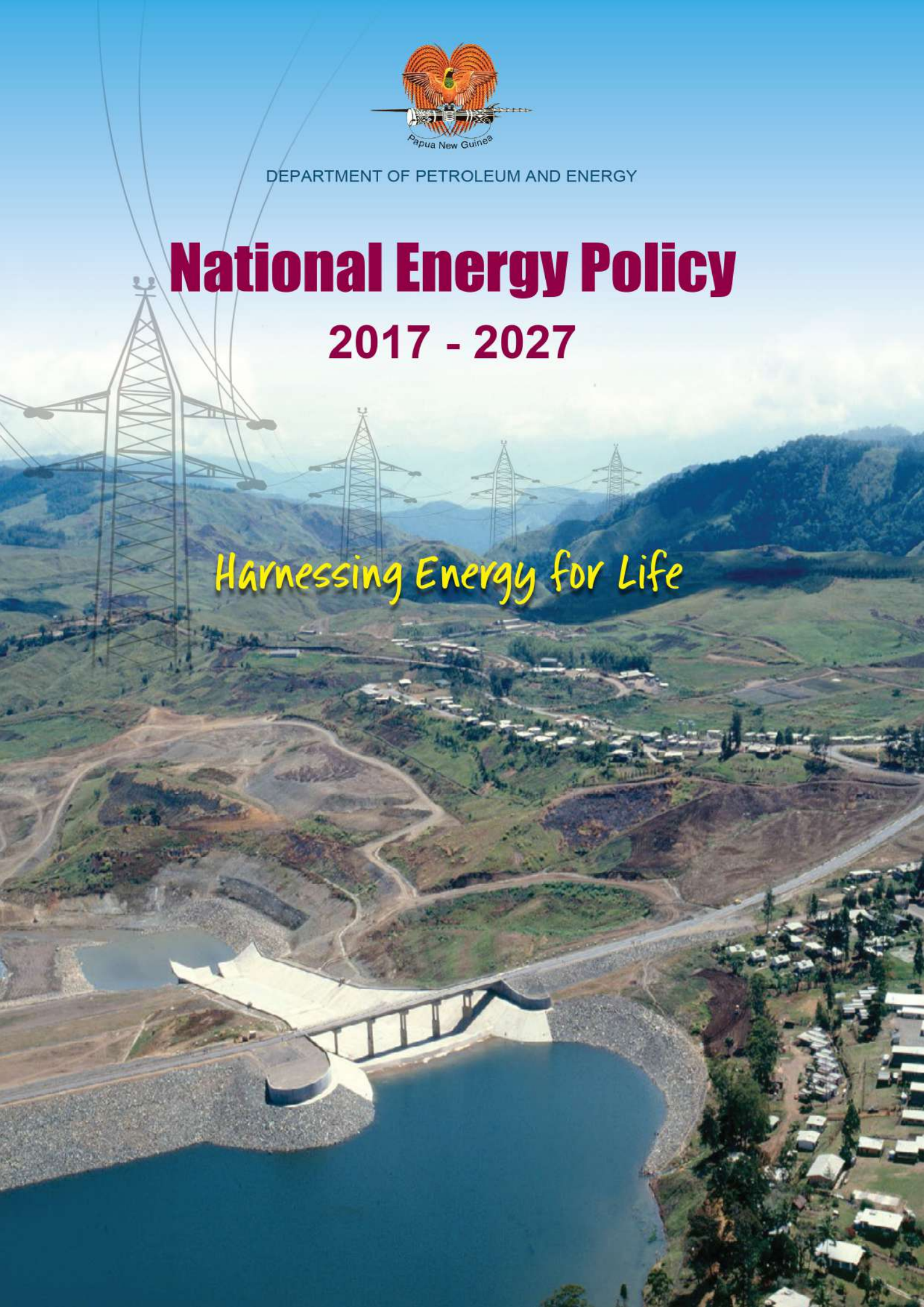
DEPARTMENT OF PETROLEUM AND ENERGY

National Energy Policy

2017 - 2027

Harnessing Energy for Life



INDEPENDENT STATE OF PAPUA NEW GUINEA

NATIONAL ENERGY POLICY 2017 - 2027

Department of Petroleum and Energy
P.O Box 1993, Port Moresby
National Capital District, Papua New Guinea

Telephone: (675) 325 3790

ISBN: 978-9950-909-84-8

CONTENTS

FOREWORD BY THE MINISTER

Energy is of vital importance for the sustainable development of our country. Countries that have placed energy in the forefront of their policies have and are experiencing leaps and bounds in their economic growth and prosperity. Energy is the engine room for economic development for any successful nation.

God has blessed Papua New Guinea abundantly with all natural resources of energy which are waiting to be harnessed to advance the economic growth, energy security, environmental sustainability and social welfare of our people and country.

Unfortunately, since 1963 when electricity became publicly available for domestic and commercial use, its development and access has reached a meagre 13% by 2017. PNG's energy sector was developed through various Acts of Parliament but its development was not coordinated properly for a period of 40 years since attainment of political Independence in 1975. This is a truly sad story, which the Nation cannot be proud of or accept. Something drastic must be done and done quickly to address this energy situation in our country.

I am proud that an overarching policy on Energy is now finally completed for me to present to the people of Papua New Guinea. The National Energy Policy will provide the enabling environment to achieve, the 2030 target for 70 percent electricity access to all households in PNG and 100 percent by 2050 using renewable energy resources.

I believe this Energy Policy is on par with modern energy development practices across the globe, fully utilising all our energy sources for domestic use and eventually for export.

The global energy sector is continually evolving and PNG must be at the forefront of utilising new technologies to harness our local energy sources having due regard to the environment. This policy advocates a balanced approach to energy production and supply, using existing technologies where appropriate and deploying new technologies.

I am grateful to the O'Neill Government for giving me the opportunity to drive the reform in the energy sector which is good for all beneficiaries, domestic, commercial and industrial users of energy.

This policy will also drive economic growth through efficient, reliable and affordable energy access across commercial and industrial sectors.

To implement the Policy. I am pleased to announce that the National Electrification Roll-out Plan (NEROP) is at advanced stages of being finalised and other sub-sector plans will be developed soon after the launching of the National Energy Policy.

This policy will be the basis of energising and powering PNG to be a smart, happy, prosperous, wealthy and modern nation.

Hon. Samuel H. Basil, MP

Minister for Communications, Information Technology & Energy - 2017

ACKNOWLEDGEMENT

By the Chairman - Energy Working Group

Development of policy for the renewable natural energy resources of Papua New Guinea over almost two (2) decades has largely taken a back seat and treated as the 'Cinderella' of the petroleum and energy sector. Petroleum has enjoyed the limelight since the discovery and development of the Kutubu Oil Fields. Bringing together non-renewable (petroleum) and renewable (hydro, solar, wind, biomass, etc.) energy under one policy, especially in the downstream marketing, sale and/or distribution of energy products is a milestone in meeting the ever increasing commercial, industrial and domestic energy needs of the country. I take this opportunity to recognise and commend the many individuals and organisations, including World Bank, AusAid and University of Technology of Sydney, which have contributed at different times over the last twenty years, along the long and arduous journey of energy policy development. All these collective contributions have finally culminated in what I believe is a comprehensive and over-arching National Energy Policy for Papua New Guinea. At the outset, I wish to thank Hon. Peter O'Neill, CMG MP, Prime Minister of Papua New Guinea and the National Executive Council for directing the Departments of Petroleum and Energy and Public Enterprises to recommence the process of National Energy Policy development in 2014/2015.

I acknowledge and thank Hon. Samuel H. Basil, MP, Minister for Communication, Information Technology and Energy, Hon. William Duma CMG MP, Minister for Public Enterprises and State Investments and Hon. Dr. Fabian Pok MP, Minister for Petroleum for their guidance in the development of National Energy Policy. Credit is also due to former Ministers Sir Moi Avei, Nixon Duban and Ben Micah for their support and contribution to the development of the National Energy Policy.

At the bureaucratic level I express my sincere appreciation to Dr. Clement Waine, the Secretary for Public Enterprises for providing intellectual capital at the many collaborative gatherings of representatives of civil servants, academia and civil society. I acknowledge with deep respect for Mr Vore Veve, a Papua New Guinean who has spent most of his working life campaigning for development of renewable energy.

On a personal note I thank Hon. Samuel H. Basil, MP for his confidence in appointing me to Chair the last of the gatherings of energy experts - the Energy Working Group on the National Energy Policy. In his first address to the Working Group the Minister said: *"the challenge for the Energy Working Group is to successfully separate the two (2) Siamese Twins";* metaphorically speaking of the task of separating petroleum from energy after the Prime Minister appointed him as Minister for Energy. I am pleased to say the Energy Working Group has delivered on that challenge and more - thus creating a clear demarcation between petroleum and energy, and sets the stage for development of the vast natural renewable energy resources, which, in my view, will far exceed all of our expectations, in terms of its contribution to long term energy security of Papua New Guinea.

I commend one and all for your contribution to the new National Energy Policy: *Harnessing Energy for Life.* May our beautiful country - Papua New Guinea, prosper through this National Energy Policy.

God bless you all.

Joseph Gabut, OBE
Chairman
Energy Working Group

EXECUTIVE SUMMARY

1 Energy is the engine of economic growth. Therefore the Government recognises the need to manage the energy sector in a manner that is efficient and sustainable. Development of the country's energy resources therefore will be coordinated in a manner that guarantees PNG attains sustainable income from energy exports while at the same time, the Goverment wants to see the unit cost of energy reduced in order to make PNG an internationally competitive country to invest in.

2 The provision of reliable, accessible and affordable energy contributes to economic and social development, and development in turn depends on more use of energy for the nation's sustenance but in a manner that is technically sound and the sector is efficiently regulated. Hence, this policy is all about finding a balance between making PNG an attractive investment destination for exporting energy to the energy hungry world and at the same time promoting PNG's economic development based on low energy cost.

3 The overall objective of the energy policy is to ensure affordable, competitive, sustainable and reliable supply of energy to meet national and provincial development needs at least cost, while protecting and conserving the environment.

4 The energy sector is guided by the *Oil and Gas Act 1998*, *Mining Act 1992, Electricity Industry Act 2002* and a number of other legislations. With the adoption of the PNG Vision 2050, there is need to formulate both the policy and accompanying legislations so as to align them with the Vision; the statutes shall be reviewed and consolidated into one.

OVERVIEW OF THE ENERGY SECTOR

5 The Energy sector currently accounts for 14 % of the GDP. The contribution to the GDP growth is attributed to the PNG LNG project. With the adoption of this policy, the renewable energy sector will also contribute to increase in GDP.

6 The Energy Sector constitutes two (2) energy sources: (i) fossil fuels (including petroleum, natural gas and coal); and (ii) renewable energy (including hydro, geothermal, solar, wind, tidal wave, ocean current, biofuel).

FOSSIL FUELS

7 Papua New Guinea has considerable recoverable natural gas reserves and fast diminishing reserves of oil. In order to fast track more petroleum discoveries in the country, the Government will intensify primary data acquisition and make it available to investors to attract them to undertake more exploration activities within the country.

8 Papua New Guinea's hydrocarbon basins are primarily gas-prone although a few oil discoveries have been made. The current oil fields are on the decline and any future significant hydrocarbon discoveries will be gas fields. The industry is governed by the *Oil and Gas Act 1998* and is largely export-driven. The gas required for domestic consumption primarily for power is relatively small and subject to commercial consideration.

9 There is therefore a need to develop adequate petroleum production capacity in the country, and also develop the petroleum supply infrastructure to meet market requirements to match the increasing demand for petroleum products locally and in the region.

10 Coal is an affordable, competitive, reliable and easily accessible source of energy, especially for electricity generation. Some coal exploration has taken place in Gulf Province. More coal exploration is going on in other parts of the country.

.

11 The Government shall promote an intensive coal exploration programme and efficient utilisation of coal resources while minimising the environmental impacts associated with its use. It will establish data and information on coal resources.

RENEWABLE ENERGY

12 Renewable energy, derived from the naturally occurring resources including geothermal, hydro, solar, wind, tidal wave energy, biomass, biofuels, biogas and municipal waste can supply our needs and those of future generations in a sustainable way if effectively harnessed through careful planning and advanced technology. In addition, renewable energy has the potential to enhance energy security, mitigate climate change, generate income, create employment and generate foreign exchange savings.

13 Papua New Guinea has huge hydro power potential, currently estimated at 15.000MW[1] , which if developed, could significantly boost PNG's energy production potential.

14 The Government shall establish the National Energy Authority of Papua New Guinea (NEA) to be the umbrella agency for development of renewable energy resources.

15 The Government shall establish the Energy Regulatory Commission (ENERCOM) to take custody of all regulatory functions within the renewable energy and electricity industries and some downstream petroleum activities.

ELECTRICITY SUB SECTOR

16 Electricity is a secondary source of energy generated through the consumption of primary energy sources. By virtue of its versatility in application, electricity is crucial to the socio-economic development of the country and is the most sought after energy service, access to which is associated with rising or high quality of life. In order to ensure there is affordable and accessible electricity supply, there is a need to restructure and reform the electricity supply industry.

INSTITUTIONAL REFORM OF THE ELECTRICITY SECTOR

17 Reform of the electricity sector is required in view of the very low access, at 13%, to the people of PNG since 1963 when electricity first became available in the country. It is time for review and reform of the sector.

18 It is very clear that PNG Power Limited which has been in the forefront of energy delivery services in the country has done very little to change the picture of very low power access to the people of this country.

[1]Projection and estimates by Shawinigan Report, 1980

19 PPL being not a fully commercial entity has faced a major challenge over many years of balancing improvement in its economic returns versus the social obligations of providing subsidised electricity to its domestic consumers.

20 Policy interventions are required to make SOEs more commercially oriented. In this regard, commercially oriented organisations or entities should be created to manage the evolving electricity industry.

INDIGENOUS PARTICIPATION IN ENERGY SECTOR

21 The government recognises that it is of crucial importance to promote and encourage citizens and national participation in the development of energy resources, downstream processing of energy sources, domestic market obligations of energy developers, rehabilitation of projects and the adequate human resourcing of energy projects.

22 The government shall promote local and national participation by citizens and SOEs into all aspects of exploration, development and commercialization activities associated with oil, gas, coal and geothermal projects.

ENERGY FINANCING, TRADING, PRICING AND SOCIO-ECONOMIC ISSUES

23 The Government through the NEA shall:

a] Explore and adopt all viable financing options from local and international sources for cost effective utilization of all its energy resources, and in so doing shall endeavour to maintain a competitive fiscal investment climate in the country.

b] Support Public Private Partnerships (PPPs) in the development, operation and maintenance of energy infrastructure and delivery systems.

24 a] Energy infrastructure development.

b] Energy sector environmental disaster mitigation, response and recovery.

c] Hydro risk mitigation.

d] Energy efficiency and conservation programmes and

e] Promotion of renewable energy initiatives.

25 In time, it is contemplated that as the energy industry evolves into one of increasing scale (where local power generation exceeds demand) and sophistication, with multiple interconnected generators the National Electricity Market will be developed where electricity will be traded as a commodity in a country and exported overseas. It will involve both wholesale generation that is transported via interconnected grid of high voltage transmission lines to electricity distributors, who deliver it to consumers (homes and businesses). In the long run the transport of electricity from generators to consumers is facilitated through a 'pool', or spot market, where the output from all generators is aggregated and scheduled at five minute intervals to meet demand.

ENERGY EFFICIENCY AND CONSERVATION

26 The importance of energy efficiency and conservation measures in the Papua New Guinean economy cannot be overemphasized. Challenges to implementation of energy efficiency and conservation initiatives include lack of awareness of the benefits and methods of conservation, apathy, limited technical capacity and inadequate data. This policy contains some of the initiatives to address these concerns.

LAND, ENVIRONMENT, HEALTH AND SAFETY

27 In carrying out its planning and development function regarding electricity, gas reticulation and energy regulation, every Provincial Government shall set aside suitable land for energy infrastructure development purposes, including but not limited to projects recommended in the national energy plans.

CROSS CUTTING ISSUES

28 The NEA may establish directorates with responsibility for policy development as well as integrated national planning in the areas of downstream oil and gas, coal resources, renewable energy, electricity, nuclear energy for electricity generation as well as energy efficiency and conservation.

29 Research, Development and Dissemination as well as human resource development are key in achieving the objectives of this policy. This will be done through existing institutions that are in place in collaboration with National Energy Authority.

1 INTRODUCTION

1.1 PNG'S NEED FOR A NATIONAL ENERGY POLICY

1 During the colonial era there was little development in the energy sector. Even now; energy development has not kept pace with the evolution of the economy. PNG's future economic growth requires a rapid increase in harnessing the energy resources of the country in a sustainable manner.

2 Energy security is all about the continuous availability of energy at all times in various forms, in sufficient quantities and at affordable prices. These conditions must prevail over the long term because energy contributes to sustainable development and growth of any nation. In PNG, attention to energy security is critical because of the export of all the produced oil and gas and yet to be developed substantial natural renewable energy resources. Thus, energy supply could become more vulnerable over the near term due to PNG's growing reliance on imported petroleum products. Energy supply has been stable in the past 50 years and has contributed to the economic development of the nation, however, the potential for conflict, sabotage, disruption of trade, and reduction in strategic reserves and increasing oil prices cannot be dismissed. These potential threats point to the necessity of strengthening national energy security.

3 Papua New Guinea has significant potential of indigenous energy resources and reserves including oil, gas, coal, hydro, biomass and other renewable energy that can be harnessed to accelerate PNG's development and progress in leaps and bounds. The energy sector currently accounts for 14% of the country's GDP, on the back of the successful World class PNG LNG project which commenced shipment of gas to overseas market in April 2014. The PNG Energy Sector has the potential to provide the foundation for growth for all other sectors in building a modern PNG economy. This can only happen if PNG makes substantial investment in the development of the energy sector.

4 Energy shortages and supply disruptions together with high cost remains serious obstacles to economic activity and growth in PNG. At present, eighty seven percent (87%) of PNG's population still lack access to electricity services and the progress of rural electrification has lagged over the years. This is due to the prolonged absence of an overarching energy policy to guide the development of the energy sector. In addition, the lack of political foresight, the high delivery costs and the lack of investment due to PNG's rugged topography and sparsely distributed population are major impediments to delivery of accessible, reliable, affordable energy and electricity services. In 2011, the O'Neill Government took an important first step by approving the Electricity Industry Policy (EIP) and National Electrification Rolf-out Plan (NEROP) to begin a 15 year programme on rural electrification. This policy is the overarching framework for development of the energy sub sector policies and plans.

5 The National Government envisions through its PNG DSP 2010 - 2030 that seventy percent (70 %) of the country will have access to electricity by 2030. The Vision 2050 in turn envisions one hundred percent (100%) power supply from renewable and sustainable energy sources.

6 A comprehensive forward looking and well-coordinated National Energy Policy is needed now more than ever to provide government leadership and certainty to private sector investment in the energy sector to seize major economic opportunities and respond effectively to long-term challenges forenergy delivery and energy security including addressing climate change issues.

7 This Policy is designed with Sustainable Development principles in mind and is intended to operate for a period of ten (10) years, reviewable every five (5)years.

1.2 STRUCTURE OF THE NATIONAL ENERGY POLICY

This policy document is organised into twelve substantive chapters, starting with the Introduction in Section 1 and Section 2 provides Overview of the energy sector in PNG and the principles of the Policy; Sections 3 and 4 treats in detail the Primary energy sources, namely Fossil Fuels and Renewable Energy, including electricity generation from geothermal and hydro resources. Section 5 covers Transportation of fuels; Section 6 deals with the Secondary energy source, Electricity, followed by Section 7 which details the Institutional Restructure of the Electricity Industry. Section 8 deals with Community Service Obligation, Section 9 covers Local Participation in the Energy Sector, followed by Section 10 which details Energy Financing, Trading, Pricing and Socio-Economic Issues. Section 11 deals with Energy Efficiency and Conservation, Section 12 covers Land Environment, Health and Safety whilst the final Section 13 details the new proposed Institutional Arrangements to be implemented under the policy.

1.3 POLICY VISION, GOAL AND OBJECTIVES

1.3.1 Vision

Improve quality of life for every citizen and provide a platform for strong economic growth through sustainable development of the energy sector in line with Vision 2050.

1.3.2 Goal

To provide sufficient, accessible, reliable and affordable energy in a manner that is competitive, sustainable and environmentally friendly.

1.3.3 Principles & Strategies

Key focus areas of the national energy policy will guide implementation to achieve the vision, goal, principles and strategies of this policy.

1.3.3.1 Social

Principle 1 Strengthen institutional capacity and recruit appropriate human resources to manage the Energy Sector.

1.3.3.1.1 Strategies

a Government shall establish the National Energy Authority and the Energy Regulatory Commission (ENERCOM) as proposed under the National Energy Policy to oversee the implementation of the Policy.

b Ensure adequate resources including infrastructure are made available for the two entities, the National Energy Authority and ENERCOM.

c Foster co-operative arrangements between the Department of Provincial Affairs and Local Level Government, Provincial Governments, District Development Authorities, Special Purpose Authorities by virtue of the National Energy Policy shall take ownership of the path of energizing the Province and Local Level areas under their jurisdiction by provisions made in 1995 where energy (electricity production and sales) was to be developed by the Organic Law on Provincial & Local Level Government (OLP&LLG).

d The National Energy Policy with its accompanying sub-sector policies and plans shall be made public to create widespread understanding, awareness and support for Government Energy Policy objectives, amongst key stakeholders including Government Agencies, industry participants, private sector investors, consumers, and the community at large.

e All Higher Level and Technical Institutions shall include energy related subjects in their curriculum.

Principle 2: Develop an integrated planning process for sustainable energy supply and utilization.

1.3.3.1.2 Strategies

a Ensure that a comprehensive National Energy Plan will be prepared together with the strategic sub-sector plans and submitted to the Government for approval.

b Promote the development of appropriate regulatory guidelines including standards to meet the needs of producers, suppliers and users.

c Promote the National Electrification Rollout Plan (NEROP) for Grid extension and off-Grid stand-alone power supply system.

d Promote one hundred percent electricity usage from renewable energy sources by 2050.

e Promote Local Landowner Participation and Community Social Obligations in line with an established Local Content plan.

f Promote energy data reporting both in supply and demand across all sectors.

Principle 3: All energy resources will be developed by the State for the betterment of all citizens.

1.3.3.1.3 Strategies

a] The State should be an active participant in the development of all energy resources.

b] The State should empower landowner participation in the development of all energy resources ensuring landowner interest in these projects is equitable.

c] The State will review and define properly in law the ownership and beneficial interest of its citizens in all energy resource developments.

d] Actively promote National and Local content in all energy businesses.

1.3.3.2 Economic

Principle 4: Promote a conducive environment for long term sustainable economic solutions in the supply of all energy sources.

1.3.3.2.1 Strategies

a] Allow competition in the Oil and Gas upstream, midstream and downstream business and promote the long-term sustainability of energy supply from oil and gas products and improve the competitiveness of petroleum supply options through appropriate regulatory framework.

b] Ensure appropriate legal and financial frameworks are in place for energy sector development for private sector participants.

c] Promote public-private partnership in energy sector development.

Principle 5: Encourage involvement of the private sector in the development and provision of energy infrastructure and services.

1.3.3.2.1 Strategies

a] Provide incentives for private sector investment through appropriate fiscal regimes.

b] Promote a competitive energy and electricity market environment for the expansion of independent power production in the near term and distribution in the long term.

c] Promote the efficiency and robustness of the Electricity Service Industries (ESI) through market reforms.

d] Promote corporatisation and commercialization mechanisms for power utility and Independent Power Producers (IPPs) where efficient to do so to facilitate improvements in power production, transmission, distribution and retail by relevant entities.

e] Government shall continue to play an important role in the regulation of retail competition, including issues of prices control and market ownership in the ESI and allow for a lower tariff for rural electricity users based on Long Run Marginal Cost (LRMC). Any control mechanisms in ICCC shall be gradually transferred to Energy Regulatory Commission (ENERCOM).

1.3.3.3 Environment

Principle 6: Ensure energy resources are developed and delivered in an environmentally sustainable manner.

1.3.3.3.1 Strategies

a] Minimize the adverse impact of energy production, distribution and consumption within the framework of the Environmental Act 2014 (as amended) and other appropriate legislation and laws including Environment Impact Assessment (EIA) of energy projects.

b] Ensure oil and gas manufacturing, storage, handling and transportation meets internationally accepted industry safety standards for export and consumption.

c] Support international action on reduction of greenhouse gases and ozone depleting substances from energy standpoint.

d] Promote and support efforts in the conservation and maintenance of forests and appropriate marine resources including aquifers as carbon sinks.

Principle 7: Promote efficient systems and safety in energy supply in all sectors (transport, residential, commercial, industrial and agriculture).

1.3.3.3.2 Strategies

a] Promote policy and regulatory framework for greater use of appropriate, cost effective and energy efficient modes of transportation including public transport.

b] Ensure minimum energy performance standards for electrical equipment, and adoption of building energy codes and other standards for safety.

c] Ensure safe transportation of energy products and wastes.

d] Promote cost-effective renewables such as solar-power and solar-thermal systems and LPG for residential, commercial and public institutions.

e] Promote best practise energy supply systems for agriculture industries.

f] Promote suitable energy supply and technology systems for industrial sector including Mining, Oil and Gas industries.

1.3.3.4 Energy Security

Principle 8	Diversify the cost-effective development and utilization of energy resources for the nation's well-being and economic prosperity.

1.3.3.4.1 Strategies

a] Promote oil & gas downstream processing for domestic energy needs.

b] Promote utilization of coal using clean coal technology for domestic energy needs.

c] Promote electricity generation for domestic needs from diversified energy sources and gas developers to commit 0.5TCF to support the Government.

d] Promote the maximum use of renewable energy resources for electricity generation.

e] Promote the introduction of renewable fuels (biofuels) for use in the transport and biomass for power generation sector.

f] Ensure security of petroleum products supply through a regulated 90 day stock level to be held by a State nominee.

Principle 9	Promote energy efficiency and conservation measures and wise use of energy.

1.3.3.4.1 Strategies

a] Draft and enforce an Energy Efficiency Policy within one year of NEA's creation.

b] Promote energy efficiency measures in all sectors (industrial, residential, agriculture and transport) of the nation in end use of equipment and appliances.

c] Promote minimum energy performance standards and appliance labelling to all electrical equipment and appliances in collaboration with PNG Customs Services (PNGCS), National Institute of Standards and Industrial Technology (NISIT), Independent Consumer and Competition Commission (ICCC) and other relevant stakeholders.

d] Promote the concept of energy efficient buildings in accordance with *Building Act 1971 and Regulations.*

e] Promote energy audits in factories and industrial locations and demand side management programs in all sectors of the economy.

2 OVERVIEW OF ENERGY SECTOR IN PNG

2.1 THE ROLE OF ENERGY IN NATIONAL ECONOMY

1 Papua New Guinea has attained a strong economic growth achieving an average of 6.0% annual Gross Domestic Product (GDP) growth rate from 2005 - 2014 with projections of over 16% growth in 2015 and beyond.

2 The energy sector currently accounts for 14% of the country's GDP and is a critical enabler for all other sectors for building a modern PNG economy. Major developments are expected in the energy sector and the economy on the back of the successful commencement of the world class PNG LNG project in 2014. The Energy sector will continue to contribute substantially to that growth.

3 The Energy Sector includes assets related to three (3) key energy resources: (i) electric power, (ii) fossil fuels (including petroleum, natural gas and coal); and (iii) renewable energy including hydro, biomass, geothermal, solar, wind, tidal waves, ocean currents and biofuel. Each of these energy sources have been dealt with in detail in the subsequent chapters of this Policy.

4 PNG is richly endowed with renewable energy sources that when harness can meet the Vision 2050 target of PNG been 100% power by renewable sources. It is estimated that PNG has hydro power potential of about 15,000MW comprising large and small hydros[2] .

5 The electricity portion of the Energy Sector includes the generation, transmission, and distribution and retail of electricity.

6 Currently, there are two main stand-alone power grids—in Port Moresby (NCD Grid) and in the Lae-Madang-Highlands area (Ramu Grid)—and a number of smaller grids that service the smaller urban centres. Because of the unreliability of grid supply, there is considerable self-generation and back-up generation taking place in urban areas, but maintenance and operation costs are high and efficiencies low.

7 PNG has about 797 megawatts (MW) of installed generation capacity, including hydro power (432 MW or 54%) diesel (217 MW or 27%), gas-fired (85 MW or 11%), and geothermal (56 MW or 7%) and biomass (7MW or 1%). PNG has significant underutilized indigenous energy sources such as hydropower, biomass, natural gas, geothermal and solar.

8 PNG Power Limited (PPL), the national state-owned corporatized power utility, manages installed generation capacity of about 300 MW, including the two main grids and 19 independent power systems that service 26 smaller urban centres. The remaining capacity of about 280 MW comprises: (i) self-generation systems owned and operated by industrial facilities, including mining companies; and (ii) private sector generators supplying the main grids or rural communities. The government's ownership in PPL is maintained through the Kumul Consolidated Holdings Limited (formerly Independent Public Business Corporation).

[2]ADB 2009, TA 4932-PNG Final Report: "PNG Power Sector Development Plan", page 3.

9 In Papua New Guinea (PNG), about 13% of the household population has access to electricity. Where power is available (generally in the main urban centres) the supply is often unreliable. Access to electricity is very limited in off-grid rural areas. Lack of access to affordable, reliable power is limiting economic growth in urban areas, constraining growth in smaller urban centres, and contributing to poverty in rural areas.

10 Sector policy formulation is managed by the Ministry of Petroleum and Energy specifically the Energy Wing.

11 Technical regulation of the sector is performed by PPL itself through agreement with the Independent Consumer and Competition Commission; however, although it is intended to eventually transfer this function to the Energy Wing. Through this policy it should be transferred to the National Energy Authority.

12 Key research activity in the power sector occurs at the University of Technology in Lae, particularly through the Rural Energy Research Group. Through this policy an Institute will be established for Energy RD&D.

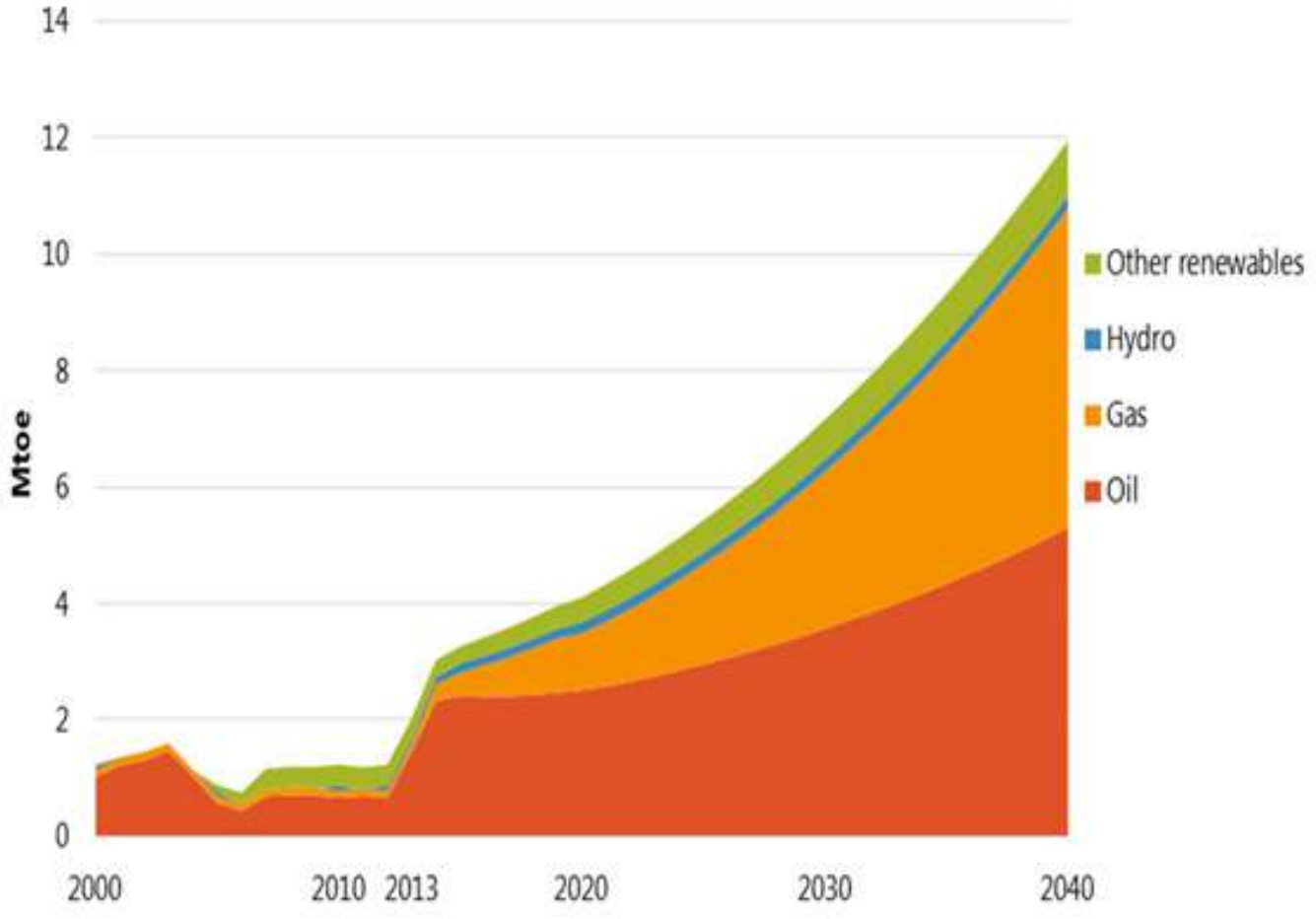
2.2 PNG'S ENERGY MIX

1 Based on the Government's policy to create a new Energy Ministry to develop a National Energy Policy for the country. The NEP will focus largely on renewable sources. This policy does not deal with the upstream Oil and Gas industries.

2 PNG's current energy mix is dominated by diesel and other petroleum refined products.

3 Based on APERC Energy Demand and Supply Outlook 6th Edition (2016) Papua New Guinea's total primary energy supply (TPES) is projected to grow approximately six fold from 2 Mtoe in 2013 to 11.9 Mtoe in 2040 as shown in Figure 1. Oil and gas dominate supply with a small contribution from renewables, primarily hydro and also geothermal and biofuels. Oil and gas will preserve their overall dominant role throughout the Outlook period with their share increasing from 80% in 2013 to more than 90% in 2040. The share and volume of gas will rise significantly, from 5% (0.1 Mtoe) to more than 46% (5.5 Mtoe), thanks to the growing production of gas as oil reserves drying up. The volume for oil increases from 1.5 Mtoe to 5.3 Mtoe but its share fell from 75% to above 44%.

Figure 1 • Papua New Guinea; Total primary energy supply by fuel, 2000-40



Source: APERC, 2016

4 Consumer energy demand in PNG mostly depends on three main fuels; electricity, diesel and biomass. In terms of primary energy supply, in 2015 by-products of oil and gas account for approximately 51%, biomass 39% and hydropower 7% and geothermal 3%. Products of oil and gas constitute most of the share in the total primary energy supply for domestic use at current trend. The demand for heavy diesel and other oil products is concentrated in the industrial sector, followed by electricity and transport while the demand for natural gas products will be driven by the need for increase in electricity generation.

OIL AND DIESEL PRODUCTS

5 As at 2014 diesel and other petroleum products accounts for about 57% of the total primary energy consumed in the country. Diesel and other petroleum products are mainly used in the transport, power generation, commercial and industrial sectors as well as households. There is no coal usage in the country. Chapter 3 treated fossil fuels in greater detail in terms of upstream, mid and downstream petroleum and gas.

GAS

6 The Government must ensure that some gas is made available to complement other renewable energy supply sources for domestic use in power generation to help meet the 70 percent of the households to be electrified by 2030. Then to progress upwards to meet the remaining 30 percent after 2030 and by 2050 all households must be electrified in terms of electricity connectivity. Close coordination is therefore required with PNG's industrialization policy and strategy so that clear economic goals and objectives are established for a domestic gas reservation policy.

ELECTRICITY

7 The current installed electricity capacity of PNG is approximately 797 MW. Hydro and Diesel currently dominate the share of electricity generation. The Government's Vision 2050 directs that by 2050 all electricity supply security must come from renewable energy sources. The Government is now on the trajectory to reduce its reliance on diesel power generation and switch its allegiance to renewable energy sources. By 2050 the electricity mix for PNG would be almost totally from renewable energy sources with shares from wind and solar. Figure 2 and 3 overleaf shows the current electricity generation mix and the projected mix from periods 2030 - 2050.

Figure 2: Current Electricity Mix - 2016

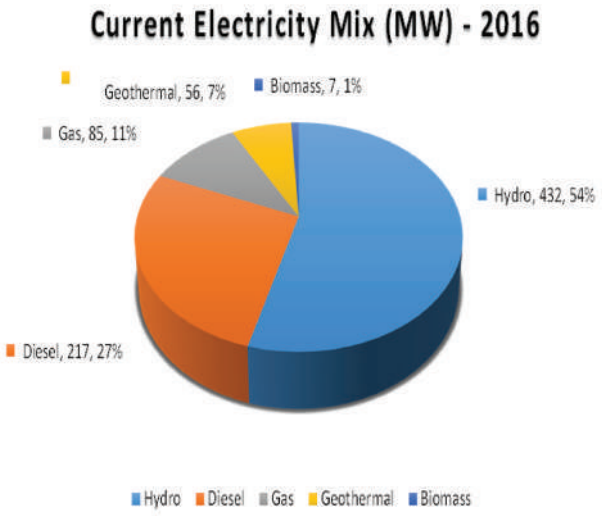
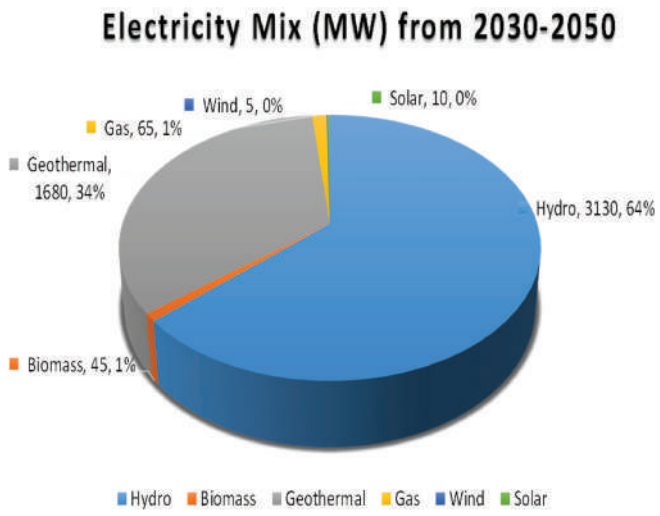


Figure 3: Electricity Mix - 2030 - 2050



Source: Energy Policy Task Force, 2015

RENEWABLE ENERGY

8 Renewable Energy is the most abundant source of energy in PNG and if fully and cost-effectively harnessed could contribute up to 100 percent powering of electricity in the country. PNG is endowed with many of these resources. However, the drawback is the costs involved with their implementation and the maturity of the technology to harness electricity.

9 Current potential of Hydropower is estimated at 15,000 MW with Geothermal at 10,000 MW, Solar, Wind and Biomass also have significant potential and are planned to be harnessed in the near term.

2.3 LEGAL AND REGULATORY FRAMEWORK

1 Energy is a broader subject with its various legal and regulatory environment loosely administered by various organizations under different laws.

2 Papua New Guinea's governing laws on the industry include: the Constitution of the Independent State of Papua New Guinea, *Independent Consumer & Competition Commission Act 2002, Electricity Industry Act 2002, Oil & Gas Act 1996* and the *Mining Act 1992*. There are other key supporting legislations though that provides a cumbersome and loose legal framework within which the energy sector operates.

3 These institutions and agencies have their own weaknesses and challenges, together with the laws they are administering, some of which date back to as far as independence days. Given such an operating environment it would be an understatement to suggest any one legal and regulatory framework.

4 The *Gas Policy 1995* and the *Oil and Gas Act 1996* has served the nation well as evidenced from the successful commercialization of first LNG project, the PNG LNG Project and large investment flowing into the next two projects. A review of the oil and gas fiscal regime and regulatory framework has started under the auspices of the Tax Review Committee chaired by Sir Nagora Bogan.

5 Nonetheless, there is a critical need for a paradigm shift in PNG's Petroleum and Energy Policy and Regulatory regime because PNG as a host country cannot easily access oil and gas for its domestic requirements while the prospect of purchase of oil and gas for domestic consumption comes at an exorbitant price.

6 This Policy recognizes these many challenges and shortfalls some of which include fiscal, funding, legal and policy vacuums, institutional, technical, entrepreneurial abilities, knowledge, environment and social. It aims to address the immediate needs of the industry, especially in so far as energy uses for electricity is concerned to kick-start the process of aligning the legislative and policy environment.

2.3.1 CONSTITUTION OF THE INDEPENDENT STATE OF PAPUA NEW GUINEA

1 In the Preamble to the Constitution, National Goal and Directive Principle three (3) provides for the Government to base their planning for the political, economic and social development and take effective measures to control and actively participate in the national economic and in particular to control major enterprises engaged in the exploitation of natural resources.

2 Goal four (4) provides for Papua New Guinea's natural resources and environment to be conserved and used for the collective benefit of all, and be replenished for the benefit of future generations.

3 These provisions in essence, provides for the aligning of the energy sector policy, legal and regulatory framework with these provisions, spirit and aspirations of the Constitution.

2.3.2 CURRENT POLICY AND LEGISLATION

There are several policies and legislations which have an implication on the energy policy as enumerated and discussed below.

1 Electricity Industry Policy provides for inter-alia, the promotion of competition within the electricity industry. This Policy is operative for a period of only three years (2011-2014) and is overdue for a review. At this juncture we hope to introduce two new policies; the Renewable Energy Policy and Rural Electrification Policy which are being funded by the World Bank.

2 The *Oil and Gas Act 1996* was enacted to regulate the negotiation and conclusion by the Government on petroleum agreements relating to the exploration, development, production and transportation of petroleum.

3 Geothermal Energy Policy provides the framework for the usage and regulation of geothermal resources use when it concerns electricity generation from heat and steam.

4 *Mining Act 1992* was enacted to regulate the exploration, development, production and transportation of minerals excluding petroleum.

5 The Mineral Resources Authority was established by an Act of Parliament in 2005 and is responsible for the management, exploration and development of Papua New Guinea's mineral resources, including safety in mining operations.

6 The *ICCC Act 2002* establishes the regime for consumer protection, promoting and protection of competition and regulating of State Owned Monopolies.

7 Alongside the foregoing principal Acts, there are several other Acts that impact the energy sector, including:-

a *The National Institute of Standards and Industrial Technology Act 1993* provides for establishment of minimum quality specifications, mode, materials and apparatus for energy use in the country. Also sets standards for storage tanks and dispensing equipment for sale of petroleum products and calibrates and regulates them for accuracy.

b *The Environment Act 2000* - provides for the regulation of all environmental related matters across industries.

c *The Organic Law on Provincial and Local Level Government and the National Capital District Commission Act 2001* - grants authority for approval by local authorities of sites for construction and installation of fuel storage and dispensing facilities; business licensing and levies for electric power poles and way leaves charges.

d *The Physical Planning Act 1989* provides for zoning of areas for storage, distribution and retailing of petroleum fuels and construction of electric power sub-stations and other infrastructure.

e *The Public Private Partnership Act 2014* - establishes institutional structures and governance arrangements for all Public Private Partnerships projects.

f *The Land Act 1996* which established the Department of Lands and Physical Planning administers State Leases in Papua New Guinea.

g *Incorporated Land Group Act (Amended) 2009* which governs arrangements relating to customary land matters and incorporation of groups by landowners for land development and related purposes.

h *The Land Registration Act (Amended) 2009* which provides for the process and procedures in relation to registration of customary land for development and related purposes.

i *The Income Tax Act 1959* provides for the tax arrangements in the country.

j *The Land Titles Commission Act 1962* established the Land Titles Commission as an Independent Judicial Tribunal for the resolution of disputes of rights in land including an interest in land, whether arising out of land regulated by custom or otherwise, provides for judicial procedures and the extrajudicial settlement of disputes and some other matters.

2.4 CURRENT INSTITUTIONAL ARRANGEMENTS

2.4.1 INSTITUTIONS

1 There are numerous institutional arrangements for the PNG energy sector. The policy functions for this sector largely come under the Department of Petroleum and Energy, Department of Prime Minister and National Executive Council, Department of Treasury, Department of National Planning and Monitoring, except for Geothermal and Coal which come under Department of Mineral Policy and Geo-Hazards Management (DMP&GHM).

2 The regulatory functions of the energy sector are currently fragmented and vested in different agencies including ICCC, PNG Power Limited and Department of Petroleum and Energy as well as Kumul Consolidated Holdings Limited in relation to PNG Power Limited project approvals.

3 The mandated functions of each institution dealing with the energy sector are briefly discussed below:

i. Department of Petroleum and Energy (DP&E)

The Department of Petroleum and Energy was established to promote and regulate the development of petroleum and renewable sources of energy for the long term benefits of the State in a way which is ethical, socially responsible and environmentally sound.

Due to capacity challenges the technical regulation for the electricity industry is yet to be transferred from Independent Consumer Competition Commission (ICCC) to the Department.

There is a proposal for the technical and economic regulation to be transferred to the proposed Energy Regulatory Commission (ENERCOM) to be housed under the proposed National Energy Authority (NEA). In addition, the electricity industry standards currently under National Institute of Standards and Industrial Technology (NISIT) is proposed to be transferred to NEA.

ii. Department of Mineral Policy & Geo-Hazards Management (DMP & GM)

The function of the Department of Mineral Policy and Geo-Hazards Management is to create effective mineral policies and policies for the reduction of Geological Risks. The Department is also responsible for upstream licencing of Geothermal and Coal resources.

iii. Mineral Resources Authority (MRA)

The Authority was established with the purpose of regulating the mining industry and its management, exploration and development of Papua New Guinea's mineral resources;

- to promote the orderly exploration for the development of the country's mineral resources.
- to oversee the administration and enforcement of the *Mining Act 1992, the Mining (Safety) Act 1977, the Mining Development Act 1955.*
- to receive and collect, on its own account and on behalf of the State, any fee, levy, rent, security, deposit, compensation, royalty, cost, penalty, or other money .

iv. Department of Public Enterprises (DPE)

The Department of Public Enterprises was created to provide policy oversight to remedy serious SOE performance weaknesses and provide serious oversight to SOEs to become profitable. The Department is looking at policy level interventions not only for rehabilitating and investing in the existing SOE businesses but also to incubate business opportunities and investments.

v. Kumul Consolidated Holdings Limited (KCHL)

The KCHL was established as an Independent Entity under its own Act to hold the majority of State-owned commercial assets in trust for the State of Papua New Guinea to manage those assets prudently to improve commercial performance and underpin economic development.

Papua New Guinea to manage those assets prudently to improve commercial performance and underpin economic development.

Kumul Consolidated Holdings Limited is also responsible for approval of PNG Power Limited's projects.

vi. Independent Consumer and Competition Commission (ICCC)

The ICCC is a regulator established by the *ICCC Act 2002* purposely for promotion of competition and fair trading, the regulation of prices for certain goods and services and the protection of consumers' interest in the country. It has the regulatory powers to investigate and charge business and industries violating its market rules set by the State.

vii. Department of Treasury (DoT)

The Department of Treasury is one of the key central agencies that functions to undertake research and provide advice to the Government on economic and financial issues that arise from the National Budget. It also prepares and monitors the National Budget and provide policy advice to the Government on the finance and resource management of National Government Departments, Provincial and Local Level Governments and State Owned Enterprises.

viii. Department of National Planning & Monitoring (DNPM)

The Department was established to lead, plan, coordinate and facilitate sustainable developments and presenting a clear vision and direction for the nation's future. It ensures to monitor implementation of projects and developments are undertaken in line with the nation's strategic plans.

ix. Conservation & Environmental Protection Authority (CEPA)

The CEPA was established under the former Department of Environment and Conservation in 1985 and vested with the powers to protect the environmental values of air, water, soil and biodiversity and the sustainable use of natural resources as mandated by the Fourth Goal of the National Constitution.

x Climate Change Development Authority (CCDA)

The CCDA's mandate is founded upon the principles that Papua New Guinea's natural resources and environment are to be conserved and used for the collective benefit of all and are replenished for the benefit of future generations. The CCDA takes full and exclusive responsibility to coordinate and facilitate all policies, initiatives and actions under Pillar Five of Vision 2050, particular to climate change.

xi. PNG Power Limited (PPL)

PNG Power Limited is one of the State Owned Enterprises established as a regulatory regime vested with the powers and responsibilities to Plan, Develop, Generate, Transmit, Distribute and Retail electricity throughout Papua New Guinea.

xii. Kumul Petroleum Holdings Limited (KPHL)

KPHL is the National Oil and Gas Company owned 100% by the State, PNG's third largest Partner in PNG LNG Project with 16.6% stake has 20.5% stake in 4 Petroleum Development Licenses (PDL 1, 7, 8, 9). KPHL is mandated to be the State nominee of all petroleum development in the country.

4 The Institutional arrangements of the energy sector will be streamlined to encourage efficiency, access and affordability. The energy regulatory functions both technical as well as economic will be brought under a new structure as detailed in chapter 13, specifically under the proposed Electricity Regulatory Commission (ENERCOM) which will perform this role.

3 FOSSIL FUELS

3.1 BACKGROUND

1 Fossil fuel consists of petroleum (oil, and natural gas) and coal resources. As at 2014 petroleum accounts for about 57% of the total primary energy consumed in the country. Petroleum is mainly used in transport, power generation, commercial and industrial sectors as well as households. There is no coal usage in the country.

2 The petroleum industry is broadly divided into three categories namely: upstream (exploration and production), mid-stream (storage, refining and transportation) and down-stream (supply and distribution). Midstream and downstream operations are sometimes combined.

3 The monetization of natural gas is more complex than the commercialization of liquid hydrocarbons. Substantial investments will be required in interrelated links in the supply chain including upstream, midstream, downstream and consumption facilities.

3.2 UPSTREAM PETROLEUM

3.2.1 Petroleum Exploration & Production

1 PNG has benefited profoundly through significant foreign investment in its upstream petroleum exploration sector over the last 30 years where some of the players are leading international oil companies.

2 Production from existing oil fields reached their peak plateau more than 10 years ago. Production has been in steady decline.

3 Currently there are accelerated exploration activities undertaken in the country and the prospect of new oil and gas discoveries appears promising. The marked increase in petroleum exploration interest is attributed to;

a Existence of an attractive legal, regulatory framework, fiscal and acceptable risk-reward balance incentive;

b Intensive promotion activities by the Government; and

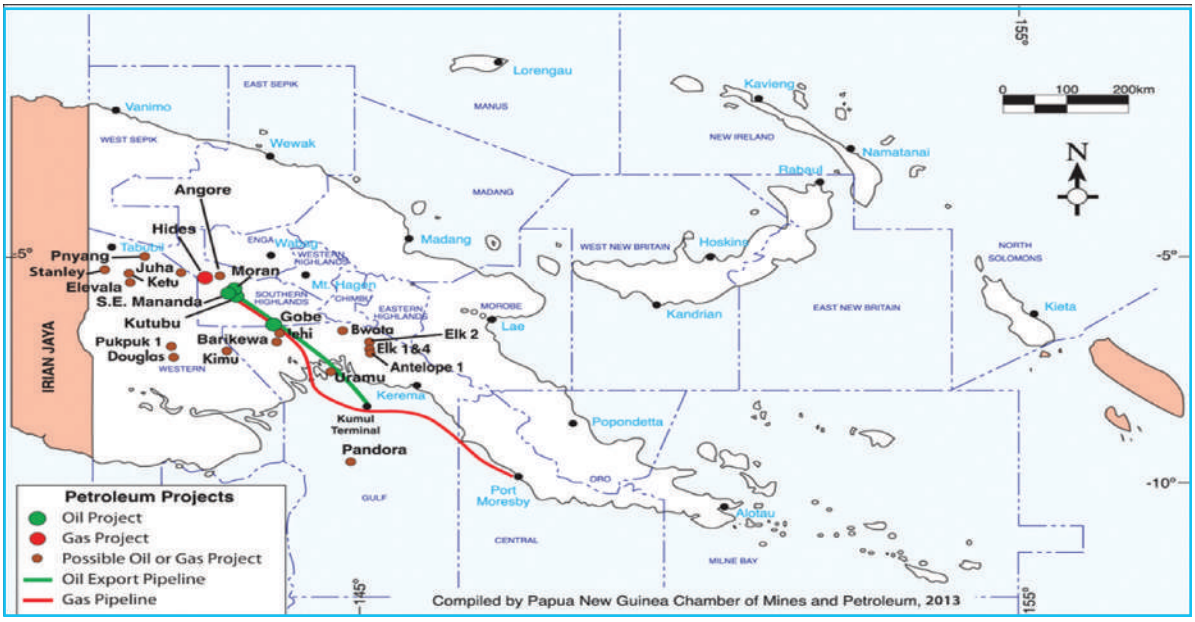
c Rising world crude oil prices.

d PNG's geological prospective.

4 PNG commissioned its first commercial gas project in 1991. Oil Search owns and operates a gas powered generation plant at Hides and supplies electricity to Porgera Gold Mine. That power generation plant delivers electricity for Porgera Gold Mine. Its major export-based gas project was the US$ 19 Billion PNG LNG Project which was successfully commissioned in 2014.

5 As at 2014, Papua New Guinea's Petroleum Projects are shown in Figure 4.

Figure 4. Petroleum Projects, 2014



Source: PNG Chamber of Mines and Petroleum, 2013

6 There are many undeveloped gas fields in the country with proven and probable reserves of over 20 trillion cubic feet of gas. Most of these discoveries are small to medium size fields.

7 As of May 2014, Papua New Guinea joined the exclusive club of LNG producers and exporters. With increased petroleum exploration being undertaken both on-shore and off-shore in the country's major sedimentary basins there is now the possibility that more reserves of natural gas would be discovered in commercial quantities. The Government will ensure 15% of gas reserves in new Oil and Gas projects should be made available for domestic gas utilization.

8 The PNG economy is comparatively very small. Gas is a very versatile and environmentally friendly fuel. The PNG Government is not too unreasonable. PNG needs gas for power generation and requirement for such needs is not even 500 BCF or 1TCF of gas. There should be no panic questionining the State when the Government is simply saying that the host country needs a tiny volume of gas for domestic purposes, especially power generation and also the creation of Petrochemical Industry.

9 The Government recognises the significance of the industry and is determined to promote efficiency in the overall administration and regulation of the hydrocarbon industry.

3.2.2 Challenges in Petroleum Upstream

1 There are several challenges in the petroleum sector and these are:

a] Attraction of capital for petroleum exploration and production activities, which are highly capital intensive due to the rugged geography.

b] Geological complexity.

c] High cost of acquisition of new technology.

d] Limited primary technical data in most of the country's exploration blocks.

e] Low oil prices that are creeping closer to the cost of production per barrel of oil equivalent.

f] Declining gas, especially oil reserves because petroleum resources is finite.

g] Small and stranded gas fields requiring infrastructure to develop.

h] Fluctuating oil and gas prices affecting revenues and energy use in PNG.

i] Non availability of crude oil and gas for downstream processing, including for petrochemical projects

2 Current and emerging issues requiring resolution and certainty in the petroleum and energy industry include:

a] Cycle time for licence applications averaging 300 days.

b] Licensing rounds.

c] Community awareness and participation.

d] Windfall profits in high oil price environments.

e] Gas sharing terms.

f] Environmental protection, conservation and management.

g] Mechanism for working out National Government, Provincial Government and Local Level Government benefits sharing and the ongoing management of those cash and non-cash benefit streams.

h] Payment of royalty on gross oil produced.

i] National Content in Project Development.

j] Domestic Market Obligation.

k] Third Party Access Regime.

l] Tax Review Committee deliberations on the petroleum industry fiscal regime and Licensing and regulatory regime for energy sector.

3 Petroleum and gas resources are finite.

4 Inadequate policy for sustainable utilization of petroleum revenue and its management.

5 The lower wellhead price of natural gas is caused either by having to compete with lower cost alternative fuels in the domestic market or as a result of lower netback prices into the export markets and longer project lead times which makes it extremely challenging to economically develop a natural gas industry based on oil-based fiscal terms.

6 High cost of gas transportation infrastructure to support gas discovery and development both offshore and onshore.

7 Inability to disaggregate into component elements of supply chain e.g. cost of wholesale gas, transportation and distribution in order to price the gas.

8 Lack of Gas Master Plan and Strategy.

3.2.3 Policies and Strategies - Petroleum Upstream

1 Necessary amendments to be made to the existing legislations (especially Oil and Gas Act and the ICCC Act) governing hydrocarbons to ensure that no vertical integration takes place in the investment, extraction, processing distribution and transportation of hydrocarbons for all new Petroleum projects.

2 Establish a petroleum upstream licensing entity to be known as the Petroleum Resource Authority following the separation of petroleum and energy functions due to the separation of the Ministry of Petroleum and Energy.

3 Develop a policy on management of commercial discoveries of petroleum resources.

4 Actively promote investment in exploration activity.

5 Introduce model Production Sharing Contracts (PSC).

6 Continuation of petroleum and gas agreements but with fiscal terms taken out and included in the general legislation.

7 Cash bidding for the unallocated, relinquished and surrendered exploration acreage.

8 Contracting out of early stage geological survey work, financed out of proceeds of cash bidding for exploration acreage or through permits for scientific investigation.

9 Review the *Oil & Gas Act 1998 (OGA 1998)* to incorporate industry best practice adapted to fit local conditions. The revised Act shall provide for gas sharing terms, compensation, windfall profits, royalties and Corporate Social Responsibility, licensing rounds; community awareness and participation; windfall profits; bonuses as may be applicable; government

share out of monetary gains, environmental protection; conservation and management; sharing of benefits mechanism between the National, Provincial and Local Level Governments and local community; payment of royalty on gross oil produced; local content requirement. The revised Act will cover new entrant into the Petroleum sector and not those existing players operating under the current regime.

10 Develop mechanisms for sharing and management of petroleum benefits in line with the Extractive Industries Transparency Initiative (EITI).

11 Strengthen monetary and fiscal regimes to maximize the Government's take on petroleum exploration while taking into account the investors' interests.

12 Provide incentives for investments in marginal oil and gas discoveries that could have the potential to deliver much financial and socio- economic value.

13 Develop Local Content Policy that covers technology and knowledge transfer, capacity building of local industry and local employment opportunities as well as laws and regulations to govern local content implementation.

14 Ensure that petroleum exploration and production activities shall include technology transfer and development of local manpower including engaging qualified local personnel as a priority.

15 Enhance manpower and technical capacity in petroleum exploration by establishing programmes in conjunction with local industry associations, local and international training institutions.

16 Support local investors that have the financial capacity and interest to participate in and/or undertake petroleum exploration and production.

17 Support collaboration and synergy by government owned agencies keen to participate in petroleum exploration and production.

18 Develop oil and gas infrastructure such as crude oil pipelines and storage tanks through PPP and JV arrangements where appropriate.

19 Develop a comprehensive Oil & Gas Master Plan; promote the intensification of exploration activities; enhance the utilisation of local capacity in oil exploration; upgrade local access to cutting edge' exploration technology; commence commercial production of petroleum.

20 To facilitate efficient use of capital and Government oversight a segmented fiscal structure covering the upstream, midstream and downstream shall be adopted. The upstream shall be subject to the proposed PSC regime while the midstream and downstream activities shall be held in separate entities outside the PSC and subject to the ITA 1959 on corporate taxation governance principles.

21 Adopt a transfer pricing mechanism to address the possibility of tax avoidance by affiliated parties in the gas value chain based on international best practice guidelines for transfer pricing for all new petroleum and gas projects.

22 Provide mechanisms for commercialization of gas taking into account elements of supply chain which shall consider the value of natural gas upon discovery, development, processing and the market for end products in order to determine the pricing.

23 Undertake measures to fast track commercial gas discovery including CBM and Shale Gas.

24 In the event of discovery of crude oil together with natural gas, companies should endeavour to ensure that secondary measures are instituted to exhaustively produce from such wells.

25 Flaring of natural gas must be regulated by way of formulating a gas flaring policy and regulation.

26 Offer more favourable fiscal terms for natural gas including more favourable profit splits as an incentive for natural gas exploration and development.

3.3 MIDSTREAM AND DOWNSTREAM PETROLEUM

3.3.1 Petroleum Demand and Consumption

1 The average consumption of petroleum products in Papua New Guinea has been increasing over the years. Some of the factors that explain this increase in consumption include GDP growth, electrical energy demand, population growth, urban population growth and increase in motorization and air transport.

2 Demand for petroleum products is projected to rise in line with the boom in economic activities triggered by the PNG LNG project.

3.3.2 Petroleum Supply and Distribution

1 The world economy emerged from the recession experienced in 2009 recording a significant growth of 4.6% in 2010. This influenced world oil demand and supply.

2 In 2011 oil prices fluctuated rapidly with the lowest at US$ 95.60 per barrel in January, peaking in April at US$ 120 per barrel and averaging at more than US$110 per barrel most of the year. In 2012 the average oil price went up by 3.1% to US$112.97 per barrel.

3 The rapid prices changes were mainly attributed to strong global demand, appreciation of the dollar and the unrest in the Middle East and North Africa. High international oil prices in the past and a weak PNG Kina have led to spikes in prices of petroleum products in the domestic market.

3.3.3 Petroleum Infrastructure Issues

1 Sufficient and efficient infrastructural systems are key to ensuring adequate, reliable and cost effective production and supply of petroleum products. The increase in local and regional demand for petroleum products has not been matched by the development of the infrastructure to meet supply chain and market demands.

2 In addition, the volatile international prices of petroleum products and the volatile foreign exchange rates have led to unpredictable consumer prices, more so in the local pump prices. From 2010 the resulting cost-push inflation has led to unsustainable increase in the cost of living.

3.3.4 Import/Offloading Facilities at Napa Napa

1 PNG's only oil refinery, the Napa Napa oil refinery located outside of Port Moresby has a processing capacity of about 36,000 barrels a day. By industry standards, this is a very small refinery. The refinery currently imports both crude oil and refined petroleum products. Currently the refinery is not operational.

2 The State would like to encourage competition in the petroleum fuels market, hence competition in the entire value chain of the fuels market from refinery to retailing will be promoted.

3 The State shall use its best endeavours to secure domestically produced crude at Kina price as feedstock to transfer cost benefits to the national economy.

3.3.4.1 Storage Facilities at Napa Napa

1) Napa Napa has a storage capacity of 750,000 barrels of crude feedstock and approximately 1.1 million barrels of refined products while its operational capacity is 35,000 bpd. This comprises Jet A1, diesel and gasoline. This capacity is adequate for domestic demand of petroleum products but the refinery currently imports some refined petroleum products as it often produces at below capacity. Currently the refinery is not operational.

3.3.4.2 Strategic Petroleum Reserves

1) The State recognizes the critical need to put in place energy security mechanisms, particularly with respect to refined fuels and therefore will address issues pertaining to feedstock, refinery capacity, storage and efficiency.

3.3.5 Petroleum Refining

1 The Puma Energy - owned Napa Napa Oil refinery was at one stage refining 36,000 bpd of crude oil. The refinery produces Jet A-1, diesel and gasoline. The State is determined to encourage competition in the oil refinery sector in order to achieve efficiency and low unit cost of production, which should be transferred to the end users and this is fundamentally crucial for the Government in growing the national economy. Currently the refinery is not operational.

2 The State would encourage local refineries to purchase domestically produced crude and that the price of feedstock crude shall be equivalent to cost of production and transportation plus a 10 percent margin.

3.3.6 Petroleum Transportation

3.3.6.1 Pipeline

1) Oil and Gas pipelines as well as processing and storage facilities are very important national infrastructures.

2) *The Oil and Gas Act 1998* provides for Third Party Access in major oil and gas pipelines, particularly pipelines which have a capacity of 30 inches and over, hence a project developer must make provision for excess capacity to be made available in the system.

3.3.6.2 Sea Transport

1) PNG's LNG sector has a huge potential for expansion and the Government's desire is to maximise PNG's benefits by encouraging State Owned Companies and Nationally Owned Companies to participate in each segment of the LNG value chain including LNG tankers.

2) Being a marine nation, sea transport is a vital part of life in PNG and the Government's desire is to create an environment where the cost structure of business in PNG is reduced including the cost of sea transportation.

3.3.6.3 Road Transport

1) Road transport will continue to play a vital role in the distribution of petroleum refined fuels in PNG and the Government recognizes the importance of making transportation less costly by addressing elements which add to increased cost of business such as bad roads and high cost of fuel.

3.3.7 Oil Marketing Companies (OMC)

1 Puma Energy, since taking over InterOil's refining assets in Papua New Guinea is the major licensed OMC allowed to import and market crude and petroleum products in Papua New Guinea. There are two more OMCs in the market, Niugini Oil Company and Mobil Oil Limited and now Total.

2 InterOil retail and wholesale distribution business distributes diesel, jet fuel, gasoline, kerosene and fuel oil as well as Shell and BP branded commercial and industrial lubricants such as engine and hydraulic oils.

3 Mobil, Puma and Total own and operate large terminals and depots throughout Papua New Guinea. InterOil supplies Jet A1 fuel to Aviation companies.

4 In addition to their wholesale distribution networks, both Mobil and InterOil run retail service stations networks throughout the country.

5 Puma owns eleven (11) airfield operations in Papua New Guinea located on or adjacent to selected airports/airstrips. Customers include the following; the National Government carrier, commercial passenger airlines, mining and exploration and independent airline operators.

6 The current Service Agreement between Puma Energy and GoPNG is under review to allow in additional competitors.

7 The Government endeavours to create a level playing field for OMCs to compete fairly so that the market forces of supply and demand will set the true economic price for refined petroleum products.

3.3.8 Regulated Industry/Regulatory Contracts

1 The retailed petroleum refined fuels market is regulated but there are imbalances in the market, hence making the cost of fuel in PNG very expensive.

2 The Government is determined to ensure the market is regulated properly in a manner where the suppliers are able to make a reasonable return on their investment while the consumers in PNG including ordinary citizens and SMEs benefit from low unit cost of fuels.

3.3.9 Global Geo - Political Issues

1 On the international scene, crude oil prices have been on a continuous and gradual increase before plunging in July 2014. There are a number of geo-political issues that affect the oil prices in the international scene not only in recent years but also in the past. The recent plummeting in crude oil prices are in one way or another influenced by factors or events such as a slowdown in China's economy, the unrest in the Middle East, the lifting of economic sanctions over Iran, reduction in production by OPEC, piracy in the Indian Ocean, increased tension between the USA and Russia over the Ukrainian/Russian conflict, increased demand for petroleum products worldwide, foreign exchange fluctuations and fluctuations in the USA strategic reserves.

2 This fluctuation of the international prices has caused shocks to domestic petroleum prices.

3 Imported petroleum products are paid for in US Dollars. Fluctuation of the exchange rate against the US Dollar shows an overall gradual depreciation. The depreciation of the Papua New Guinea Kina against US Dollar negates any drop in international crude oil prices and makes imports more expensive.

4 Other major costs that impact consumer prices are taxes and levies on petroleum products.

5 Other costs which have increased are the transportation and distribution costs and the allowed marketer's margin to cover overheads and profit.

3.3.10 Challenges in the Mid and Downstream Petroleum

1 Out-dated refinery:

a] Higher than normal fuel and loss performance because of Tops recirculation;

b] Programme yield is based on test run conditions (i.e. under controlled condition for a day, neat crude processing and without any upsets) which may not ordinarily be achieved.

c] High sulphur levels have adverse impacts on the environment and health. Diesel sulphur specification is becoming stringent world-wide for cleaner environment.

2 Frequent power interruptions.

3 Inadequate infrastructure for storage and evacuation of petroleum products.

4 High initial cost of acquiring the necessary infrastructure.

5 Lack of proper planning and coordination of petroleum infrastructure.

6 Lack of a petroleum (oil and gas) master plan.

7 Whereas spot buying has various advantages, it exposes the country to price volatility and unreliability as opposed to long term supply contracts which come with price stability and reliability.

8 Inadequate competition.

9 High prices of petroleum products.

10 Adulteration of petroleum products.

11 Lack of centralized gas reticulation infrastructure to homes.

3.3.11 Strategies in Midstream and Downstream Petroleum

1 Necessary amendments to be made to the existing legislations (especially Oil and Gas Act and the ICCC Act) governing hydrocarbons to ensure that no vertical integration takes place in the investment, extraction, distribution and transportation of hydrocarbons for all new Petroleum projects.

2 Provide a legal and regulatory framework for midstream petroleum and gas infrastructure including third party access at reasonable terms and conditions. Government to co-ordinate energy infrastructure development which are interlinked to facilitate efficient utilization of petroleum resources.

3 Facilitate KPHL's role of stabilizing the market/prices by using appropriate measures including market presence and importation of at least 30% of the country's LPG demand.

4 Introduce incentives to attract investment in retail networks in the remote areas of the country.

5 Enhance consumption of LPG, being an environmentally friendly and economic modern fuel by:

a] Constructing import handling, storage and distribution facilities.

b] Providing fiscal incentives on LPG and related appliances.

c] Encouraging private sector investment in additional capacity for handling and storage of LPG.

6 Enforce minimum construction and operation standards for retail and wholesale dispensing sites.

7 Creation and Provision for Strategic Petroleum Reserves in the *Oil & Gas Act1998.*

8 Provide appropriate incentives to facilitate and support public and private investments in the development of petroleum infrastructure including petroleum jetties, gas filling terminals, loading and storage facilities in all parts of the country at least cost.

9 Construct petroleum storage facilities at appropriate locations to meet 30 days of operational stocks and 90 days of strategic reserve stocks.

10 Petroleum products quality to be reviewed occasionally to align them with international standards by enhancing institutional capacity in Papua New Guinea's National Institute of Standards & Industrial Technology (NISIT) to enforce compliance with fuel quality specifications for both domestic import and export market.

11 The Government may facilitate KPHL to procure the ninety days petroleum strategic reserve stock.

12 The Government shall fast track the development of new refineries to enhance petroleum refinery capacity in the country.

13 The Government shall facilitate and support public and private investments in off-loading, storage, transportation and evacuation infrastructure for adequate supply and distribution of petroleum products.

14 The Government shall establish mechanisms to ensure stable power supply to support petroleum business.

15 Government shall where necessary cushion Papua New Guinean consumers from the negative effect of high petroleum prices.

16 Assess the continuing feasibility of pump price regulation.

17 Introduce measures including incentives to increase distribution and consumption of LPG.

18 Provide incentives for investment in centralized gas reticulation systems.

19 Transportation of petroleum products by road to be restricted where other cheaper and safer modes of transportation are available.

20 The Government shall put enabling mechanisms to allow KPHL apply its expertise regionally in petroleum infrastructure development.

3.4 MID AND DOWNSTREAM NATURAL GAS

3.4.1 Background

1 Natural gas has the potential of meeting future energy needs of the country and offers a number of significant environmental benefits over other fossil fuels mainly due to its chemical simplicity that burns cleaner than all other fossil fuels.

2 The country could harness some of the indigenous gas to meet the growing energy requirements of the country and would seek to reduce reliance on imports.

3 The monetization of natural gas especially in marketing and distribution is frequently more complex than the commercialization of hydrocarbon liquid reserves as demonstrated in the PNG LNG Project. Frequently, investments will be required in interrelated links in the supply chain including upstream, midstream, downstream and consumption facilities.

3.4.2 Utilization

1 **Electric Power Generation:** The main use of natural gas is through gas-fired power generation, preferably Combined Cycle Gas Turbines (CCGT) to ensure maximum efficiency. Generation of power through gas fired plants have several advantages over other fossil fuelled power plants in that they have much lower environmental impact. Natural gas pipelines would need to be constructed from the field to the power plant or from the LNG processing facilities or import pipeline (should one ever be required).

2 **Industrial:** The following industries are potentially economically feasible when sufficient quantities of natural gas are available at reasonable cost (after considering the import parity price of end-product concerned).

a] Manufacture of ammonia for fertilizer production. More than 97% of the world's strategic fertilizer is produced from synthetically produced ammonia derived from natural gas. The natural gas is both a feedstock and fuel.

b] Manufacture of fuel additives, plastics detergents, formaldehyde are among others.

c] Manufacture of Steel through the modern Direct Reduced Iron method which directly removes oxygen by reacting the ore with a hydrogen-rich and CO-rich gas produced by catalysing methane derived from natural gas. The natural gas is both a feedstock and fuel,

d] Manufacture of construction materials.

3 **Gas** to **Liquids:** This application is used to produce diesel and other fuels. However the technology for Gas to Liquids (GTL) has not yet been commercially proven and therefore shall not be an option until such technologies are well developed and available at reasonable cost.

4 **Transport:** Compressed Natural Gas (CNG) is methane pressured at 200 to 250 bars (2900 to 3500 psi) at which it is stored and distributed. In this case, Methane is compressed to

less than 1 % of the volume it occupies at standard atmospheric pressure. CNG technology shall be applied in PNG for transport where economic relative to alternatives.

5 **Commercial and domestic use:** The Government shall initiate pilot projects for residential domestic and commercial purposes for space heating, water heating, cooking, and street lighting. Networks shall be developed for supplying residential and commercial consumers with clean and reliable natural gas.

3.4.3 Challenges

1 Lack of economic, legal, regulatory and fiscal framework to facilitate the export options as the easiest and quickest option to monetize natural gas discoveries.

2 Lack of facilities that are economic to exploit natural gas reserves e.g. power plants, petrochemical plants and fertilizer plants.

3 Lack of infrastructure for supply to commercial, industrial and residential consumers.

4 Lack of a Gas Master Plan.

3.4.4 Strategies - Mid and Downstream Natural Gas

1 Necessary amendments to be made to the existing legislations (especially Oil and Gas Act and the ICCC Act) governing hydrocarbons to ensure that no vertical integration takes place in the investment, extraction, distribution and transportation of hydrocarbons for all new petroleum projects.

2 Develop a Gas Master Plan and policy that identifies priority domestic sectors for gas utilization, provided sufficient volumes are discovered. This will allow gas to be separated and exported at international market prices.

3 Develop a Standard Gas Project Agreement template.

4 Develop the gas sector by: ensuring the safe supply of gas to end users; attracting investment in the sector by establishing a transparent and efficient legislative framework; promoting private sector participation in all parts of the gas value chain and establishing a regulatory framework on Economic Regulation, Negotiated Access and Operational Regulation according to international norms.

5 Adopt a segmented fiscal structure covering the upstream, midstream and downstream segments to facilitate efficient use of capital and Government oversight.

6 Facilitate industries to exploit supplies of natural gas based on market studies of priority markets, based on their economic merits for PNG.

7 Initiate networks to supply residential and commercial consumers with clean and reliable natural gas where cost competitive with alternatives.

8 For Gas to Liquids the policy shall be to allow the technology to be commercially proven before adoption locally.

9 CNG technology shall be applied for transport starting with public transport initially on pilot basis in areas with a cost-effective supply of natural gas.

10 Carry out studies for overall gas demand in the country to facilitate planning.

11 Establish a regulatory framework for the midstream and downstream natural gas sector.

12 Develop the Domestic Gas Reservation Policy.

3.5 CLEAN COAL RESOURCES

3.5.1 Overview

1 Coal is a combustible rock containing more than 50% by weight and more than 70% by volume of carbonaceous material formed from compaction of variously altered plant remains. It is used as a source of energy mainly for electricity generation. It is amongst the most affordable fuel worldwide and has a potential to become the most reliable and easily accessible energy source. However, the true cost is not known until transport and processing economics (to the end market) have been assessed relative to alternative sources of fuel.

2 The introduction of Clean Coal Technology (CCT) in 'coal fired' power plants reduces emissions and extracts sulphur for other applications such as chemical and fertilizer production while capturing carbon for storage (CCS). However, this may still be substantially higher than alternatives. Current world coal energy consumption by sector is 42% electricity, 25% industrial and 4% other uses.

3 The country has adequate coal deposits for commercial exploration and the Government is fast tracking exploration, economic assessment and development of the resource for potential power generation and industrial use.

4 Interest in coal has also increased recently in PNG with prospectors securing dozens of new coal exploration permits starting in early 2011. Australian based Waterford is investigating coal shale long the Sepik and the Ramu basin in the northeast of the country, while other attention has also been shown in the Gulf basin in the southwest. Having completed initial exploratory efforts, the results are now being analysed and expected to be submitted to the Mineral Resources Authority (MRA) by mid 2012.

5 Since PNG is a signatory to the COP 21 Agreement, consideration on the use of coal as a source of energy to generate electricity is considered with caution. However, with technological advancement, clean coal will be considered for base load power to support projects of national significance that have large power requirement.

3.5.2 Demand for Coal

1 In Papua New Guinea, there is a demand for coal for cheap and alternative electricity generation. Clean coal has been considered an alternative option for base-load electricity generation in PNG and thus its domestic demand may be expected to rise with introduction of the technology, subject to cost competiveness versus other fuel sources and after factoring in transport and conversion costs.

2 Domestic consumption is expected with the discovery of coal deposits by Mayur Resources[3], in the Gulf Province and other parts of the country.

3 Global demand for coal is also challenged.

3.5.3 Coal Upstream Development

1 There are potentially commercially viable coal reserves in the Gulf Province.

2 Coal reserves there are yet to be confirmed.

3 Further exploration for coal is being carried out in other parts of the country.

3.5.4 Challenges in Coal Exploration

1 Limited skills and expertise in core drilling disciplines.

2 Limited coal reserve data due to low intensity of exploration.

3 Poor infrastructure; coal resources are mostly situated in remote areas where there is lack of developed road, water, communication and electricity.

4 Lack of interest by major coal exploration companies due to limited technical data.

5 Absence of a legal, fiscal and regulatory framework for coal exploration, exploitation and development.

6 Lack of a special purpose vehicle to spearhead exploration, assessment and development of coal resources.

3.5.5 Coal Mid and Downstream Development

1 There are no coal fired power plants in PNG as yet.

2 The Government will encourage clean-energy technology for the development and consumption of coal in the country.

[3]*Mayur Resources is a privately held company with one of the largest tenement holdings in PNG;this comprises a pipeline of exploration and development projects, across a diversified portfolio including Coal, Iron sands, Copper & Gold.*

3.5.6 Challenges in Coal Mid and Downstream

1 Inadequate technical capacity for coal mid and downstream activities.

2 Absence of standards relating to import and export of coal handling facilities.

3 Underdeveloped road transportation system.

4 Undeveloped processing facilities for coal.

5 Insufficient power supply in the coal field.

6 Undeveloped capacity to store and evacuate coat products.

7 High initial cost of acquiring the necessary infrastructure.

8 High transportation cost from the processor to end user.

9 High emissions industry relative to alternative fuels readily available in PNG.

3.5.7 Strategies - Coal (Upstream, Midstream and Downstream)

1 Necessary amendments to be made to the existing legislations (especially *Oil and Gas Act 1998 and the ICCC Act 2002)* governing hydrocarbons to ensure that no vertical integration takes place in the investment, extraction, distribution and transportation of hydrocarbons for all new petroleum projects.

2 Develop a standard Model Mining Development Contract (MMDC) and or alternatively Mining Code for Coal (MCC) and other minerals.

3 Continuation of resource development agreements/mining development contracts but with fiscal terms taken out and included in general legislation.

4 Cash bidding for unallocated, relinquished and surrendered exploration acreage.

5 Contracting out early-stage geological survey work, financed out of proceeds of cash bidding for exploration acreage.

6 Develop local expertise and enhance local content in coal exploration and production through training and collaboration with exploration companies, training and research institutions.

7 Create appropriate legal, fiscal and regulatory framework for coal exploration, exploitation and development.

8 Establish coal energy research centre within the proposed national energy institute capable of handling coal analysis and other related studies.

9 Adapt clean coal technology and provide appropriate fiscal incentives.

10 Create new coal exploration blocks based on technical data.

11 Enhance regional co-operation in data and information exchange for coal exploration.

12 Papua New Guinea's State Owned Entities shall maximise the utilisation of available transport modes and do the feasibility of Rail Transport for transportation of clean coal products.

13 Enhance budgetary support for exploration and development of coal resources.

14 Encourage private sector participation in coal exploration, mining, development and use through PPP and JV arrangements by providing appropriate incentives.

15 Construct necessary infrastructure to support coal industry, including provision for handling import and export of coal.

16 Intensify coal exploration activities by upgrading exploration technology and mobilizing resources.

17 Test the economic, environmental, social advantage of the development of a 10 MW coal fired plant in Port Moresby and development of other coal fired plants in other feasible sites in the country where proved attractive against alternatives.

18 If commercially and environmentally attractive develop an integrated infrastructure for coal storage, transportation and utilization to facilitate development of the coal industry.

19 Incentivize those Provincial and Local Level Governments with coal deposits to develop infrastructure in potential coal mining sites to encourage investments in coal mining.

20 Put in place mechanisms of sharing of revenue to ensure that the local community benefit from the development of the resource.

21 Ensure compliance with the best coal industry practice in exploration, mining, processing, development and rehabilitation.

22 Ensure that all coal development activities are clearly documented and communicated to the Chief Secretary and the respective Provincial and Local Level Governments including the relevant stakeholder agencies concerned.

3.5.8 Cross Cutting Strategies in Fossil Fuels

1 Adopt and implement the Extractive Industries Transparency Initiative (EITI) principles (governance, increasing scrutiny over revenue collection from oil and gas) as a demonstration of its commitment to coal resources and improving the country's investment climate.

2 Enhance infrastructure development for fossil fuels.

3 Adopt clean technologies in exploration, exploitation and development of fossil fuels.

4 Develop frameworks and methodologies for determining the oil, gas and coal resource reserves, reporting fossil fuel discoveries and provide penalties for falsification of data.

5 Government shall classify strategic energy installations such as oil and gas fields, coal mines, refineries, jetties, pipeline systems, petroleum, storage facilities as protected areas and provide security during construction and operation.

4 RENEWABLE ENERGY

4.1 BACKGROUND

1 PNG is endowed with abundant renewable energy resources. Over 80% of the country's population is without access to electricity. Out of the 80%, only 7% are within 1km radius of the grid. Given the topography and settlement patterns of people, 75% of the population will be electrified by grid and 25% by off-grid electrification through National Electricity Roll Out Plan (NEROP). PNG has significant underutilized indigenous energy sources such hydro, biomass, natural gas, geothermal, solar-based systems and wind. Development of these resources would accelerate PNG's potential to enhance electrification rate, energy production and export (where possible) and sustain economic growth.

2 Renewable energy is a naturally occurring non-depletable sources of energy such as hydro, solar, wind, geothermal, tidal wave, ocean current, biofuel and biomass to produce electricity, gases and liquid fuels, heat or a combination of these energy types. Some of these renewable energies such as wind and biomass have been used for thousands of years.

3 Current consumer energy in PNG mostly depends on three main fuels; hydro, oil and biomass. In terms of primary energy supply in 2011 oil products accounted for approximately 57%, biomass 37% and hydro, gas and geothermal power the remaining 6%. The energy sector accounts for 14% of the country's GDP.

4 With the developments of renewable energy technologies, these renewable energy sources can be used to generate electricity. Taking into account the sustainable character of the majority of renewable energy technologies, they are able to improve use of these resources, promote energy security and diversify energy supply with minimum environmental impact.

5 PNG is a net oil importer but there is considerable potential over the medium term for reduction in oil imports. The development of the renewable energy sector requires investment to reshape the future energy mix, reduce the current volume of oil imports and address energy security. For instance, adequate investment in hydro power with potential of 15,000 MW of electricity will significantly address the energy needs of PNG. This requires significant policy interventions and specialized business entities focusing on renewable energy to materialize the dreams of the Vision 2050 relating to energy.

6 Policy interventions, increased investment, specialised business entities and appropriate technologies are needed to harness renewable energy sources to accelerate electrification in off grid and rural areas.

7 The PNG Vision 2050 asserts that by the year 2050 PNG will be 100% powered by renewable energy sources at the backdrop of our aspirational policy. PNG is at the crossroads and must now more than ever promote and develop our natural energy resources towards sustainable economic growth.

8 Major energy impact projects have played a significant role in the development of nations both in terms of domestic energy needs and export of energy. In terms of energy exports there will be concerted efforts made to implement the existing arrangements entered into with neighbouring countries and

explore other future arrangement for export of excess energy. For example, the proposed Purari Hydropower is a major impact project and when developed will produce least cost energy to drive industrial growth in the country with excess power exported to neighbouring countries.

9 The strategy under this policy is to identify and develop other major impact energy projects throughout the country. One of the roles of the National Energy Authority (NEA) to be established through this policy will be to oversee feasibility studies and implementation of major energy projects.

10 Appropriate institutions will be established under the policy to develop specific energy sources in line with commercial best practices.

11 The delivery of major energy projects will require concerted multi-agency approach in supporting and providing necessary approvals to avoid lengthy and costly delays currently experienced by major project developers and investors.

12 The technical feasibility studies identified Wabo as the preferred site for the construction of a dam with a capacity to produce up to 2,500 MW of power. This level of generation has the potential to propel industrial development in PNG, supply consumers in Port Moresby and the Ramu power systems as well as the potential to export excess power to Australia and Indonesia. However, it might be the most expensive project ever undertaken in PNG and large scale hydro is seldom seen as renewable, given resulting long term methane emissions from flooded and rotting vegetation.

13 The State should be actively involved in the development of renewable energy resource for the following reasons:

a] To ensure the achievement of the Vision 2050 goal of 100% electricity access to all consumers.

b] To ensure that there are adequate returns on investment from renewable energy projects.

c] To ensure investment in renewable energy projects benefit the country as well as the resource owners equitably.

14 State commercial participation in the development of renewable energy projects. The level of State participation:

a] Up to 10 MW is reserved for State investment including National Government, Provincial Governments, LLGs and landowners.

b] Beyond 10 MW the State has the option to participate ranging from 20 - 40 percent.

15 The launch of the National Biofuel Policy Consultation Workshop in 2014 and the drive to develop a Biofuel Policy by the Department of Public Enterprises (DPE) is also a step in the right direction to meaningfully utilise PNG's renewable energy resources under the auspices of the government's 'Green Growth Strategy'. The Workshop findings revealed that the growth of biofuels in PNG in recent years has been spurred by increasing prices of fossil fuels, the need to survive financially in business, environmental concerns and unreliable supply of energy. Biofuels are also viewed as a potential means to stimulate rural development and create employment opportunities. The thrust of the Biofuel Policy would be to facilitate and bring about optimal development and utilization of indigenous biomass feedstock for production of biofuels.

4.2 GEOTHERMAL ENERGY

4.2.1 Background

1 Below the earth's crust there is a layer of hot and molten rock called magma. Heat is continually produced mostly from the decay of naturally radioactive materials such as uranium and potassium. The amount of heat within 10,000 metres of the earth's surface contains 50,000 times more energy than all the oil and natural gas resources in the world. Four types of geothermal energy are usually distinguished:

a] Hydrothermal - Hot water or steam at moderate depths (100 - 4500 meters).

b] Geopressed - Hot water aquifers containing dissolved methane under high pressure at depths of 3 - 6 kilometers.

c] Hot dry rock - Abnormally hot geologic formations with little or no water.

d] Magma - Molten rock at temperatures of 700 - 1200 degrees celsius.

Currently, hydrothermal resources are used on a commercial scale for electricity generation and as a direct heat source.

2 The areas with the highest underground temperatures are in regions with active or geological young volcanoes. These occur at plate boundaries or at places where the crust is thin enough to let the heat through.

3 Papua New Guinea is situated on the "Pacific Ring of Fire", a seismically active zone. Known seismic active zones are in the New Guinea Islands Region and the Northern Coast of the Mainland. The Gazelle Peninsula and Talasea are known areas for geothermal activity. Incidentally they also contain viable commercial quantities of geothermal energy reserves.

4 The only commercially known use of this energy source in the country is on Lihir Island where a plant uses the energy to supply power to the mining operations at the Lihir Gold Mine. However, this resource is seen as declining and increasingly unreliable for baseload generation.

5 Geothermal power plants use steam or hot water from a natural underground reservoir to generate electrical energy and heat for other industrial applications. Other uses of geothermal energy include:

a] Dairy industry - refrigeration and pasteurization of milk products;

b] Grain Silos - drying of grains (wheat and maize) and other farm products such as pyrethrum;

c] Space heating and cooling - green houses, residential houses, hotels and other buildings;

d] Industry - production of industrial sulphur, treatment of hides and skins and honey processing.

e] Water heating for fish and crocodile farming, spa and swimming pool.

6 The Geothermal Energy Policy shall be developed by the National Energy Authority (NEA).

4.2.2 Challenges

1 Relatively long lead time of between 5 - 7 years from conception to production of electricity (similar to oil and gas exploration).

2 Geothermal projects typically progress through stages of reconnaissance, surface exploration, feasibility study, exploratory drilling, appraisal drilling, production drilling, steam field development and power plant construction stages which normally involve high upfront investment costs.

3 High resource development risks due to difference in pressure, temperature as well as imminent seismic activities.

4 Inadequate geothermal expertise and expensive technology.

5 Remote location, siting restrictions and long distances to existing load centres necessitating heavy investment in transmission and other support infrastructure.

6 Competing and conflicting interests in use of land and natural energy resources by various sectors of the economy.

7 Relocation and resettlement of affected persons during geothermal development.

4.2.3 Strategies - Geothermal Energy

1 The Government will continue to support and facilitate the public sector as well as encourage the private sector to invest in geothermal subsector through various means including PPP and Joint Venture arrangements.

2 The Government will promote research development and dissemination and capacity building for geothermal development through provision of fiscal and other incentives.

3 The Government shall streamline licensing and allocations of geothermal tenements.

4 Promote and encourage direct uses of geothermal resources such as utilization of heat, water, gases and minerals.

5 Utilize the best available technologies that optimise the resource and conserve the reservoir such as binary generation and bottoming cycles.

6 The developer of a geothermal field shall guarantee geothermal steam supply for the contract term of the plant.

7 Promote early geothermal generation through implementation of efficient modular geothermal wellhead technologies.

8 Undertake further geothermal resource assessments to determine additional economically viable geothermal resources.

9 Increase Government allocation of funds for geothermal policy development and programs.

10 The specific details of the Geothermal Energy Policy to be developed by the NEA.

11 The specific legislation to regulate Geothermal Resource to be developed by the NEA.

4.3 HYDRO ENERGY

4.3.1 Background

1 Hydro power is electricity generated using the energy of moving water. Rain or melted snow, usually originating in hills and mountains create streams and rivers that eventually run to lakes, seas or oceans. This energy has been used for centuries. In the late 19th century hydro power became a source for generating electricity.

2 A typical hydro plant is a system with three parts: an electric plant where the electricity is produced; a dam that can be opened or closed to control water flow; and a reservoir where water can be stored. The amount of electricity that can be generated depends on how far the water drops and how much water moves through the system.

3 Hydro power is, to date, the most successful form of renewable energy. The amount of electrical energy generated depends upon the quantity of available water. Adverse hydrology can have a devastating effect on an economy that is heavily dependent on hydropower.

4 Papua New Guinea has an estimated hydropower potential of about 15,000 MW comprising large hydros (sites with capacity of more than 10 MW) and small hydros, according to the Shawinigan Report of 1980.

5 There are four major hydro power stations in Papua New Guinea, namely: Rouna (Port Moresby), Yonki (Kainantu), Warangoi (Gazelle) and Baiune (Bulolo). These hydro power stations are critical to the country's socio - economic wellbeing.

4.3.2 LARGE HYDROS

4.3.3 Background

1 PNG has significant potential in large hydro based power generation, given its high rainfall and many large fast flowing rivers systems.

2 There are four (4) major Drainage Basins in the Country; the Strickland-Purari, Fly, Ramu and Sepik River Drainage Basins. The two promising ones for major hydro developments are the Ramu and Strickland-Purari due to their geography and volume.

3 Funding will be required for Government to undertake more feasibility studies to develop large hydros in the country.

4 The Hydro Energy Policy shall be developed by the NEA.

4.3.4 Challenges

1 Hydropower is vulnerable to variations in geology, hydrology, climate and water turbidity (PNG rivers have one of the highest sediments load in the world contributing to turbine silting and high operations and maintenance costs). This is a big challenge as no rain results in power and energy shortfalls, reducing the contribution of hydro power in the energy mix.

2 The economic risk in hydropower projects is relatively higher than other modes of electricity generation because they are capital intensive (very high fixed costs, but low operating and maintenance costs) and wholly dependent on hydrology.

3 A major challenge for hydro power projects requiring dams is relocation and resettlement of affected persons given PNG's customary land tenure arrangement.

4 Long lead time of construction between 7-10 years.

5 Insufficient geological and hydrological data throughout Papua New Guinea and does not capture quality nor cover required periods of at least 50 years.

6 Water charges that have an effect of increasing the cost of hydro generated electricity.

7 Conflicting and competing land and water uses between various sub-sectors of the economy with regard to development and utilization of the same for electricity generation.

8 Ownership of physical dam reservoirs which have stifled redevelopment.

4.3.5 Strategies - Large Hydros

1 Establish an inter-departmental committee comprising relevant stakeholders to draft a policy on large hydro development.

2 Energy conservation and efficiency will be promoted in the design of hydro power plants.

3 Environmental conservation of catchment areas will be promoted to mitigate soil erosion, high sediment loads and land use practices which do not aggravate the surface geology and top soil and cause rapid siltation of dams and river systems. The developer shall be responsible for funding the initiative. Where possible use other alternate hydro generation technologies.

4 The Government shall where possible implement hydro power projects as multi-purpose projects providing power and water needs of consumers. Consideration will also be given to leasing of such projects for operation through long-term concessions.

5 The private sector will be encouraged through Feed-in-Tariff to develop potential sites to generate electricity for their own consumption and for sate to the national grid and export.

6 Provide necessary support for raising funds for the proposed Purari Hydro project.

7 Undertake pre-investment studies on hydro resources to define their technical and economic viability.

4.3.6 Small Hydro Background

1 Classification of hydro by sizes (MW) varies in jurisdictions. Therefore, for our purposes, we categorise most hydro systems within Papua New Guinea to fall under the category of small hydro. Small hydro can range from generating capacity up to 10 MW.

2 PNG's system comprise several small to medium scale hydro ranging from 0.8 MW to 58 MW. Tables 1 and 2 below shows existing and proposed hydro developments.

Table 1. Existing Hydro power plants

Existing Hydropower plants - owned and operated by PPL (176MW)										
	Port Moresby System		Ramu System		Gazelle System		Minor hydros (West New Britain)		Other Initiative	
		Installed Capacity		Installed Capacity		Installed Capacity		Installed Capacity		Installed Capacity
Name	Sirinumu Dam	1 MW	Yonki	75MW	Warangoi	10 MW	Ru Creek	0.8 MW	Privately owned	
	Rouna 2	40 MW	Pauanda	12 MW			Lake Hargy	1.5 MW	Ok Tedi Mine	58 MW
	Rouna 1 & 3	12 MW							PNG Forest products	8 MW
	Rouna 4	24 MW								

Source: PNGPower 20210

Table 2. New and Proposed Hydro power projects

New and proposed Hydro		
Name	**Installed Capacity**	**Status**
Yonki - Toe of Dam (Yonki)	18 MW	Preliminary Site works; PPL
Divune - Popondetta	~4MW	Preliminary Site works; ADB/PPL/DP&E
Ramazon - Buka	~4MW	Preliminary Site works; ADB/PPL/DP&E
Naoro - Brown	~80MW	Feasibility Stage; PPL through PPP
Wabo - Purari	~1800MW	Feasibility Stage; PNG EDL
PHD - Edevu	51MW	Under construction; PHD
PNG FP Bauune	10MW	Feasibility Stage;

Source: PNGPower 20210

3 PNG has significant hydro electric potential with vast rivers, numerous creeks, streams and mountain spring water flows throughout the country that can be harnessed to produce hydro electricity power for the rural population of PNG.

4 The specific details of small hydro as a renewable energy resource will be captured in the Renewable Energy Policy to be produced by the NEA.

4.3.7 Government Actions

1 The upsurge in demand for electrical energy in PNG fuelled by high economic growth provides an exciting potential for investment in the small hydro sector. The Government will endeavour to:

a] Promote investment in infrastructure to make small hydro projects viable.

b] Provide adequate financial resources for feasibility studies.

c] Promote collection and processing of hydrological and geological data.

d] Mitigate and address competing interests between stakeholder's sites (landowner issues).

e] Promote landowner participation in all power infrastructure projects.

4.3.8 Strategies - Small Hydros

1 Promote protection of catchment areas and environment.

2 Provide incentives for public private partnership.

3 Provide incentives to promote the local production and use of efficient small hydro power systems.

4 Formulate and enforce standards, legal and regulatory regimes for small hydros.

5 Promote small micro-enterprises through fiscal incentives to reduce small hydro's start-up costs.

6 Create awareness and disseminate information on the benefits of small hydros and its coexistence with other usages of the resource.

7 Promote development of capacity and knowledge upon the locals on usage of appropriate technologies.

4.4 BIOMASS

4.4.1 Background

1 Biomass is organic matter that can be used to provide heat, make fuel and generate electricity. Wood-fuel, the largest source of biomass has been used to provide heat for thousands of years. Many other types of biomass are also used as an energy source such as plant residue from agriculture or forestry and the organic component of municipal and industrial wastes or newly planted environmentally friendly forest plantations. Landfill gas is also considered a biomass source. Biomass resources can be replenished through cultivation of crops such as fast growing trees and grass.

2 Biomass fuels are the most important source of primary and potentially secondary energy in Papua New Guinea with wood-fuel (firewood, crop residue and charcoal) being the predominant consumer energy fuel.

3 In spite of past efforts to promote wood fuel substitutes, the number of people relying on wood fuel is not decreasing. Consequently, wood fuel will continue to be the primary source of energy for the majority of the rural population and urban poor until affordable alternate sources of energy reduce dependence on firewood.

4 Wood fuel supply management is crucial to ensure sustainable supply to meet the growing demand. Key issues here include: competing land use activities, supply demand balance and the impact of any positive versus environmental impacts from poor management as well as related land and tree tenure issues.

5 The specific details of Biomass as a Renewable Energy resource will be captured in the Renewable Energy Policy to be developed by NEA.

4.4.2 Challenges

1 Unsustainable use of biomass with attendant negative impacts on the environment can lead to local climate variability and unpredictability in rainfall patterns.

2 Emissions from wood fuel in poorly ventilated houses leading to health hazards among residential users.

3 Lack of public awareness on growing fast maturing tree for fuel as an environmentally and commercially viable business.

4 Inadequate data on biomass production and consumption.

5 Disjointed approach in policy implementation by the various ministries and organizations responsible for biomass energy use.

6 Inadequate recognition of biomass as a source of energy despite its predominance in the energy mix.

7 Use of inefficient technologies in production, conversion and consumption of biomass energy.

8 Limited awareness programs aimed at encouraging investment in biomass as a renewable energy.

9 Competing interests over land use between biomass plantations, food production and other commercial uses.

10 Lack of appropriate legal and regulatory framework for sustainable production, distribution and marketing of biomass

4.4.3 Strategies - Biomass

1 Develop and maintain a database on biomass energy resources and potential in PNG.

2 Formulate and implement a national strategy for coordinating subsistence and commercial biomass production.

3 Promote and update standards for efficient conversion and clean utilization of biomass.

4 Promote Research, Development and Dissemination (RD&D) of biomass energy technologies.

5 Undertake capacity building with regard to biomass energy technologies.

6 Provide incentives for private sector participation in generation, exploitation, production, distribution, supply and use of biomass energy.

7 Enhance public participation in the management, protection and conservation of the environment.

8 Collaborate with other relevant ministries and stakeholders to grow and sustain tree cover to above 10%.

9 Collaborate with other stakeholders to ensure efficient use of land resource to minimize the adverse effects arising from competition for land use between biomass energy and food production.

10 Identify and reserve land for use in biomass energy production and undertake awareness programmes to sensitize the landowners and public on the importance of the various land uses such as for biomass, food production and other human needs.

11 Undertake studies to identify and promote the most appropriate biomass energy conversion technologies and implement the recommendations.

12 Promote inter-fuel substitution to reduce the over reliance on wood fuel for residential use, commercial uses and applications.

13 Strengthen existing energy institutions and programs and establish others to cover all provinces with a view to promote efficient biomass energy use.

14 Promote the use of biomass briquettes as alternatives to residential wood fuel and kerosene in cooking, water heating and steam generation.

15 Undertake a comprehensive study with the view to eliminate use of kerosene in households.

16 Prepare, review and update biomass energy development plans.

4.5 BIOFUELS

4.5.1 Background

1 Unlike other renewable sources, biomass can be blended into liquid fuels called biofuels to meet energy needs.

2 The use of biofuels in transportation would reduce vehicle emissions and save on foreign exchange required for importing petroleum fuel, improve on the balance of trade and create employment.

3 A strategy for introduction of biofuel blends in the market is being considered and soon to be developed by the NEA [4].

4 Commercial extraction of biodiesel for blending has already been initiated by several private companies and some institutions such as PAU and PNG Unitech in PNG.

5 Land will need to be set aside for the production of energy crops as feedstock for biofuels. This calls for the formulation of strategies to optimise land use, as well as to harmonise land use policies with the energy policy. Most biofuel projects underway or being planned involve sugarcane, cassava and sweet sorghum as the main feedstock for ethanol, jatropha, castor and other vegetable oil crops such as, coconut, palm oil, croton, peanut and cotton seed for biodiesel.

6 The specific details of a policy on Biofuels as a renewable energy source will be captured in the policy to be developed by NEA.

4.5.2 Challenges

1 inadequate investment in development of biofuels projects.

2 Insufficient feed-stocks to continually produce biofuels.

3 Limited research data/information for the use and production of biofuel.

4 Threat of competition over land use that could lead to food insecurity.

5 Reliance on slow maturing crops and dependence on rain fed agriculture.

6 Inadequate RD&D on alternative biofuel feed-stocks and technologies.

[4]Workshopped in 2014, the Policy and the accompanying NEC Submission is yet to be approved.

7 Lack of knowledge among the public on the viability of growing crops for biofuel as a business.

8 Illegal export and illicit use of ethanol.

9 Insufficient legal and institutional framework to support sustainable generation, utilisation, production, distribution, supply and use of liquid biofuels.

4.5.3 Strategies - Biofuels

1 Prepare legislation, regulations and institutional framework to enhance the sustainable generation, production, distribution, supply and use of liquid biofuels.

2 Support RD&D for the cultivation of high yielding and fast maturing feedstock so as to enhance the production and use of liquid biofuels.

3 Provide fiscal incentives for biofuel production projects, plant, equipment and marketing in so far as such products are used to meet energy demands.

4 Collaborate with other stakeholders to ensure efficient use of land resources to minimize the adverse effects arising from competition for land use between liquid biofuel feedstock and food production.

5 Work with Provincial Governments, DDA's and LLG's to increase economic development through biofuel programmes.

6 Create awareness on the importance and viability of growing biofuel feedstock among the public.

7 Promote joint venturing between government agencies and private sector, (PPP's) on the development and utilisation of biofuels.

8 Encourage and assist farmers to access cheap farm Inputs and high yielding fast maturing biofuel feedstock.

9 Undertake a comprehensive study on the viability of biofuels and map out (resource mapping) potential biofuels production feedstock across all provinces.

10 Government to secure land in potential locations for piloting of biofuel feedstock production and establish appropriate benefit sharing arrangements with land owners.

11 Review the feasibility of gasohol and biodiesel production.

12 Pilot ethanol-gasoline (E-10 Mandate) blend in Government vehicles and in public transport vehicles.

13 Pilot biodiesel blend in Government vehicles and in different blending ratios for use as hybrid fuel at isolated power generation plants.

14 Develop a blueprint and road map for national biofuel implementation programme.

15 Use annual Agricultural Show such as in Lae, Trade Fairs, Workshops, Seminars and Energy Institutions to demonstrate and disseminate information on the importance and viability of growing biofuel feedstock among the public.

16 Provide incentives to encourage all diesel vehicles in the country to use biodiesel.

4.6 BIOGAS

4.6.1 Background

1 Any gas fuel derived from the decay of organic matter such as the mixture of methane and carbon dioxide produced by the bacterial decomposition of sewage, manure, garbage and plant crops.

2 Biogas is considered to be a renewable source of energy. Since it is often produced from materials that form sewage and waste products, the only time it will be depleted is when we stop producing any waste.

3 It is also considered to be non-polluting in nature. The production of biogas does not require oxygen which means that resources are conserved by not using any further fuel.

4 It also uses up waste material found In landfills, dump sites and even farms across the country.

5 Applications for biogas are increasing as the technology improves for its utilization. It can be used to produce electricity and for the purpose of heating and cooking as well. Compressed Natural Gas (CNG) is biogas that has been compressed and can be used as a fuel for vehicles. Production can be carried out through many small plants or one large plant.

6 New Britain Palm Oil Limited and the West New Britain Provincial Government have agreed that electricity generated from the company's waste products across the New Britain Island. Figure 5 below shows the Biogas collection at New Britain Palm Oil Limited's operation in West New Britain.

Figure 5. Biogas plant in New Britain Palm operation.

Source: Business Advantage

7 There is a great opportunity for West New Britain Province to be solely powered by green energy in future years according to New Britain Palm Oil Limited (NBPOL).

8 If the project becomes successful, the Province is likely to become the first to use biogas for its power generation needs.

9 The specific details of Biogas Policy as a Renewable Energy resource will be formulated by NEA.

4.6.2 Challenges

1 Lack of information on the benefits and potential of biogas technology.

2 Lack of RD&D on biogas emerging technologies.

3 High upfront costs of domestic and commercial biogas plant and equipment.

4 Lack of skilled personnel for post installation, operation and maintenance service for plant, equipment and appliances.

5 Lack of clear registration, certification and inspection guidelines for biogas installation contractors.

6 Lack of acceptance of technology.

4.6.3 Strategies - Biogas

1 Create awareness on the benefits and potential of biogas technology.

2 Provide appropriate fiscal incentives for local manufacturers as well as importation of biogas plant and equipment.

3 National and Provincial Governments to initiate capacity building programmes in institutions such as village polytechnics on biogas installation, operation and maintenance skills.

4 Develop guidelines for registration, certification and inspection for contractors and technicians.

5 Promote domestic and community based biogas plants to cater for the urban settlements.

6 Promote large scale production, piping and storage infrastructure for biogas.

7 Use public trade fairs, workshops, seminars and energy institutions to demonstrate and disseminate information on the importance and viability of harnessing biogas feedstock.

8 Promote the use of biogas as an alternative to wood-fuel and kerosene for domestic and commercial energy needs.

9 Develop training programmes for biogas technologies in collaboration with relevant training institutions and through the energy institutions.

10 Undertake a comprehensive study on the viability of bottling and piping of biogas for rural development depending on availability of technology.

11 Roll out Biogas Master Plan to supply public institutions including prisons, schools and hospitals as well as the public across the country.

12 The specific details of Biogas as a Renewable Energy resource will be captured in the Renewable Energy Policy to be formulated by the NEA.

4.7 SOLAR ENERGY

4.7.1 Background

1 Solar energy is the light and heat radiated from the sun that powers earth's climate and supports life. Solar radiation often called the solar resource is a general term for the electromagnetic radiation emitted by the sun. Solar technologies allow control use of this energy resource. Solar radiation can be captured and turned into useful forms of energy such as electricity and heat using variety of technologies. Solar energy is among the largest potential renewable energy resource in Papua New Guinea due to its close proximity to the equator where the country experiences sunshine all year around.

2 Solar photovoltaic (PV) panels are the most common solution for harnessing the sun's energy. The basic building block of a PV system is the solar cell. Thermal systems convert sunlight into thermal energy to produce electricity.

3 Solar PV has spread gradually in PNG over the past 30 years with small independent solar systems marketed by private suppliers and used mainly for lighting and also for communications. From 1998 - 2002 some 3000 solar home lighting systems were sold to individuals. The PNG Telecommunication Company (Telikom PNG) has large number of solar sites with a total capacity of over 200 kWp. The expansion of mobile phone system into rural areas is rapidly increasing solar use for telecommunication and increasing demand for solar powered phone chargers. A PGK 15 million (about USD 11.3 million) Japanese-supported project provided solar electrification for 320 schools in twenty (20) Provinces of the country from 1997 - 1998, however, by 2004 only a few of the panels installed were still operating (IRENA, 2013).

4 The PNG University of Technology (UNITECH) has supported small-scale applied research projects involving solar energy. The latest initiative is the Renewable Energy (Solar and Wind) Resource Mapping project aimed at determining the potential of solar and wind energy to support its development in various locations though out PNG for both utility-scale generation and for village power and other off-grid applications.

5 The specific details of Solar Energy as a Renewable Energy resource shall be captured in the Renewable Energy Policy to be developed by the NEA.

4.7.2 Challenges

1 The need for a coordinated approach in policy development and implementation.

2 The percentage of solar energy harnessed for commercial and domestic applications is insignificant relative to the potential due in part to its cost effectiveness and lack of storage technology in many applications.

3 Solar power systems are expensive and therefore favourable fiscal incentives and appropriate credit and financing mechanism to be supported by the Electricity Trust Fund and other funding sources.

4 Lack of regulations to address the issue of importation of sub-standard systems and follow up of after-sales service.

5 Rampant theft and vandalism of solar photovoltaic panels which discourages their installation.

6 Lack of awareness on the potential opportunities and economic benefits offered by solar technologies.

7 Landowner issues hindering the development of solar farm for power generation.

8 Disposal of battery is harmful to the environment.

4.7.3 Strategies - Solar Energy

1 Promote the wide spread use of cost-effective solar energy through formulation of regulations and standards to be developed as a matter of urgency.

2 Promote the use of solar and hybrid solar systems for domestic, commercial and industrial uses.

3 Provide incentives to promote the local production of solar and hybrid solar systems.

4 Provide a framework for connection of electricity generated from solar energy to national and particularly isolated grids or non-grid solutions through direct sale or net metering.

5 Promote the use of hybrid power generation systems involving solar and other energy sources to manage the effects caused by the intermittent nature and availability of solar energy.

6 Enforce minimum standards for solar energy technologies.

7 Provide for offences and penalties for theft and vandalism of solar systems in the NEA Act and Regulations.

8 Create awareness on the potential opportunities and economic benefits offered by solar energy technologies.

9 Partner with financiers to enable the public access credits schemes.

10 Encourage installation of solar PV systems in all public facilities and in the off grid areas.

11 Promote installation of at least 100,000 units of solar PV home solar systems by 2020 to be considered in the roll-out plan.

12 Develop a programme for hybrid power generation systems involving other energy sources.

13 Develop a programme for raising awareness on requirements for conformity with mandatory regulations for solar water heating systems.

14 Undertake Research Development and Dissemination on solar technologies.

15 Facilitate generation of electricity from solar, among others: funding, setting aside land, fast-tracking issuance of permits and licences as well as acquisition of data and information so as to realise at least 100 MW from solar by 2030.

16 The specific details of the Solar Energy as a Renewable Energy Resources to be developed by the NEA in the near future.

17 The NEA shall draft a new legislation specifically to regulate Solar Energy.

4.8 WIND ENERGY

4.8.1 Background

1 Wind energy uses naturally occurring energy of the wind for practical purposes like generating electricity, charging batteries and pumping water. Large modern wind turbines operate together in wind farms to produce electricity for utilities.

2 With the rising cost of oil, development of wind energy has become more attractive. Substitution of thermal generation with wind power plants will cut down on the large amounts of foreign exchange required to import fossil fuels for the thermal power plants.

3 Further, partial substitution or combining wind with gen-sets (wind-diesel hybrid) and some form of renewable energy storage such as pumped storage in hydropower could cut down on running or overall costs by substituting renewable energy sources for significant amounts of diesel.

4 Using wind energy to substitute thermal generation will also lead to less $C0_2$ emissions thus contributing to reduction in global warming. The carbon credits associated with the reduction of the emissions can be sold as certificates of emission reduction.

5 There is currently a lack of data on potential wind energy resources in the country. Usage of wind energy in the country is limited to pumping of water by windmills on cattle farms or for irrigation. Areas near the coast often experience a good steady flow of wind. The Markham Valley being the largest plain in the Morobe Province is a very ideal location and good area for development of wind farms as well as other valley systems in the country.

6 The specific details of Wind Energy as a Renewable Energy resource shall be captured in the Renewable Energy Policy to be developed by the NEA.

4.8.2 Challenges

1 High upfront costs and lack of storage technology.

2 Lack of wind resource mapping to identify potential areas for wind energy generation.

3 Lack of inadequate wind energy industry standards imposed by fast changing technologies.

4 Lack of in-country experience in dealing with wind energy generation.

5 Competing interest in land and sea based generation with other commercial activities.

6 Lack of Research Development and Dissemination in wind technologies.

4.8.3 Strategies - Wind Energy

1 Enhance the institutional capacity to promote wide spread use of wind energy while enforcing the regulations and standards.

2 The NEA to promote, undertake data acquisition, accelerate exploitation of wind energy and provide a one stop shop for information to investors.

3 Provide incentives to promote the local production and use of efficient wind systems.

4 Promote the use of hybrid power generation systems involving wind and other energy sources.

5 Provide a framework for connection of electricity generated from wind energy to national and isolated grids.

6 Formulate and enforce minimum standards for wind energy technologies.

7 Plan transmission lines to facilitate evacuation of power from areas with high wind potential to major load centres.

8 Encourage Higher Institutions of learning to undertake Research Development and Dissemination (RD&D).

9 Enhance capacity building on wind technologies.

10 Provide fiscal incentives on wind energy projects.

11 Continue wind resource mapping to collect wind energy data to update the wind energy atlas.

12 Facilitate development of wind power generation of at least 100 MW by 2030.

13 Highly skilled personnel are required in implementing wind energy generation systems in keeping up with changing wind energy technology standards.

14 Promote the development of pilot projects on wind energy.

15 The specific details of the Wind Energy will be captured in the Renewable Energy Policy to be developed by the NEA.

4.9 MUNICIPAL WASTE

4.9.1 Background

1 Municipal waste consists of solid waste including durable and non-durable goods, containers, food scraps, yard waste and inorganic waste from homes, institutions and businesses. Also waste generated by manufacturing, agriculture, mining and construction and demolition debris, as well as sludge and liquid waste from water and waste water treatment facilities, septic tanks, sewerage systems and slaughter houses.

2 In order of preference municipal waste can be managed by reduction of its production at source. Reuse or recycling and treatment to destroy or reprocess waste to recover energy for other beneficial resources if the treatment does not threaten public health, safety, the environment or dumping and disposal.

3 Most of the municipal waste in PNG is disposed in poorly managed dump sites. With appropriate waste to energy technologies, municipal waste can be used to provide energy while helping to clean the environment.

4 The current upgrading of the Baruni Waste Dump in the National Capital District funded by the Japanese International Cooperation Agency (JICA) using the Fukuoka Method can be utilised to produce Biogas for commercial use.

5 The specific details of Municipal Waste as a Renewable Energy resource will be captured in the Renewable Energy Policy to be developed by the NEA.

4.9.2 Challenges

1 Lack of legal, regulatory and institutional framework for development.

2 Inadequate data and information on potential of municipal waste.

2 Lack of incentives for development.

4.9.3 Strategies - Municipal Waste

1 In collaboration with the relevant line Departments, develop legal, regulatory and institutional framework to address management and utilisation of municipal waste.

2 In collaboration with Provincial Governments, acquire adequate data and information on potential of municipal waste.

3 Provide incentives for conversion of municipal waste to energy.

4 Roll out Fukuoka Method to other Waste Dump sites in the country's major cities and towns.

4.10 CO-GENERATION

4.10.1 Background

1 Co-generation refers to the simultaneous production of heat and power from one single fuel source. It is common where plant processes require both heat and power such as sugar processing and offers opportunity for improved plant energy efficiency besides reducing energy costs and providing additional revenue stream through surplus power export to the national grid.

2 The co-generation industry is one of the more advanced industries around the world, particularly with Biomass. Bagasse (Sugarcane by-product) is only one potential form of co-generation fuel. Others available in PNG include sustainable wood and other fibres. Technical capacity for biomass co-generation should be understood and deployed.

4.10.2 Challenges

1 Inadequate technical capacity in commercial and emerging co-generation technologies.

2 Lack of awareness in co-generation potential in areas where the agro-waste is available.

3 Inadequate data and documented assessment of resources.

4 Lack of model Power Purchase Agreement (PPA) for co-generated power in PNG.

5 Insufficient information to investors on issues relating to licensing, taxation and Feed in Tariff policy.

4.10.3 Strategies - Biomass Co-generation

1 Accelerate investment in efficient and emerging technologies, including co-generation technology.

2 Promote programmes and projects in production and supply of raw materials such as sugarcane for bagasse.

3 Undertake capacity building programmes in co-generation technologies.

4 Carry out awareness programmes in co-generation potential areas.

5 Carry out a comprehensive study on co-generation potential.

6 Develop a model PPA for co-generation projects.

7 Formulate and implement a national strategy for coordinating development of co-generation.

8 Undertake RD & D in co-generation technologies and encourage manufacture of co-generation technologies.

9 Address governance issues in co-generation.

10 Reduce start-up costs by providing appropriate fiscal incentives.

11 Government to enter into PPP arrangements with the private sector entities to accelerate co-generation.

12 Develop criteria for certification of schemes for co-generation.

4.11 RECOVERED ENERGY GENERATION

1 A waste heat recovery system is an energy recovery heat exchanger that recovers heat energy from hot streams with potential high energy content such as hot flue gases from diesel generation or steam from cooling towers or even from waste water from different cooling processes such as hot steel cooling.

2 A good example of recovered energy generation is the ORMAT's organic rankine cycle. ORMAT recovered energy generation power plants expertise is based on the ORMAT energy converter (OEC). The OEC is based on a thermodynamics process that transfers heat to an organic motive fluid that is vaporized. This fluid has a lower boiling point therefore vaporizes faster. The expansion pressure inside a vapour turbine drives a generator or an additional compressor coupled to the unit.

3 The electricity generation is known as co-generation where the fuel is burnt and the exhaust gases are than piped to recover the heat which is later used to drive another turbine to produce electricity. The recovered energy power plants are environmentally safer and more efficient.

4 Recovered energy also applies to hydrocarbon fuel sources.

4.12 FEED IN TARIFFS

4.12.1 Background

1 A Feed in Tariff (FiT) is an instrument of promoting electricity generation from renewable energy sources. It is also an instrument used to charge tariff for non-renewable energy source generation. It enables power producers to generate and sell Renewable Energy Sources Generated Electricity (RES-E) to a distributor at a pre-determined fixed tariff for a given period of time.

2 The objectives of the FiT Policy are to:

a] Encourage investment in power generation to meet the increasing demand for electricity.

b] Reduce transaction and administrative costs and delays by eliminating the conventional bidding process.

c] Provide a reasonable rate of return to I PP's investors as an incentive to be involved in power generation.

3 The specific details of FiT for Renewable Energy resources will be captured in the Renewable Energy Policy to be developed by the NEA.

4.12.2 Challenges

1 Insufficient data and analytical tools to inform the level of tariffs for different technologies.

2 Lack of awareness on FiT among the potential investors.

3 Uncertainty as to the capacity of PPL to honor its obligation under long term contracts for power purchase.

4 No clear guidelines on PPA negotiations which results in lengthy negotiations.

5 Inadequate technical and financial capacity of some community based projects.

4.12.3 Strategies - Feed in Tariff

1 Undertake a study on the capital expenditures and the operating costs on the different types of technologies and develop sufficient analytical tools to inform the level of tariffs for different technologies.

2 Initiate promotion campaigns to reach potential investors.

3 Develop model Power Purchase Agreements for the various modes of generation under FiT.

4 Provide capacity building and financial assistance to community based projects.

5 Expand the scope of FiT to include the emerging technologies.

6 NEA to provide guidelines and timelines for PPA negotiations.

7 Develop an investment guide.

8 Set minimum and maximum tariffs to guide the negotiations for PPA under the FiT.

9 Review the FiT Policy to include operations and maintenance cost components.

4.13 OTHER RENEWABLES

4.13.1 Background

1 Other renewable energy sources and technologies are not yet widely demonstrated or commercialised. These include ocean energy, biomass gasification, bio-refinery technologies and concentrating solar power. Particularly, a subject of interest is ocean energy owing to the coastline of Papua New Guinea.

2 The oceans contain huge amounts of power that can be drawn from different technologies and harnessed for generating useful energy. The most developed conversion systems use tidal energy, thermal energy, ocean currents and waves.

3 Fast-flowing ocean currents between Sohano and Buka passage in North Bougainville can be harnessed as well as other coastal areas of extreme differences in high tides and low tides.

4 The specific details of other renewable energy resources will be captured in the Renewable Energy Policy to be developed by the NEA.

4.13.2 Challenges

1 Lack of legal, regulatory and institutional framework for utilization of emerging renewable energies.

2 Inadequate data and information on potential of renewable energies.

3 Lack of incentives for utilization.

4.13.3 Strategies - Other Renewables

1 Develop legal, regulatory and institutional framework for utilization.

2 Acquire data and information on potential of other renewable energies.

3 Provide incentives for exploitation.

4 The Renewable Energy Policy to be developed by the NEA in the immediate future.

5 The NEA shall draft a new legislation specifically to regulate renewable energy.

4.14 CROSS CUTTING ISSUES

4.14.1 Challenges

1 Criteria for allocation to investors of energy resource areas such as geothermal fields.

2 Licensing of renewable energy projects.

3 Management of multi-purpose projects such as dams and reservoirs for power generation, portable water, flood control and irrigation.

4 Management of energy resource areas such as catchment areas, forests, municipal waste as well as areas with good wind regimes, tidal and wave energy.

5 Corporate Social Responsibility requirements.

6 Environmental protection, conservation and management.

7 Mechanism for determining National Government, Provincial Governments and Landowners benefits sharing.

8 Payment of royalty and equity on proceeds from renewable energy resources.

9 Other than geothermal energy and large hydros, there is no lead agency to spearhead development of other renewable energy resources.

10 Absence of local credit schemes and financing mechanisms.

11 Inadequate public awareness on the economic opportunities offered by renewable energy and renewable energy technologies.

4.14.2 Strategies - Cross Cutting Renewable Energy Issues

1 Partner with financiers to enable the public to access credits schemes.

2 Develop capacity building programmes for players in renewable energy technologies in collaboration with training institutions and the energy institutions.

3 Introduce net and smart metering policy to encourage consumers to sell excess power generated from the renewable energy systems.

4 Prepare a Master Plan for renewable energy.

5 Promote community based power generation.

6 Create awareness on the benefits resulting from development of clean energy technologies.

7 Establish green energy certification schemes.

8 Establish energy efficiency/conservation projects certification schemes.

9 The Government will provide necessary support for the implementation of the renewable energy projects in the populated areas including facilitation of acquisition, relocation and resettlement of project affected person.

5 TRANSPORTATION FUELS

5.1 BACKGROUND

1 It is of significant national interest that the transportation fuels sector is regulated in a manner that is efficient and environmentally sound while at the same time security of supply is adequately managed through appropriate mechanisms. The Government understands the inherent need to better regulate this sector as the national economy cannot progress without the fuels sector performing efficiently.

2 What is principally important to the Government is that the provision of fuels in the country is affordable, accessible, and reliable. Most importantly, fuels sold in PNG must meet quality and environmental standards and the Government would make sure appropriate standards and regulations are put in place to better regulate the sector.

3 This policy supports the PNG National Transport Strategy (NTS) for the use of sustainable energy through encouraging the following measures;

a] The introduction of fuel-efficient transport and engines that are able to operate on biofuels.

b] Domestic biodiesel and bioethanol for the transport sector.

c] The operation and maintenance of equipment in a manner that minimizes consumption and emission of carbon dioxide emissions; and

d] The use of vehicle fleet-weighted against the fuel and emissions efficiency, ascertained from annual report.

5.1.1 Land Transportation Fuels

1 Road transportation is a very important mode of transportation and a very reliable medium for the delivery of goods and services in PNG. The Government would like to see this sector grow and significant capital investments have been already made in road construction and more funds will be injected into this vital sector of the economy.

2 Diesel and petrol are the two main fuel types used widely in the country together with lubricants. Prices for these fuels are amongst the highest in the region and the world. The Government would address high fuel cost concerns by encouraging competition in the market including encouraging investments in new oil refineries.

3 The cost of fuel and basic goods and services in areas located far from the main cities and towns are even far higher because of the associated cost involved with long distances. The Government will open up many new roads and focus on building a modern road network that provides the catalyst for economic growth.

4 The Government will strongly push for the development and use of alternative clean fuels to replace high pollutant fuels like diesel and petrol. Natural gas in the form of Compressed Natural Gas (CNG) and Liquefied Petroleum Gas (LPG) are such fuels that will be seriously assessed for use in the future for the transport sector. Other fuels like solar and hydrogen will be also considered for research and trials as well for use in the road transportation sector.

5 The rapid development of electric and hybrid vehicles as well as trains are now on the market and could be an option the Government can consider now and in the future.

6 Specific regulations will be formulated to also control noise and air pollution from the production and use of fuels. These regulations will also cover the production and use of petrochemicals.

5.1.2 Sea Transport Fuels

1 Marine transportation is also very crucial for coastal villages and towns as well as for all other economic and commercial activities. The current high cost of fuel is a concern to the Government because businesses often transfer the high costs they incur down to the end users. For instance, the fisherman would always factor the cost of fuel to be reflected in the price of fish that he sells to the consumers.

2 Diesel, petrol, zoom and lubricants are the main fuel types used in this sector.

3 Again, the Government believes that the fuels market in PNG must be open to competition so the fuel consumers benefit from comparatively cheaper fuel prices.

5.1.3 Air Transportation Fuels

1 The aviation sector plays a pivotal role in the PNG economy. It is a sector that is so important to the country because of the rugged and mountainous conditions of the country.

2 Cost of air transportation is extremely high in PNG and perhaps this is one of the reasons why the cost structure of business in PNG is very high. In simple terms, it means that the high cost of fuel is captured in the prices of all other goods and services in the country.

3 The Government is aware that high aviation cost is a disincentive to investment in PNG including tourism. It will therefore take appropriate actions to address the high cost of aviation through competition and construction of more road infrastructures.

4 One key area of interest to the Government is to assess how Jet-A1 fuel can be produced domestically using domestically produced crude oil. Additionally, the PNG Government is aware that the international aviation industry is undertaking research and development in harnessing solar energy as an alternative fuels to the fossil-oriented Jet-A1 fuel. Therefore, the Government will closely observe the development and success in the use of this new technology so that it can be adopted in PNG aviation industry.

5 Use of biofuels in the aviation industry is now being used and PNG will consider this for the future.

5.1.4 Supply Sources

1 The Government recognizes the importance of the fuels market and how important it is to growing the PNG economy and to improve the living standards of the people. Therefore efficient management of the sector is an important priority of the Government.

2 In order to reduce the cost of fuels, the Government would seek to secure feedstock crude oil from domestic oil and gas projects for another refinery to be built to create competition. The feedstock crude will come from a portion of the State's equity share in various oil and gas fields in the country. Through appropriate policy the government would seek to obtain crude stock from any oil and gas projects at a Kina purchase price equivalent for refineries. This policy should also be applicable to the off-taker and utilization of natural gas for domestic purposes including the use of gas for transportation fuels such as CNG and LPGs.

3 The objective of this policy is to reduce the current high business cost structure in PNG which is a major disincentive to business and investment in the country. Hence, the Government aims to ensure the price of refined fuels in PNG is reduced by 40 - 50 percent of the current market price which is based on the Import Parity Price (IPP).

5.1.5 Compressed Natural Gas (CNG) and Liquified Petroleum Gas (LPG)

1 The Government would seriously look Into the commercial and technical viabilities of utilizing CNG and LPG as the predominant transportation fuels in PNG. Once studies confirm that CNG and LPG is feasible to be used, the Government would encourage the use of CNG and LPG in vehicles with the option of starting with public land transport.

2 All CNG and LPG requirements would be produced domestically and the feed gas would be sourced from a portion of the State equity interest in any oil and gas project in PNG or would be secured under the 15 per cent Gas Reservation Policy (or Domestic Market Obligation) and at a price equivalent to the cost of production.

3 The Government would invest in Research and Development in order to determine the feasibility of utilizing CNG and LPG in the marine transportation sector as well.

5.1.6 Competition

1 The Government shall encourage competition in the fuels market in the entire business value chain. This means any investor can invest in a new refinery as long as they conform to quality standards and specifications. The PNG economy and the people would be the biggest beneficiaries under such a competitive market environment.

2 In order to promote efficiency and price transparency, the Government shall encourage the separation of ownership in all segments of the market from wholesaling to distribution and retailing.

5.1.7 Ownership

1 All new players as from the commencement of this policy in the fuels market in PNG will be wholly nationally-owned companies from wholesales to retailing segments of the market.

5.1.8 Regulation

1 The NEA will initially be the principal regulator of the fuels market until the establishment of an independent regulatory entity.

5.1.9 Government Subsidy

1 Many Governments around the world offer price subsidies to the fuels sector in order to relief businesses and citizens from high fuel prices. The PNG Government considers that the most appropriate way to support the economy and the citizens is to establish the appropriate policies as well as regulatory frameworks for a strong and robust market economy where competition is promoted so that the correct price is set by the market forces.

5.1.10 Challenges

1 The high costs of transportation fuel.

2 The heavy use of petroleum based fuel in the transportation sector which contributes to GHG emissions.

3 The lack of promotion and usage of alternative fuel sources like LPG, CNG, Methanol and Ethanol in vehicles including ships.

4 Lack of promotion and usage of technology/vehicles that use alternative fuels.

5 Lack of domestic production of Jet A1 fuel which contributes to high prices for this kind of fuel which affects aviation industry.

6 Lack of data collection on transportation fuel usage in the country.

7 Lack of clear policy and roll out plan for use of CNG and LPG.

8 Lack of a National Biofuels Policy.

9 The lack of competition in the transportation fuels market.

10 The lack of fiscal arrangements/incentives (like fuel subsidies for marginalised communities situated in areas where there is extreme transportation difficulties to access markets and goods and services like on remote mountain tops and isolated islands).

5.1.11 Strategy

1 Promote the domestic production of transportation fuel, including alternative fuel, through the Downstream Processing of Hydrocarbons Policy and Renewable Energy Policy by the mandated entities.

2 Ensure rigorous enforcement of environmental standards/laws through responsible agencies like Climate Change and Development Authority and Conservation and Environment Protection Authority.

3 Promote the usage of alternative fuel through fiscal/tax incentives for importation of vehicles that use such fuels.

4 Promote the use of technology/vehicles that use alternative fuels.

5 Ensure Jet A1 fuel is produced by the current set-up at Napa Napa Refinery by providing appropriate incentives.

6 Through National Energy Authority, ensure that data collection of transportation fuel is undertaken expeditiously to inform policies and strategies in this sector.

7 The NEA shall develop the National Biofuels Policy as a matter of urgency.

8 Introduce competition in the transportation fuels market sector by reviewing the InterOil Refinery Project Agreement and allowing additional players into the market. Also prevent vertical integration in the market.

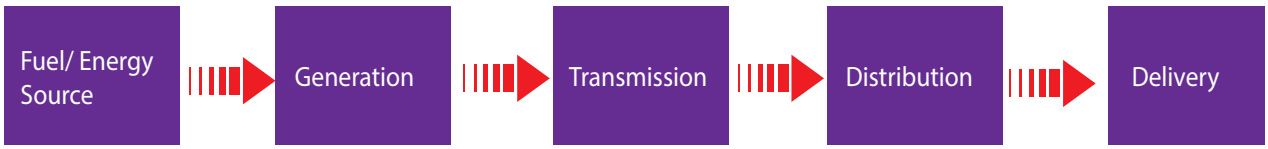
9 Provide fiscal arrangements/incentives (fuel subsidies) for marginalised areas as a short term measure.

6 ELECTRICITY SUPPLY INDUSTRY

6.1 BACKGROUND

1 Electricity is a secondary source of energy generated through the consumption of primary energy sources namely fossil fuels, renewable energy and nuclear energy. By virtue of its versatility in application, it is crucial to economic growth and is the most sought after energy service by society. Access to electricity is associated with rising or high quality of life.

2 The Electricity Supply Industry (ESI) value chain consists of four elements, as shown below.



a] First, there is generation, requiring both a fuel source (e.g. hydro, geothermal, petroleum or wind energy) and a power plant to convert the fuel source into electrical energy.

b] Second, the generated electricity is transformed (stepped up) for transmission over high voltage power lines; and matching end user requirements (demand) with energy availability (supply), referred to as system operations.

c] The third element is distribution where electricity is transformed again (stepped down) to enable delivery or supply of electrical energy to end users or consumers via a vast network of power lines and substations.

d] Finally, there is delivery or supply which entails retailing of electrical energy to consumers through a series of commercial functions - procuring, pricing, selling, metering, billing and revenue collection.

e] Generation, transmission, system operations and distribution are physical functions while wholesaling and delivery/retailing are merchant or commercial functions.

3 Competition in the industry generally means competition in the generation of electricity as well as in the commercial functions. The transportation (transmission and distribution) as well as system operation functions are generally natural monopolies (particularly in a developing economy) as it does not make economic, environmental or aesthetic sense to build multiple sets of competing systems in any one area. System operations is also non-competitive, since the system operator has to control all the plants in a control area, otherwise the system would not function efficiently or safely.

4 The Electricity Supply Industry (ESI) in Papua New Guinea has been undergoing reforms and restructuring since the mid-90s with the aims of, ***inter alia:***

a] Creating appropriate legal, regulatory and institutional framework for the ESI.

b] Ensuring provision of affordable, reliable, efficient, accessible and sustainable electric power supplies.

c] Increasing the population's access to electricity as a means of stimulating economic growth. To date only 13 percent of the households are connected to electricity after 50 years of existence by the State's ESI.

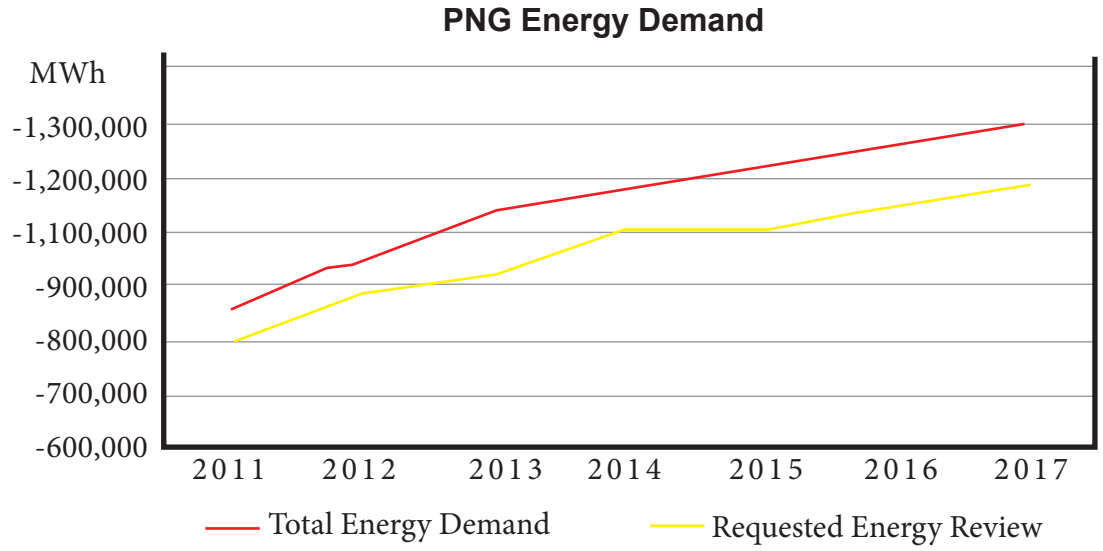
d] Improving the efficiency of power distribution and supply through reductions in technical losses and collection of revenues.

5 Creating a more competitive market structure with clear definition of roles for public and private sector players in generation, transmission, distribution and retail functions.

6.2 DEMAND FOR ELECTRICITY

1 Demand for electricity has shown an upward trend since the year 2011 due to accelerated economic growth. Figure 6, below shows ICCC's forecasted demand for electricity (regulated and total demand).

Figure 6. Estimated domestic energy demand



Source: *ICCC Report on the PNG Power Ltd Regulatory Contract Review*

2 PNG does not operate on an interconnected national power grid instead with only islanded electricity networks located around the more populated areas and industrial sites. Out of the total 580 MW installed generation capacity in PNG, PPL capacity is estimated at 300 MW while the 280 MW is generated by other entities that consume power mainly for their own use (e.g. mining enclaves).

3 Due to the population distribution where the majority of the population live in rural areas (and difficult terrain) the electrification access coverage is only 13% in PNG; with less than 1% access to electricity by most people in the outer provinces, except NCD with some 16.4% access to electricity in terms of the total population.

4 Major drivers of the demand include increased economic activities in various zones, particularly within the Lae (Ramu), Port Moresby and Gazelle systems. Additional latent demand coming mainly from the extractive industries remains unmet due to the very large electricity requirements. Table 3 below shows PPLs generation demand per zones as of end of 2014.

Table 3: PPL's Generation Demand per zones

ZONES		PEAK (KW)	Base Load(KW)	Energy (MWh)
3	Aitape	277	133	1,297
3	Alotau	2,870	1,149	12,441
3	Arawa	557	253	3,010
3	Daru	700	450	4,096
3	Finschafen	150	75	767
1	(Rabaul)	9,730	5,200	51,310
3	Kerema	319	156	1,610
2	Kimbe	4,272	1,677	15,012
3	Bialla	551	323	3,030
3	Manus	1,299	656	6,977
3	Maprik	323	150	1,772
3	Samarai	137	75	245
3	Vanimo	1,180	555	5,532
2	Wewak	3,609	1,847	17,144
1	Port Moresby	N/A	N/a	N/A
1	Ramu	N/A	N/A	N/A

Source: *PNG Power Limited; (Information not available at the time of finalisation of policy)*

5 It is anticipated that electricity demand will rise sharply as energy intensive activities such as mining, infrastructure developments, new LNG facilities, commercial and residential building constructions and numerous other activities are ramped up in the short to medium term. Table 4 below shows some of the recent and proposed project in the mining sector with estimated electricity demand.

Table 4: shows existing and proposed mining projects

EXISTING AND PROPOSED PROJECTS		
Existing & Proposed Projects	Status	Estimated Demand
Yandera	Exploration	135MW
Wafi-Golpu Stage 1	Feasibility	45MW
Wafi - Golpu Stage 2	Pre-feasibility	80 - 100MW
Ramu Nickel	Developed	85MW
Hidden Valley	Developed	20MW
Frieda Gold Mine	Exploration	< 200MW

Source: Department of Public Enterprises, 2014

[5] *Zone 1 - (Port Moresby, Ramu and Gazelle Systems); Zone 2- (Wewak, Kimbe System); Zone 3 - (Alotau, Buka, Daru, Finschaffen, Kavieng, Kerema, Lorengau/ Lombrum, Maprik, Popondetta, Samarai, Vanmo and Bialla system).*

6 To meet these new demand, several key generation projects will be initiated as shown in Table 5 below:

Table 5: New and potential generation projects

Energy Source	Site	Potential	Size	Status
Hydro	Edevu	20 - 50	Small	Under construction
Hydro	Naoro Brown	70 - 80	Small	Advanced feasibility
Hydro	Purari	2,000	Large	Feasibility
Hydro	Tua (Simbu)	1,000	Large	Pre-feasibility
Biomass	Markham	30	Small	Feasibility
Biomass	Madang	15	Small	Feasibility
Geothermal	Talasea	> 1,000	Large	Pre-feasibility
Geothermal	Rabaul	< 500	Medium	Pre-feasibility
Geothermal	Lihir	80	Small	Operating
Geothermal	Milne Bay	< 100	Small	Pre-feasibility
Gas	Hides	28 - 85	Small	Feasibility

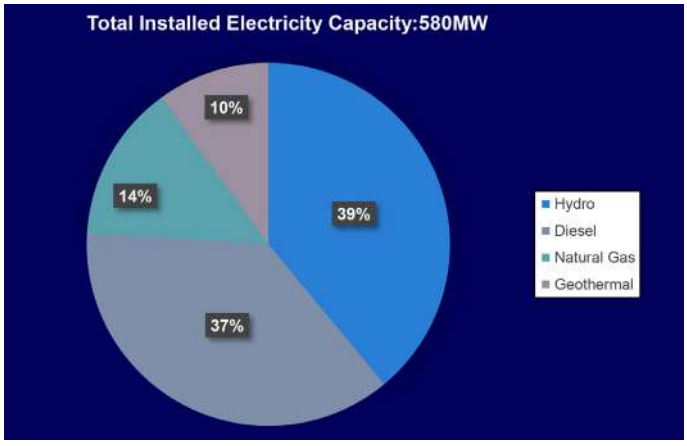
Source: Department of Public Enterprises, 2014

6.3 ELECTRIC POWER GENERATION

6.3.1 Background

1 Electricity generation in PNG is liberalised with several licensed electric power producers whose combined installed capacity was 580 MW as of December 2013[6] . This includes privately owned generation by major mining activities. A combination of several renewable and non-renewable sources used for this generation as shown in Figure 7 below.

Figure 7. PNGs Total Installed Capacity



Source: PNG Power Limited

[6] *ICCC PPL regulatory Contract Review Report 2013*

2 The Ramu (especially Lae City) and the Port Moresby Systems rely on hydro power generated from Yonki in Eastern Highlands Province and Rouna in Central Province. These hydro powered centres are also backed up by diesel power stations (both reciprocating diesel generators and open cycle gas fired turbine generators being run on heated diesel). Western Power also relies on small diesel power stations to supply electricity to its customers in Western Province.

3 IPP's like PNG Forest Products Limited, PNG Biomass, Oil Search Limited and Hanjung Power Limited generate power in Bulolo, Markham, Hides and Kanudi respectively and sell the power generated to PPL.

4 Whilst total installed capacity stands at some 580 MW, total electricity demand is projected to increase to a substantial 800 MW by year 2020.

5 In order to provide affordable electricity for these activities which are expected to transform our economy, a roadmap to raise the generation capacity has to be undertaken.

6 The road map (NEROP) will require the construction of various transmission lines to evacuate power to respective load centres. This will require significant investment by the Government.

6.3.2 GENERATION OF ELECTRICITY USING FUELS

6.3.2.1 Background

1 Thermal power plants generate electrical energy using fossil fuels mainly, oil, natural gas and clean coal.

2 All thermal generating plants in PNG are run on imported petroleum fuels which are subject to volatile international oil market prices which are passed through to consumers. Consumption of oil will be progressively reduced and be replaced by natural gas and biofuels in the medium to long term.

6.3.2.2 Advantages

1 Thermal power generation:

a] Requires a relatively shorter period of between 12 to 18 months for construction.

b] Requires smaller physical space compared to hydro and geothermal power plants.

c] Lower capital cost compared to hydro power and geothermal power plants.

d] Can be installed in any part of the country as compared to hydro power and geothermal plants which are site specific.

e] Attractive to private investment due to faster return on investment.

6.3.2.3 Challenges

1 Inadequate infrastructure for power supply to communities in the neighbourhood of generation plants.

2 High recurrent cost due to use of petroleum fuels as well as operation and maintenance cost, replacement and upgrading leading to higher electricity costs.

3 Combustion of fuels cause environmental pollution which requires costly mitigation measures.

4 Thermal power plants have a relatively shorter life span of about 10 to 20 years compared to hydropower plants which have a lifespan of over 50 years.

5 Thermal power has relatively lower conversion efficiency of less than 50% compared to hydropower plants which have over 90% efficiency.

6.3.2.4 Strategies - Electric Power Generation

1 The Government shall do necessary amendments to the *Electricity Industry Act 2002* (EIA 2002) and other legislations and vest the regulating of the industry with the industry regulator. The NEA will initially be the principal regulator until the establishment of an independent regulatory entity.

2 The NEA shall review the Electricity Industry Policy as a matter of urgency to complement this National Energy Policy.

3 Put in place mechanisms to ensure that the local communities benefit from developments of the electricity supply infrastructure.

4 The Government shall encourage electricity generation using renewable energy sources through PPPs and IPPs.

5 The Government shall encourage electricity generation using local fossil fuels primarily natural gas and clean coal through PPPs and IPPs for base load power.

6 The Government will ensure that all equipment procured for thermal power plants shall be designed and constructed to minimise the environmental impact while giving consideration to visual impact, wildlife and temporary disturbance during construction, maintenance and operation.

7 The Government shall promote the utilisation of Combined Cycle Gas Turbine (CCGT) plants to increase efficiency.

8 Regulator to develop appropriate standards and mechanisms for consumer protection including but not limited to reliable, and stable, power supply includes repair and maintenance time lines. The regime should include penalties.

9 Establish natural gas handling and storage facilities in the country.

10 Promote generation from renewable energy resources based on least cost and efficiency criteria.

6.4 GENERATION OF ELECTRICITY USING NUCLEAR ENERGY

6.4.1 Background

1 The uptake of nuclear power technology has been growing over time across different countries and regions. Various countries without existing nuclear power technology in their power systems have expressed interest in investing in nuclear electricity production while developed countries with existing nuclear plants have been expanding their capacities. All over the world, as of September 2013, there were 435 nuclear power plants in operation, 28 under construction and 222 in the planning stage.

2 Although PNG does not have a clear position on Nuclear energy development and deployment it is recognised as a form of energy used in other developed and developing countries, which PNG could develop in time.

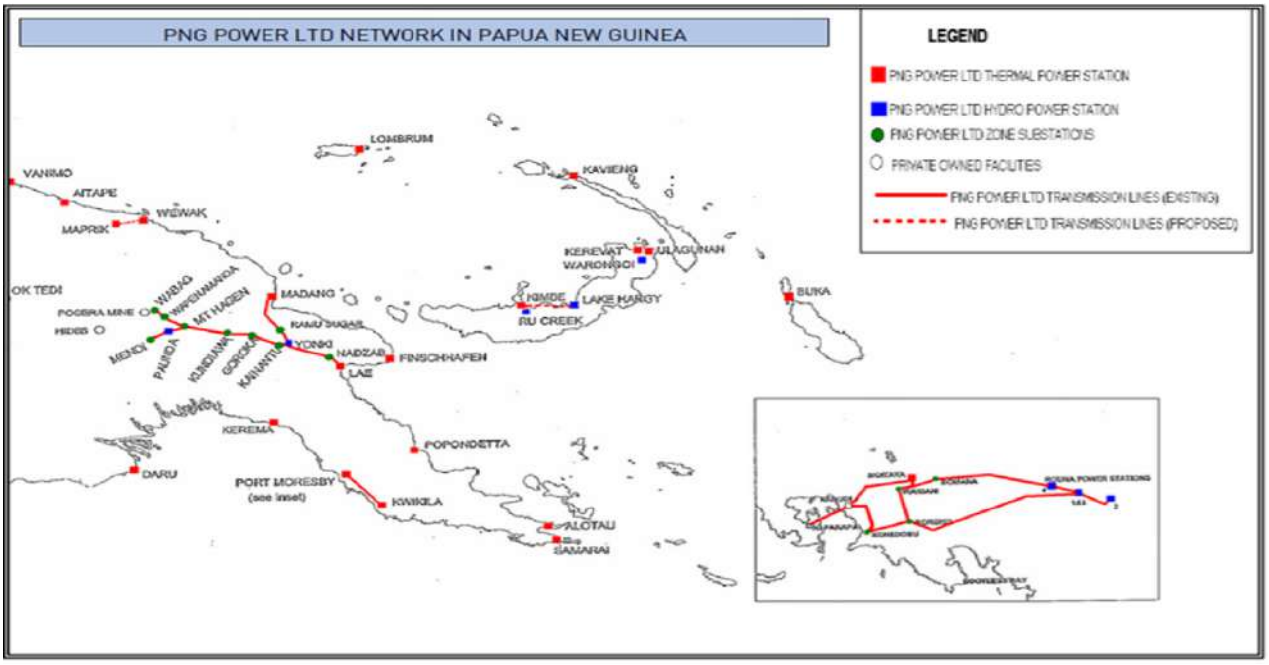
3 Careful policy considerations are required before PNG embarks on any concrete plans to develop nuclear energy due to serious dangers associated with explosions causing loss to human lives and damages to environment.

6.5 ELECTRIC POWER TRANSMISSION

6.5.1 Background

1 The existing transmission network is currently confined to the three (3) major systems in Port Moresby, Lae (Ramu) and Gazelle respectively as shown in the Figure 8 below. This system is anticipated to be extended dramatically in order to improve network coverage in line with the proposed National Electricity Rollout Plan (NEROP).

Figure 8 - PPLs existing transmission network



Source: PNG Power Ltd, as at October 2014

2 This existing transmission system capacity is severely constrained particularly during peak hours. The problem is partly due to inadequate reactive power in major load centres and also transmission constraints particularly in Port Moresby, Ramu and Gazelle systems.

6.5.2 Extension of the National Transmission Network

1 As part of its mandate, PPL is currently undertaking new transmission projects aimed at developing a robust grid system to:

a] Evacuate electricity through additional transmission lines across existing system including economic corridor system inter-connections.

b] Improve quality and reliability of electricity supply throughout the country by ensuring adequate evacuation capacity.

c] Reduce the cost of electricity to the consumer by absorbing the capitai cost of transmission lines since they will be fully funded by the National Government.

d] Provide interconnection links with the neighbouring countries in order to facilitate power exchange and develop electricity trade in the region.

e] Reduce transmission losses through upgrading of transmission line from current 60 kV to 132 kV for distances greater than 100 kilometres and up to 400 kV for distances greater than 500 kilometers.

f] Open up off-grid areas in order to ease connectivity to electricity by constructing transmission lines to link them up to the national grid. Alternatively, develop off-grid solutions for remote areas that are not economic to connect to the grid.

g] As earlier stated, the numerous economic activities springing up in major areas of the country requires a corresponding increase in generation capacity and transmission network. Consequently, the number of transmission lines projected for construction in the next 5 years needs to be substantial to meet this need. The NEROP is the vehicle to achieve these activities.

6.5.3 Regional Interconnection

1 There is a potential for Papua New Guinean transmission network to be interconnected with Australia and Indonesia's system through a 400 kV or more double circuit transmission line. The arrangement would allow for electrical energy exchange between PNG and a number of Australian cities of the State of Queensland such as Gladstone; thus likewise corroborate to connect electricity systems to neighbouring cities in Indonesia.

2 At this stage, focus of the export of the energy would be between regional areas such as from Southern into the Highlands and onto the Momase Regions respectively via network connections of the main grids.

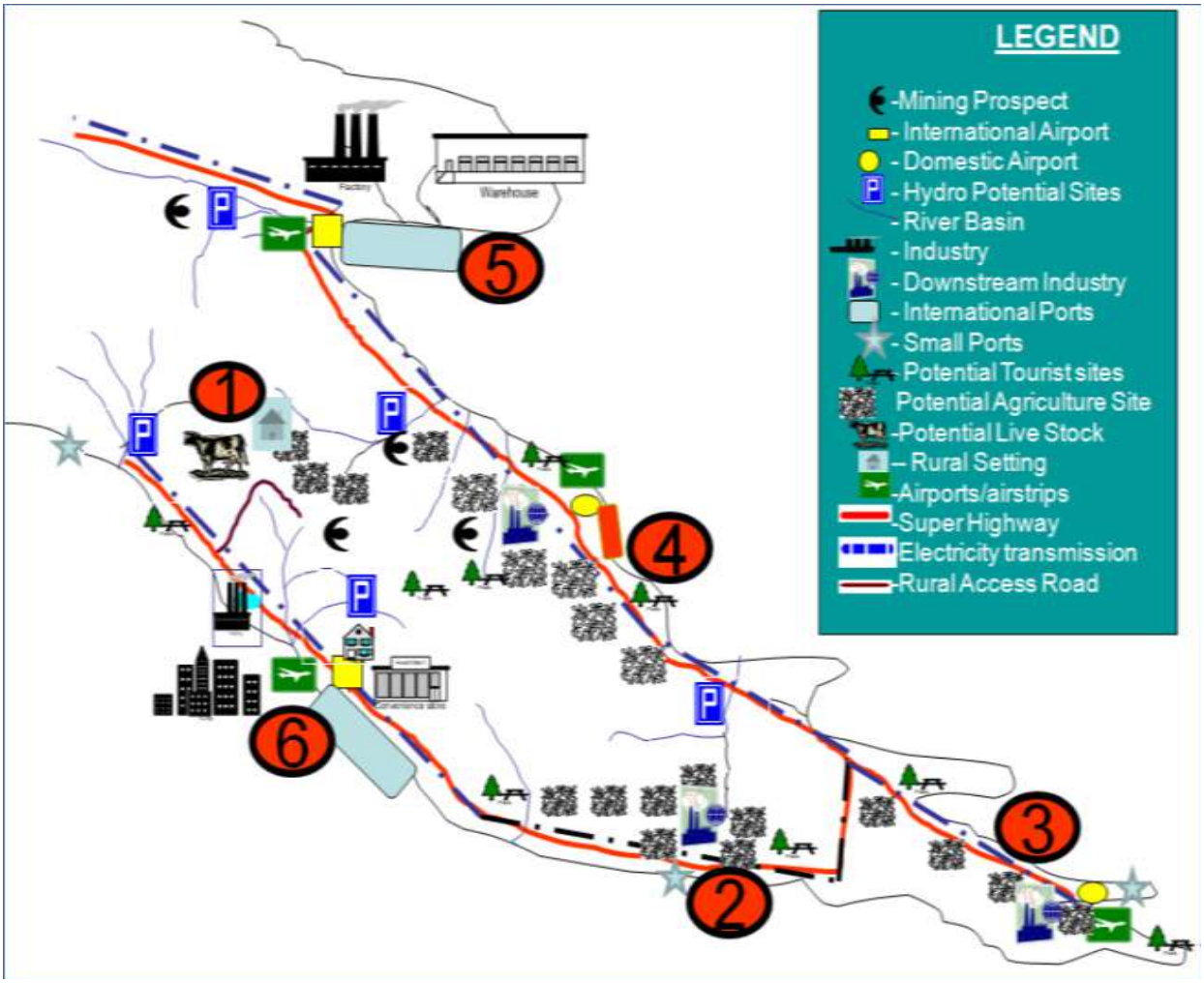
6.5.4 PNG Economic Corridors

1 Energy development planning will be based on the ten economic corridors as per the PNGDSP 2010-2030 as shown in Figure 9 below.

2 The Ten (10) Economic Corridors are proposed to alleviate poverty, as they will be located in the poorest regions of PNG with the aim of extending the benefits of development to the most disadvantaged regions. This is the region where the government has plans to develop well planned zoning system, comprehensive and effective network of transport and utilities, quality education and health services.

3 Within this region, businesses are able to operate at low cost and well designed incentives, thereby encouraging foreign and domestic private sector investments. By concentrating the construction of essential infrastructure within certain regions the economic corridor approach takes advantage of the substantial economies of scale and scope associated with large service sector infrastructure.

Figure 9. PNG's Economic Corridors



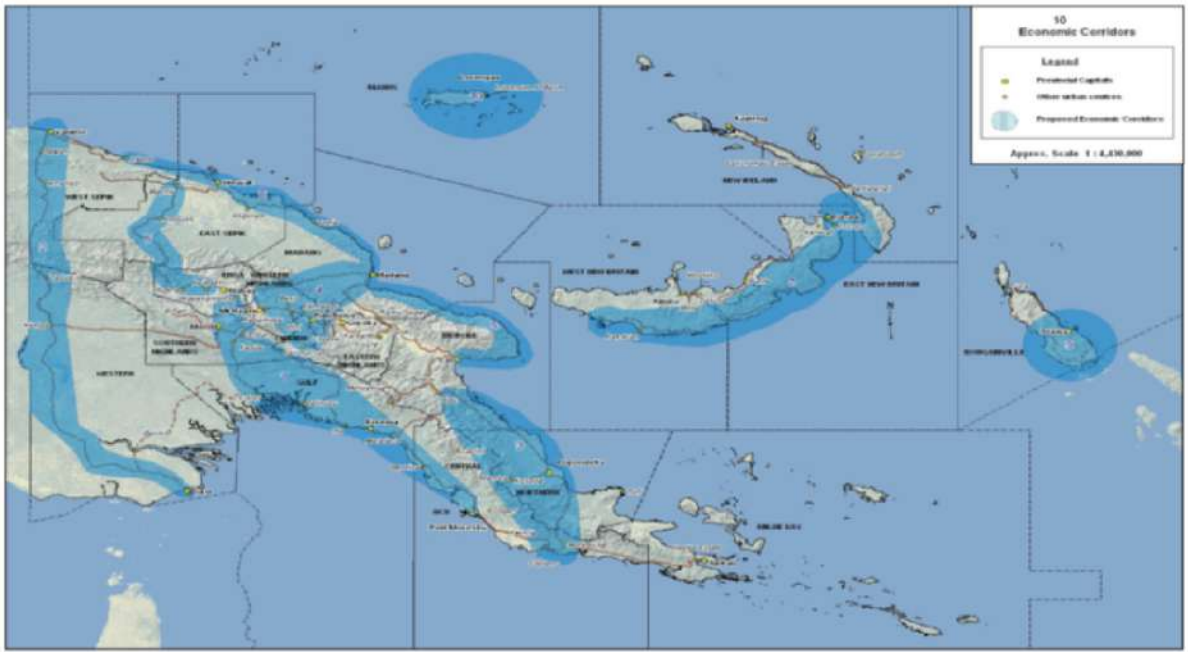
Source: PNG SDP 2010 - 2030

4 The Ten (10) Economic Corridors are:

- Petroleum Resource Area Economic Corridor (PRAEC): Southern Highlands, parts of Enga, Gulf, and Central provinces. The PRAEC was approved by Cabinet in May 2009.
- **Border Corridor** (Western, Southern Highlands and Sandaun Provinces)
- **Central Corridor** (Central, Milne Bay, Oro and Morobe)
- **Madang - Baiyer- Karamui - Gulf Corridor** (Madang, Simbu, Gulf and Western Highlands)
- **Morobe-Madang Corridor**
- **Enga-Sepiks Corridor** (Enga and East & West Sepik Provinces)
- **South Coast Corridor** (East New Britain and West New Britain)
- **Momase Corridor** (Madang, East Sepik, and West Sepik Provinces)
- **Solomons Corridor** (Autonomous Region of Bougainville)
- **Free Zone Corridor** (Manus, New Ireland, East and West Sepik).

5 Figure 10 below shows the footprint of the economic corridors across the various areas of the country. This is shown in the blue-shaded regions on the map.

Figure 10. Proposed 10 economic corridors



Source: PNG Medium Term Development Plan

6 The potential demand to be created from the economic corridor concept lies in such economic developments:

a] Livestock, crops and an agricultural processing plant;

b] Downstream processing facilities and agricultural farms;

c] Tourism, service centre and downstream processing;

d] Heavy industries and international trading zones; and

e] Light industries and international service and trading zones.

6.5.5 Benefits of Interconnectivity

1 Security of supply and system stability due to increased generation mix.

2 Increasing national economic efficiency by operating on lower reserve margins.

3 Expanded power market sizes and reduced country specific risks.

4 Capital saving as the country need not invest in new stations.

5 Increases competition by providing options for cheaper power.

6 Electricity access to remote areas.

7 Shared reserve margin benefit relating to interconnectivity.

8 The transmission infrastructure acts as a catalyst for investment in non-conventional renewable energy sources.

6.5.6 Challenges

1 Weak, inadequate and poorly - integrated transmission infrastructure capacity.

2 Displacement, environmental, health and safety issues.

3 Vandalism on transmission network.

4 Inadequate local technical skills especially in HVDC systems.

5 Land and way leaves acquisition.

6 Encroachment of the way leaves trace.

7 Insufficient framework for private participation in development of transmission infrastructure.

8 Inadequate policy, legal and institutional framework for the operationalization of the independent system operator.

6.5.7 Strategies - Electricity Transmission

1 The Government shall do necessary amendments to the Electricity Industry Act and other legislations and vests the regulating of the industry with the industry regulator to be known as the Energy Regulatory Commission.

2 The Government shall, review the Electricity Industry Policy as a matter of urgency to complement this National Energy Policy.

3 The NEA to be established will be responsible for the management and regulation of the Electricity Supply Industry.

4 The Government shall support open access of the transmission network taking into account existing contractual commitments and provide a mechanism for determination of wheeling charges applicable to transmission lines in accordance to the Third Party Access Code (TPAC).

5 The Government will establish the legal and regulatory mechanisms for competitive electricity market and further support regional integration of the power system to enhance regional power trade.

6 The Government will continue to fund the development of the national transmission system to enhance affordability. The Government will continue to assist transmission licences access credit to enhance capacity, improve reliability and reduce losses in the networks.

7 The Government will designate and provide legal and institutional framework for an Independent System Operator (ISO).

8 Ensure transmission infrastructure is put in place to evacuate electricity generated from main plants including geothermal plants.

9 The Government to ensure transmission reliability by establishing redundancies in transmission system.

10 Increase national and regional transmission network for full regional interconnection.

11 Establish international transmission connectivity with Australia and Indonesia to promote export and import of power.

6.6 ELECTRIC POWER DISTRIBUTION

6.6.1 Background

1 The distribution network entails receipt of bulk supply of electrical energy from generation or transmission network and transfer of this energy through distribution lines and distribution substations to consumers.

2 Reliability and quality of supply remains a key area of concern. As such, more focus should be given to resolve repetitive breakdown cases to reduce the number of incidences and improve repair time. The sharp increase in vandalism considerably contributed to this worsening situation leading to a number of transformer failures and consequential power outages.

3 The technical and commercial losses arising during the transmission and distribution of electricity are as provided in Table 6.

Table 6. PNG Power Distribution system

Year	Actual Generation	Fuel Used	System losses
2007	817, 947	3,155,534.00	246,814
2008	849,678	42,672,915.00	85,124
2009	895,706	4,232,449.00	188,785
2010	953,191	5,000,324.00	200,567

Source: (PPL, 2010) NB, Current figures from 2011 onwards not publicly available.

6.6.2 Distribution Expansion Plan

1 The objective of the ongoing Energy Access Scale-Up (EAS-U) programme is to increase connectivity countrywide. It involves expansion of the national power distribution grid to connect new customers both in urban and rural areas through NEROP.

2 In addition, more projects will be initiated to reduce system losses, enhance reliability and quality of supply by enhancing the sub-transmission. By the year 2020, capacities of primary and distribution substations, High Voltage lines and Medium Voltage lines are estimated to increase substantially.

6.6.3 Challenges in Distribution

1 High end-user electricity tariffs including standing charges.

2 High electricity connection charges.

3 Vandalism of electric power infrastructure.

4 Lengthy process of way-leaves acquisition.

5 Encroachment of way-leaves trace.

6 Weak distribution network characterized by limited redundancy and aging installations leading to frequent and prolonged supply interruptions.

7 Most of the distribution networks in major cities, urban areas and the coastal strip are overhead and therefore prone to frequent interruptions due to corrosion and climatic changes.

8 High system losses.

9 Illegal power line connections and theft of electricity.

10 Physical plans in most cases do not provide an infrastructure corridor for electricity reticulation.

11 High arbitrary levies charged by the public institutions on power infrastructures.

12 Lack of a legal framework for operationalization of open access.

6.6.4 Strategies - Distribution

1 The National Government shall ensure gradual elimination of overhead distribution systems (where economic/affordable) to provide efficient and safe distribution services by duly licensed network service providers so as to reduce power supply interruptions and improve the quality of supply and service.

2 Provincial Governments may plan and develop distribution networks and transfer them to distributors duly licensed to operate and maintain them in line with the national policy of having only one distributor in a given area at any particular time for efficiency and technical effectiveness of the national power network.

3 The National Government shall provide a legal framework to support open access of the distribution network taking into account existing contractual commitments and provide mechanism for determination of wheeling charges applicable to distribution lines.

4 The Government will continue funding the development of distribution network in rural areas and continue to support strengthening of distribution network in rest of the areas through licensed distributors through NEROP.

6.7 RURAL ELECTRIFICATION

6.7.1 Background

1 Energy shortages and supply disruptions coupled with high cost remains serious obstacles to economic activity in PNG. At present 87% of the PNG's population still lack access to electricity services and the progress of rural electrification has lagged over the years.

2 Some Provincial Governments and District Development Authorities (DDAs) have embarked on various rural electrification programs with PPL, unguided by any appropriate policy mechanisms. Making electricity accessible to the masses at the rural levels would require a holistic government approach.

6.7.2 Challenges

1 High costs of connection.

2 Scattered population settlements in the rural areas leading to long distribution lines. The uncontrolled sub-division of arable land has escalated this problem.

3 Harsh terrains and inaccessibility due to under developed infrastructure leads to high cost of rural electrification projects.

4 High operating costs of grids in rural areas due to low population density.

5 Difficulties with acquisition of way-leaves, due to high compensation demand by land owners.

6 Vandalism of power infrastructure.

6.7.3 Strategies - Rural Electrification

1 Through NEROP develop a Rural Electrification Master Plan.

2 Create a rural electricity funding and delivery mechanism.

3 Promote grid and off-grid renewable energy technologies.

4 Give impetus to the Electricity Trust Fund (ETF) to empower rural areas.

5 Seek funding from development partners for specific programmes especially in areas less attractive to the private sector and complement self-help groups and private sector efforts in rural electrification projects.

6 Build appropriate local capacity for manufacture, installation, maintenance and operation of appropriate energy technologies in rural areas.

7 Provide incentives to both users and producers of energy technologies in rural areas.

8 Package and disseminate information on energy systems in rural areas to create investor and consumer awareness on economic potential offered by these systems.

9 Support the activities of organizations and bodies that deal with rural electrification initiatives.

10 Implement cooperation arrangements with Provincial Governments and Local Level Governments for accelerated implementation of rural electrification programme.

6.7.4 Cross Cutting Issues

1 Outdated or lack of land use master plans which have made it difficult and expensive to acquire land and way-leaves for power infrastructure development.

2 The policy and decision making processes by public energy sector players are complicated by their corporate governance structures which are influenced by government policy, board appointments, existing laws and regulations.

3 High cost of financing energy infrastructure projects.

4 Insufficient fiscal and other incentives for private sector investment.

5 Lack of adequate port facilities for handling cheaper energy resources including clean coal and natural gas to support power generation.

6 The restructuring of the sector creates challenges due to existing obligations including Power Purchase Agreements (PPAs), financial covenants and asset ownership.

7 Demand for power in some areas is low due to lack of economic activities as well as poor infrastructure rendering some of the electrification projects unsustainable.

6.7.5 Strategies - Electricity Cross Cutting Issues

1 The Government will:

a] provide funds for pre-feasibility and feasibility studies for energy and electricity projects;

b] ensure that integrated plans for the electricity supply system are prepared;

c] where necessary acquire land and way-leaves for energy infrastructure development;

d] develop a resettlement policy and action plan for electricity related projects.

2 The Government will provide fiscal incentives to encourage investors to acquire and apply energy development technologies and where appropriate improvise to suit local conditions.

7 INSTITUTIONAL REFORM OF THE ELECTRICITY INDUSTRY

7.1 PNG POWER LIMITED

1 Reform of the electricity sector is required in view of the very low access at 13% to the people of PNG since 1963 when electricity first became available in the country. It is time for review and reform of the sector.

2 The major focus on the reform of the electricity sector should be the institutional structures currently in place.

3 It is very clear that PNG Power Limited which has been in the forefront of energy delivery services in the country has done very little to change the picture of very low power access to the people of this country.

4 Poor management, political interference and restrictive policies of government with regard to PPL have been the main reasons for poor performance in delivery of electricity services.

5 PPL being not a fully commercial entity has faced a major challenge over many years of balancing improvement in its economic returns versus the social obligations of providing subsidised electricity to its domestic consumers.

6 Some seminars and reports recommended “Unbundling” of a number of State Owned Enterprises (SOEs) including PPL as the way forward.

7 Some of the reasons put forward by experts organisations including ADB and NRI for non-performance of SOEs and recommendation of unbundling of these SOEs are as follows;

a] Poor management and lack of appropriate skills.

b] Organizational structures and business processes do not clearly distinguish the major function of businesses.

c] Lack of governance and accountability.

d] Legacy issues amongst employees still retaining Public Service way of doing things.

e] Regular changes to Board Membership and Senior Management.

8 Policy interventions are required to make SOEs more commercially oriented. In this regard, commercially oriented organisations or entities should be created to manage the evolving electricity industry.

9 The recent declaration of Emergency within the Electricity Services by the National Executive Council in its Decision No.357/2014, supports the notion that drastic measures have to be taken to turn the company around, and improve the reliability and availability of power supply throughout the country and communities which entirely depend on the company for their electricity needs.

10 To address these concerns raised in NEC Decision No. 357/2014, it now seems inevitable that separate commercially oriented entities should be established for generation, transmission, distribution and retailing.

11 In terms of Generation, the Electricity Industry Policy allows for competition within PPL's exclusive zone (10 km radius). The Government should establish companies to be involved in power generation on their own or through Joint Ventures or Public Private Partnerships (PPP).

12 In the case of PPL generation companies' specific to PPL assets can be established to manage production and sale of electricity. Other SOEs have established similar subsidiaries to engage in commercial ventures in their respective sectors.

13 Transmission is currently under PPL by law. Further reforms to Transmission will be effected when the interconnections are established throughout the country because it will be too difficult for PPL to manage.

14 Currently PPL is responsible for Distribution and Retailing of electricity. Future reforms on the Distribution and Retailing will depend on the consumer base in the country.

8 COMMUNITY SERVICE OBLIGATIONS

1 It is the aim of the Government to ensure that the cost of electricity usage by consumers in terms of tariffs is affordable, that the cost of new connections as a result of network extensions is also affordable. This requires taking into accounthigher cost areas of investments through suitable price regulation by the price regulator and the need for a clear CSO framework. Some rural areas in PNG may not present a prospective outlook for commercial investments and cannot attract investors, thus would normally be bypassed and left out in the provision of and from the benefits of electricity services.

2 A community service obligation is defined, in generic term, in one of the two categories of definitions adopted from a Commonwealth study in 1994, as:

i. provision of service, to some customers at least, at a price less than the cost of production;

ii. doing things for reason of government policy, which commercial enterprises operating in a competitive environment and subject to normal government regulations, would not do.

3 This definition will be further clarified in a specific CSO policy to be developed by the Government. However, for current purposes, these generic definitions will be adopted for the electricity sector in PNG. For the electricity sector, the Government will need to provide incentives to encourage investments in rural areas and utilize the private sector including procurement option of public-private partnership (PPP) to deliver CSOs on its behalf with the consideration of not jeopardizing their commercial interests.

4 CSOs may be in the form of functions performed, services provided and the allowance made for concessions that should entail greater private sector participation. CSOs are purchased from or facilitated through private entities operating on commercial interests by the Government for its targeted constituents.

5 In line with the underlying approach of this Policy and consistent with the current regulatory framework that this Policy basically retains, the targeted constituents for CSOs would be the small loads (less than 10 MW by individual demand for power) in, especially, rural areas. There is a need to clearly define, identify, and cost out possible CSOs as part of the implementation of this Policy and prioritize those CSOs in accordance with the funds available to implement this Policy.

6 CSO to be implemented on cost basis with investment partners.

7 Some of the specific subjects to be addressed in the future after the adoption of this policy are;

a) Tariff regulation in delivery of Community Service Obligation.

Under this Policy, the NEA (as the regulator of electricity price) will implement a commercial price regulation model that features price flexibilities reflecting on the costs of investments to ensure the incentives exist in both higher cost and lower cost areas of investments.

b) Available tax incentives of the Government.

The current tax provisions provide a range of rural development incentives that will be available to certain investors in relation to this Policy. The tax incentives include accelerated and flexible depreciation as well as income tax exemptions on the net income of new business set up in specifically designated under-developed areas that are not dependent on the exploitation of natural resources. New "rural development industries" as defined under the Income Tax Act exempt from income tax for ten years after the year the business commences operation. Eligibility for these tax concessions are assessed and determined by the Internal Revenue Commission (IRC) and will depend on compliance with the specific provisions and conditions in the Income Tax Act.

c) State Financing towards Community Service Obligations through Competitive Tender

A suitable mechanism is required for ensuring that intervention of State financing by the Government so CSOs are effective and efficient. State financing should be focused on clearly identified CSOs, appropriately costed and tendered to the lowest substantive bidder to achieve the lowest - cost delivery of the CSO. With the industry being opened up for competition, IPPs can take the opportunity to compete with PPL for the money that the State makes available for funding the Government's CSOs.

d) Delivering Community Service Obligations

Delivering CSOs for the electricity sector is the sole responsibility of Department of Treasury responsible for managing the Government's policy on these CSOs and their administration.

The management of the CSO delivery and as part of its overall planning and implementation of this Policy, it is necessary for the Government to implement the National Electrification Roll-Out Plan (NEROP).

In the case of market failure where there is an inability to achieve economies of scale, there would not be an interest from the private sector to deliver Government's CSOs. For the Government to use PPL to deliver CSOs in this situation will have detrimental ramifications on PPL to operate as a commercial entity, hence undermining its capability to be competitive in the contestable industry.

e) Rural Electrification under CSO

There is an inherent inability to recover costs on the provision of electricity services to rural areas in PNG broadly. The differential between the postage stamp price (which is a feature of the current regulatory framework) and the actual cost of service provision does not usually prove economic sense for private sector investments as it only makes the outcome of a rural electrification venture unprofitable or a loss.

The current practice of allowing flexible price regulation to allow investment in higher cost areas to take place, addresses this issue in some way. In addition to this the policy measure of identifying, costing and funding CSOs should enable the extension of rural networks or building electricity assets in new and potential market areas. The government agency that is responsible for implementing CSOs in rural electrification will opt for whichever of these two options that is more efficient when executing the normal competitive tender process and subsidize the most efficient bidder to develop the electricity project.

f) Urban Electrification under Community Service Obligations

State financing should not only be employed to progress rural electrification at the exclusion of urban areas, however, urban areas (or parts of them) need to be assessed against a CSO framework to ensure that the activity is actually a CSO before they are costed and financed.

g) Community Service Obligations in Electrification within PNG Power's Exclusivity Zone

State financing towards these network extension projects will solely and independently be determined by the Government in line with its priority for electrification and not influenced by PPL's request for assistance. All "profitable" ventures to PPL in this area of supply will not be subsidized by the Government as they do not qualify for State financing.

The economic regulator will require adequate access to information on PPL to assist the Government to properly assess and determine this.

h) Community Service Obligations in Electrification outside PNG Power's Exclusivity Zone

Competition for the market will ensure IPPs "monopolizing" certain market areas. IPPs whose operations feature rural electrification should be favoured in large loads. Where rural electrification priorities of the Government in line with its CSOs warrant it, and as it deems efficient, the Government will continue to subsidize existing producers in the area to progress rural electrification. Otherwise, the Government will open up competition for fresh entry into the market and subsidize the construction of new electricity assets through the appropriate process it administers.

i) Ownership of State-subsidized Electricity Assets

Where the State subsidizes a CSO, the State will not be the owner of the assets. Should the State retain ownership of these assets, there would likely be a conflict of interest with PPL being a state-owned entity. For the private investors, retaining ownership of assets would also provide an incentive to maintain the assets and ensure their efficient operation. It is intended that the developers of electricity assets that are developed with some State subsidy would own and operate these assets on commercial basis. PPL could own and operate these assets if it tendered the best proposal to the Government.

j) State-ownership of the Transmission Infrastructure

The State may retain the right of ownership over all the electricity transmission infrastructure and networks in PNG. The generation, distribution and retail segments of the electricity industry are open for private sector ownership

9 LOCAL PARTICIPATION IN THE ENERGY SECTOR

9.1 LOCAL CONTENT IN THE ENERGY SECTOR

9.1.1 Background

1 Major energy projects in the country source goods and services both domestically and overseas.

2 Local Content refers to the procurement or sourcing of goods and services from domestic and international sources by a Locally Owned Company engaged by the Energy Project Developer Company.

3 Locally Owned Companies are those companies which are majority owned (51 % +) by the citizens of Papua New Guinea from immediate project areas.

4 The concept of Local Content is to enable or encourage more locally owned companies to participate as sub-contractors or otherwise, hence creating more business and employment opportunities within the local/domestic economy.

5 Local content also includes employment of citizens with various skills level in any energy project

9.1.2 Challenges

1 Absence of a Local Content Policy and Plan.

2 Inadequate capacity and capabilities of Locally Owned Companies for technically complex tasks.

3 Lack of funding and finance for locally owned companies.

4 Lack of compliance by major energy project developers on Project Agreements.

5 Lack of monitoring and enforcement by State agencies on Project Agreements.

6 Lack of compliance with Local Purchase Obligations contained in the *Oil and Gas Act 1998.*

7 Lack of tax and fiscal incentives accorded to Locally Owned Companies.

8 Lack of incentives by the State to the Developer to comply with the local content objectives.

9 Lack of compliance with laws and regulations by the Developers.

9.1.3 Strategies

1 The State to immediatefly formulate a Local Content Policy/Plan with the establishment of a Local Content Policy/Plan Committee, comprising relevant Government agencies such as Department of Commerce & Industry (DCI), Department of Labour & Employment, NFA, PNGFA and NEA including Industry representatives and other stakeholders in the energy sector, i.e. Mining, Oil & Gas Industry.

2 The Developer to assist Locally Owned Companies to attain industry standards.

3 The challenge of lack of skills will be addressed under the sub-Chapter on Human Resource Capacity Building in Energy Projects.

4 Government to provide fiscal and monetary assistance to Locally Owned Companies to assist them partake of opportunities available in Energy Projects.

5 Timely release of Business Development Grants (BDGs) to Locally Owned Companies well in advance of a projects development to make them prepared to participate in business spin-offs in development of projects.

6 Ensure adequate monitoring and enforcement of a Developer's Local Content undertakings under a Project Agreement.

7 Ensure no Transfer Pricing arrangements by a Developer and its related subsidiary companies under a Project Agreement.

8 Ensure good Government Liaisons between Developer and the State.

9 Landowner Participation Policy to be developed to assist Landowners structure themselves commercially to participate in Projects.

10 The Government shall support landowners in project early works.

11 The Landowners, using Land as their equity can engage dialogue with the investor partners for equity shares starting at 5 % up to 30%.

12 Priority to be given to Locally Owned Companies from the immediate Project Area, then from the respective LLGs, District, Province and finally to Nationally Owned companies (which will be covered adequately below on the sub-Chapter on National Content in the Energy Sector).

13 Creation of Reserved Activities List are depicted on the next page (Tables 7 and 8) as a guide to show the suggested ratio of local content vs overseas content relating to energy projects.

Table 7: *Labour and Employment Procurement*

Employment Category	Ratio of Local NC Vs Overseas	Ratio of Local NC Vs Overseas
	Period of 1st 20 years (project life time)	
Managerial	20 percent to 80 percent	60 to 40 percent60 percent to
Skilled	60 percent to 40 percent	80 to 20 percent 100 percent
Semi-skilled	100 percent	100 percent
Unskilled	100 percent	100 percent

Table 8: *Awarding of Contracts/Sub-contract to locally owned PNG Companies*

Large-scale Infrastructure Construction and Skilled Building Construction and Marine terminal processing facilities	Outsource abroad or PNG Joint Venture (JV)
Large-scale Facilities Construction/Aero-drome/ Pipeline	Outsource abroad or JV
LNG Shipment	Outsource abroad
Large-scale road construction network	Outsource/Joint PNG Venture
Insurance & HSE Provisions	Preference PNG owned or Joint PNG Venture
Catering Contracts	Preference PNG owned Joint PNG Venture
Security Provisions	Preference PNG owned Join PNG Venture
Cleaning Contracts	Preference PNG owned Join PNG Venture
General Roadwork Maintenance	Preference PNG owned Join PNG Venture

9.2 NATIONAL CONTENT IN THE ENERGY SECTOR

9.2.1 Background

1 National Content refers to the procurement or sourcing of goods and services from domestic and international sources by a Nationally Owned Company engaged an Energy Project Developer.

2 Nationally Owned Companies are those companies which are majority owned (51 % +) by the citizens and citizen owned companies of Papua New Guinea or SOEs.

3 The concept of National Content is to enable or encourage more nationally owned companies to participate as sub-contractors or otherwise, hence creating more business and employment opportunities within the domestic/national economy.

4 National content also includes employment of national citizens in various skills level in any (energy) project (which will be covered adequately in the sub-Chapter on Human Resource Capacity Building in Energy Projects).

[8]*Developers prefer Joint Venture arrangements with internationally reputable companies.*

5 The recent LNG Project participants include some nationally owned companies, SOEs such as Kumul Petroleum Holdings Limited (formerly National Petroleum Company of PNG), Mineral Resources Development Company and Oil Search Limited (10 % owned by then IPBC).

6 Most major hydro projects in the country are owned by PNG Power Limited.

7 The Mineral Resources Development Company (MRDC) participates through the collection of landowner equity and business development activities.

9.2.2 Challenges

1 Absence of a National Content Policy and Plan.

2 Inadequate capacity and capabilities of Nationally Owned Companies for technically complex tasks.

3 Lack of funding and finance for Nationally Owned Companies to participate in energy projects.

4 Ineffectiveness of monitoring agreements by Government.

5 The lack of compliance with Local Purchase Obligations and Domestic Market Obligations (DMO) contained in the *Oil and Gas Act 1998*.

6 The lack of tax and fiscal incentives accorded to Nationally Owned Companies to participate in Energy Projects.

7 Lack of compliance of laws and regulations by the Developer's personnel and management.

9.2.3 Strategies

1 The State to immediately formulate a National Content Policy/Plan with the establishment of a National Content Policy/Plan Committee, comprising relevant Government Institution such as Department of Commerce & Industry (DCI), Department of Labour & Employment, Industry representatives, and other stakeholders in the Energy Sector, i.e. Mining, Oil & Gas Industry.

2 The State to assist Nationally Owned Companies to attain world standards to meet Developer's expectations.

3 The challenge of inadequate skills will be addressed under the sub-Chapter on Human Resource Capacity Building in Energy Projects.

4 Government to provide fiscal and monetary assistance to Nationally Owned Companies to assist them partake off opportunities available in Energy Projects.

5 Ensure adequate monitoring and enforcement of a Developer's National Content undertakings under a Project Agreement.

6 Ensure no Transfer Pricing arrangements by a Developer and its related subsidiary companies.

7 Ensure good dialogue and liaisons between Developer and the State.

8 Landowner Participation Policy to be developed to assist Landowners structure themselves commercially to participate in Projects.

9 Priority to be given to SOE's (Kumul Petroleum Holdings Limited and National Gas Corporation in oil and gas sector) to participate for the collective benefit of the nation.

9.3 DOWNSTREAM PROCESSING IN THE PETROLEUM SECTOR

9.3.1 Background

1 Papua New Guinea is strategically located in a region where both oil and gas reserves are abundant within the Asia/Pacific region which comprises countries such as Australia, Malaysia, Brunei and Indonesia. These countries have established world class petroleum and associate industries such as LNG and Petrochemicals by effectively utilizing their petroleum resources. They also compete against each other in order to secure as much market share in the region and at the global scenario. In the Asia/Pacific region, buyers are driving hard bargain in price to take advantage of the increase of supply in the Gas markets. Products such as Compressed Natural Gas (CNG) and Dimethyl ether (DME) are expected to increase in competition with other well established fuels. Competitiveness in costs and environmental factors are key factors to securing products, markets by attracting investors.

2 In order for PNG to be competitive and secure leadership in such highly competitive Asia/Pacific regional markets and also attract potential investors, it is of critical importance that the Government formulates an attractive policy directive and an enabling environment targeting commercial and bankable investments in Downstream Processing in the Petroleum Sector (Oil & Gas).

3 PNG Petroleum Sector must support the growth of an economically viable and vibrant downstream sector which will in turn provide a strong foundation for large-scale downstream processing. This will in turn enhance Gas-based activities in a sustainable, environmentally friendly and safe approach, hence:

a] Building a foundation of strong revenue base hence maximises economic benefits.

b] Secure energy security.

c] Enhance growth and experience to the National economy.

d] Reduce high dependence on expensive imported fuel and petro chemical products and encourage local cheap substitutes (refer also to Domestic Market Obligation-DMO).

e] Attract the interest of Investors to increase exploration in the upstream hydrocarbon industry.

f] Creation of more job in the hydrocarbon industry for our citizen (refer also to local content).

g] Address poverty alleviation.

4 The current Government's focus to promote investments in the local content in downstream activities is more than monitoring direct monetary benefits. The promotion of downstream processing supports the National Energy Policy to grow the economy as reflected in the Government's Development Strategic Plan (DSP 2010 - 2030) and Vision 2050. This will encourage the procurement of products and services and utilising local sub-contractors for the purpose of provision of goods and services to the projects and act as a major boost to the economy. This will maximise the Government's gains as a result of the economy multiplier effects triggered by the energy project's downstream activities.

5 The current low spot price for LNG which will persist for some time in the future but oil prices are likely to remain volatile.

9.3.2 Challenges

1 Lack of a Downstream Processing Policy/Plan to encourage investment in downstream projects.

2 Serious difficulties in sourcing crude and gas for downstream processing.

3 The lack of reliable infrastructure and associated works to supply energy to power industrialisation/ downstream processing of hydrocarbons.

4 The lack of trained and skilled manpower/personnel.

5 The lack of fiscal incentives for potential developers to downstream processing.

6 The lack of a Domestic Market Obligations Policy/Plan to secure gas reserves for downstream processing (refer sub-Chapter on Domestic Market Obligations in Section 9.4).

9.3.3 Strategies

1 The NEA shall develop the Downstream Processing Policy and Plan for the energy sector.

2 The National Energy Policy will itself address issues relating to reliable energy supply.

3 The sub-Chapter on Human Resource Capacity Building will address the lack of trained manpower/personnel.

4 Formulation of good fiscal regime/incentives for potential developers.

5 Use joint venture arrangements between reputable developers/proponents and nationally owned companies to downstream.

6 The NEA shall develop the Domestic Market Obligations Policy/Plan to address downstream processing for Energy resources.

7 Ensure that Domestic Market Obligations component is factored into every new Project Agreement between the State and Developers.

8 Enforcement of Domestic Market Obligations component in the Oil and Gas Act and if possible to increase the amount of petroleum available for Domestic Market Obligations.

9.4 DOMESTIC MARKET OBLIGATIONS IN THE ENERGY SECTOR

9.4.1 Background

1 Domestic Market Obligation is used to assign/reserve a certain percentage of export petroleum for local/domestic consumption.

2 It is vital that higher end products may be manufactured from gas secured under the Domestic Market Obligations.

3 Almost all the gas recovered under the PNGLNG Project was committed under long- term sales arrangements with international consumers leaving nothing available for Domestic Market Obligations. As a result, there are none available for Domestic Market Obligations to be utilised in electricity generation and petrochemical production.

4 A more robust system must be developed and enforced for DMO.

5 The NEA will negotiate and enforce the DMO.

9.4.2 Challenges

1 The lack of a Domestic Market Obligations Policy.

2 The lack of enforcement of what is provided for under the *Oil and Gas Act 1998.*

3 The non-implementation of the Third Party Access provisions of the *Oil and Gas Act 1998.*

9.4.3 Strategies

1 Formulation of a Domestic Market Obligations Policy for Petroleum.

2 Enforcement of Domestic Market Obligations component in the *Oil and Gas Act 1998.*

3 The State should strictly enforce the Third Party Access provisions of the *Oil and Gas Act 1998.*

9.5 ENERGY PROJECT ENVIRONMENT REHABILITATION

9.5.1 Background

1 Projects involving energy, use varying amounts of finite resources like water and land. For instance, drilling and exploring for oil and gas uses less land than coal or uranium mining.

2 Likewise producing energy from Geothermal plants uses significantly less land/space and water than a hydro dam and its reservoir.

3 Some may cause minimal disruption to the local ecosystem like solar and wind turbines. Some may be eco - friendly in that they use waste products to produce energy like biofuels from cooking oil.

4 The rehabilitation of the environment after these projects have come to the end of their life is crucial.

5 In Papua New Guinea, most petroleum projects leave little environmental footprint. Experience from mining projects especially Ok Tedi, Panguna and Misima leaves a lot to be desired. There are no major mining of coal and uranium activities as yet, if they do happen, they must not follow the same path.

6 Rehabilitation of hydro reservoirs has not yet been experienced since these projects are currently operational. However, impact of the environment downstream must be catered for in any rehabilitation plan under the Project Agreement.

7 Solar and wind are harnessed but on a much smaller scale and not industrial.

8 Biofuel is yet to take off on a large scale. Its production from plantations, smallholders, etc. then needs to be taken into account as they will leave an environmental footprint.

9 Some unsustainable Biomass is also one sector that may leave a big footprint. However, sustainably grown biomass which does not impinge on native forests has a significant footprint and does not require rehabilitation, as it results in increased forest area over project life, however recognised certification processes should be employed to ensure that no use of native forests occur for Biomass.

9.5.2 Challenges

1 1. No regulatory framework to cover rehabilitation of energy projects

9.5.3 Strategies

1 Legislations and regulations to be enacted to better regulate the rehabilitation of energy projects.

2 There must be a post project closure rehabilitation environment plan.

9.6 HUMAN RESOURCE CAPACITY BUILDING FOR ENERGY PROJECTS

9.6.1 Background

1 All facets of energy development, production, usage and conservation need a trained pool of people to manage.

2 Technical people like petroleum and nuclear engineers, geologists are needed mostly in the operational areas of energy.

3 In addition, good quality energy policy analysts, etc. are needed.

4 PNG currently has no specific training related directly to energy. However, the recent move by UPNG to introduce the Bachelor of Sustainable Development which contain aspects of climate change and energy conservation.

5 There were recent moves by the WNBP Governor to send mothers to India for Solar Academy training.

6 Most projects are required to produce a Training and Localisation Plan prior to developing a resource. Most do not comply with this Plan.

9.6.2 Challenges

1 Developers lack of compliance with the Training and Localisation Plan.

2 Lack of trained researchers and academics specialised in Energy Development and use.

9.6.3 Strategies

1 Robust enforcement and inspection by State Agencies to ensure that a developer adheres to a training and localization plan that it submits.

2 Skills transfer by Developers to citizens should be made mandatory.

3 Adequate funding and training by the state for energy related training overseas.

10 ENERGY FINANCING, TRADING, PRICING AND SOCIO-ECONOMIC ISSUES

10.1 BACKGROUND

1 The funding required for the energy sector is substantial so needs to be based on sustainable and viable economic models. New investments are needed for exploration, utilization, generation, transmission and distribution activities. Long-term financing options that involve both foreign and domestic financing resources are required. However, foreign investment capital and national foreign earnings provide the greater proportion of needed funds.

2 The Government shall continue to encourage private sector investment in the energy sector through Public Private Partnership (PPP).

3 To attract foreign investment in the energy sector, certain necessary conditions would have to be met. Experience has shown that some Independent Power Producers (IPPs) require incentives to mitigate their perceived political and economic risks.

10.2 CHALLENGES

1 Inadequate funding for the energy sector.

2 Lack of continuity in the funding of projects in the energy sector.

3 Low foreign investment from a highly competitive international finance market.

4 Inadequate local development of energy technologies.

5 Insufficient scale and development of a competitive domestic energy industry to yet develop an energy trading mechanism for spot and long term markets.

6 Foreign exchange fluctuations.

7 Historic over reliance on volatile US dollar-denominated and oil price based fuels such as heavy fuel oil and diesel

10.3 STRATEGIES FOR ENERGY FINANCING

1 The Government shall explore and adopt all viable financing options from local and international sources to ensure cost effective utilization of all its energy resources, in economic order of merit and so shall endeavour to maintain a competitive fiscal investment climate in the country.

2 The Government shall continue to provide financial support for energy infrastructure development. Such support may include:

a] Specialized tax concessions for domestic energy producers of petroleum products such as tax credits, deductions, exemptions and allowances and particular incentives on clean burning petroleum products thus encouraging adoption of clean and efficient refining technologies, following the discovery of commercially viable crude oil in Papua New Guinea.

b] Fiscal incentives for the refining sector similar to that provided to refineries by governments in the Middle East and Asia. This recognizes the investment in infrastructure that is commonly accessed by the industry and benefits the entire economy.

c] Provision of incentives for renewable energy projects so as to reduce the reliance on expensive petroleum based energy in the long term.

3 The national government shall grant appropriate fiscal incentives for energy expansion projects from time to time.

4 Provide for high import duty for non-efficient energy technology while zero rating efficient technologies.

5 Allow procurement of equipment for exploration, exploitation and development of energy sources related spares and accessories free of duty and taxes.

6 Allow procurement of plant, equipment and related accessories for generation and transmission projects free of duty and taxes during project implementation. Procurement of major parts for the power plants, transmission and distribution systems and materials shall also be exempted from duty and taxes.

7 Support power generation in joint venture partnerships where the IPPs will be unwilling to participate in development of energy generation projects without Government participation due to perceived project risks.

8 Grant tax holiday to investors in exploration, production and processing of coal and petroleum for a period of between 5 and 10 years depending on size of investment.

9 Dedicating a certain percentage of the nation's income from conventional energy sub-sector to support training, research, development demonstration and technology acquisition.

10 Providing fiscal incentives for prospective investors in energy.

11 Reviewing the existing laws and regulations for the operation of energy sector industries so as to increase private sector participation in the industries.

12 Ensuring a reasonable return on investments through cost-effective energy pricing.

13 Establishing guaranteed and dependable repayment schemes for loans invested in energy projects.

10.4 ENERGY FINANCING OPTIONS

1 Establishing a favourable investment climate to attract investments in the energy sector.

2 Providing adequate infrastructural facilities to investors involved in the development of the energy sector.

3 Encouraging energy firms to source development funds from alternative sources.

4 Expanding the scope of venture capital financing to embrace investments in the energy sector.

5 An Electrification Trust Fund is proposed to solicit and fund rural electrification project proposals across the country. This will make rural electrification an active national policy, and will ensure equity, effective coordination and sustainability.

6 Review the *Income Tax Act 1959, Goods Act 1951*, the *Goods & Services Tax Act 2003* and other relevant legislations, to provide fiscal incentives in the energy sector.

7 Develop a National Energy Trading Hub in the country including spot and long term markets for energy products.

8 Encourage development partners to establish financial facilities for financing energy related projects at minimal interest rates especially for renewable energy and energy efficiency projects.

9 Provide incentives to attract investment in petroleum retail networks in the remote areas of the country.

10 Seek financing of clean energy projects through carbon credits under Clean Development Mechanism (green energy) through relevant government agencies.

11 The Provincial Governments will be encouraged to source their own funding for energy projects within their mandate according to Organic Law and National Government support.

12 Encourage public private partnerships in energy projects including IPPs, strategic petroleum reserves, infrastructure development and power generation projects.

10.4.1 Public Private Partnerships

1 The Government will support Public Private Partnership (PPP) as provided for in the PPP Policy document. Systems have been set for participation of private sector in financing, construction, development, operation, or maintenance of infrastructure or development projects through concession or other contractual arrangements and the establishment of institutions to regulate monitor and supervise project agreements, infrastructure or development projects.

2 Apart from market-driven competition, the Government recognizes private sector participation to occur in the form of service contracts lasting between 1 - 2 years, management contracts of a 3 - 5 year term, leases from 8-15 years, concessions which duration range from 25 - 30 years and other forms (models) of public-private partnerships (PPP) such as service-operate-transfer (SOT) or build-operate-transfer (BOT) that should have a term between 20 - 30 years

3 All PPP's formed shall be the outcome of a competitive bidding process, and vetted by the relevant regulator. The State currently has a National PPP policy to guide such decisions, and the National Energy Policy will be implemented in a manner consistent with that policy.

10.4.2 Consolidated Energy Fund

1 The Government shall set up a National Energy Fund (NEF) under the National Energy Authority to cater for the following: -

a] Acquisition of strategic petroleum reserves and the construction of appropriate infrastructure.

b] Assist in energy sector environmental disaster mitigation, response and recovery.

c] Hydro risk mitigation during times of prolonged drought.

d] Promotion of economic renewable energy initiatives such as small hydro, biomass, wind and PV solar.

2 The sources of the money for this energy fund will be as below:

a] Levies and license fees in the energy sector except those with specific purposes.

b] Contribution from energy sector player.

c] Contribution from public institutions for the discharge of their mandates.

d] Raising funds through the stock market (bonds and bills).

3 The fund shall be managed by the proposed National Energy Authority.

10.5 ENERGY TRADING

1 Electricity is a commodity capable of being bought, sold and traded in a well-developed electricity market, particularly if generation from multiple interconnected generation exceeds available system demand. However, Electricity unlike other products is by its nature difficult to store and has to be available on demand. In addition, it is likely to be some years before PNG has the pre-conditions necessary to have a competitive supply-side market. Therefore, there is a physical requirement for a controlling agency, the transmission system operator to coordinate the dispatch of generating units to meet the expected demand of the system across the transmission grid. Under this policy, it is envisaged that the ENERCOM will perform that role.

2 National Electricity Market involves both large scale wholesale generation that is transported via interconnected grid of high voltage transmission lines to electricity distributors, who deliver it to consumers (residences, industries and commercial users).

3 In a mature market the transport of electricity from generators to consumers is facilitated through a 'pool', or spot market, where the output from all generators is aggregated and scheduled at five minute intervals to meet demand.

4 The pool is not a physical thing but a set of procedures that ENERCOM will manage in line with National Electricity Law and National Electricity Rules.

5 The market uses sophisticated systems to send signals to generators instructing them how much energy to produce each five minutes so that production is matched to consumer requirements, spare capacity is kept ready for emergencies, and the current energy price can be calculated.

6 The scope of each electricity market consists of the transmission grid or network that is available to the wholesalers, retailers and the ultimate consumers in any geographic area.

7 A wholesale electricity market exists when competing generators offer their electricity output to retailers. The retailers then re-price the electricity and take it to market. Large end-users seeking to cut out unnecessary overhead in their energy costs are beginning to recognize the advantages inherent in such a purchasing move.

10.6 ENERGY PRICING AND SOCIO-ECONOMIC ISSUES

10.6.1 Energy Pricing

1 The Government shall set up a National Energy Fund (NEF) under the National Energy Authority (NEA) to cater for the following: -

10.6.1 Energy Pricing

1 Electricity pricing shall be based on the principles of Long Run Marginal Cost of supply. The End-User-Tariff incorporates all prudent costs in the value chain and a fair return to the investors. The bulk tariffs are negotiated between producers and the off-taker, however, the Power Purchase Agreement is subject to approval by ENERCOM. The retail tariffs are regulated by the Commission and may be subject to review at least every five years.

2 Fuel costs and exchange rates gains/losses are pass-through costs in the current regime. These account for power cost variations in the event of fluctuation in the international crude oil prices as well as instability with PNG Kina against foreign currencies, mainly the US Dollar.

3 PNG imports some petroleum products from overseas (eg. Heavy fuel oil and diesel). The international price of crude oil and petroleum products has been on a steady increase (reduced significantly recently but volatile) and has had an impact on the cost of petroleum and associated products.

4 The impact of crude oil price increases lead to inflationary pressure in the economy which is translated to increases in prices of goods and services. This tends to depreciate the exchange rate and increase interest rates. An increase in diesel prices leads to an increase in farming costs, the cost of inputs in the manufacturing and transport sectors and subsequently an increase in consumer prices making PNG products uncompetitive. With the income of consumers remaining relatively constant, these increases lead to erosion of purchasing power of the consumers in addition to reducing monies for other needs.

5 The Impact of crude oil price reliance also means energy pricing is volatile, multiplied by the USD - Kina price movements, which inhibits the ability to make long term investment decisions in a certain price environment. Therefore a key aim is to diversify electricity supply sources to help mitigate this volatility through the Kina and Kina - USD price cycle.

10.6.1.2 Affordable Energy Price

1 The reliability of energy services enjoyed by the urban energy users is unreliable by international standards because of the way the energy sector is structured in the country. The conditions of modern energy infrastructure in PNG is in a deplorable state and needs to be upgraded or replaced to ensure that these facilities perform to the highest expectations to deliver the energy services required by the end users.

2 Demand for production and utilization of energy is a function of price. It is important to take into consideration the low ability of paying energy users amongst large sections of the population.

3 When developing or constructing modern energy infrastructure it is essential that the developers must consider imposing affordable energy price and risk (fix cost and volatility) to the

consumers. The developers must consider appropriate cost savings in the designs of the energy infrastructure through improved operating efficiencies and minimizing on unnecessary expenditure.

4 Incentives that make PPL and other energy developers seek efficiency measures to minimize their costs and risks and an enforceable and suitable price mechanism should alleviate the situations that bring about unaffordable prices of energy services.

10.6.1.3 Competitive Energy Markets

1 To improve reliability of energy services competition will be promoted and introduced in the energy sector. Competition in energy supply provides choice to consumers, places downwards pressure on prices and incentivizes efficient investment. However given the current stage of development of the energy market, particularly the low rate of electrification, competition is best introduced to minimise costs once the sector is sufficiently developed and electricity penetration reach developing country norms. Competition for the opportunity to develop already occurs so market supply competition is still some years away.

2 The Government will push for reforms and initiate programmes for ensuring energy markets continue to work effectively and competition is promoted.

3 Tariff regulation, as a second best option to competitive markets would continue to play an important role in ensuring an affordable and reliable energy to end users.

10.6.2 Over-seeing Oil Market

1 The petrol and diesel prices are largely determined by international oil markets. However, the Government will over-see oil markets to ensure petrol and diesel prices at the pump to fairly reflect industry costs as per international oil market.

2 Similar to the gas sector, oil commercialization and development will be promoted in PNG in the future to reduce reliance on fuel imports and promote energy security.

10.6.3 Other Socio-Economic Issues

1 Investment in property relating to exploitation of natural resources for energy production must benefit the local communities and their economies as well as future generations. Therefore there is need to provide:

a] A framework to ensure that local communities benefit from energy resources within their region.

b] A funded, national coordinated rural electrification program is required.

The Electricity Trust Fund (ETF) is proposed to solicit and fund rural electrification project proposals across the country. This will make rural electrification an active national policy, and will ensure equity, effective coordination and sustainability.

10.7 THE TARIFFS AND PRICING MECHANISMS

10.7.1 Background

1 Papua New Guinea (PNG) has a low electrification rate compared to other similar developing countries whilst the sector has a vertically integrated monopoly with a few independent power producers. Given such a scenario, PNG has developed and now had in place its own electricity sector policies. Since there are provisions in the regulatory licensing framework for private sector participation, these arrangements can be combined with some elements by learning through the reformed experiences of other developing countries that could be considered for the way forward in reforming the sector's regulation, thus encouraging competition to improve efficiency in the provision of electricity services.

2 As such, given that there is potential for more competition in the electricity sector with increasing number of interest shown by the private sector to participate on the back end of high demand for electricity due to increase economic activities, the regulatory arrangements and tariff structuring will provide provisions for continuous restructuring and adjustment overtime, concurrent with the development in the electricity industry.

3 Therefore, to accommodate the increasing interests shown by the private sector to participate in all or any of the segments of the electricity sector, certain form of pricing mechanism or tariff structure need to be set in place to provide and or administer the returns on the value of investments.

4 The ENERCOM must be encouraged through the existing regulatory framework to implement a robust price mechanism that is conducive to and or favourable for all entrants into the different segments of the industry, to ensure industry development and gain a positive return on their investments thus promoting accessibility, affordability and reliability in the industry.

5 Furthermore, ENERCOM must consider the different areas of operations, in terms of the urban and rural settings and the respective low and high cost areas; and apply different charges at those varying connection(s) points with those parties, albeit set an appropriate price mechanism and or tariff structure that will drive efficiency.

6 More so, in order to achieve the overarching objectives of this policy; apart from other strategies, there is considerable need for structuring and setting of pricing mechanism. Any proposed price mechanism should be reviewed and structured concurrently with the phase of development, restructuring and eventual defragmentation of the electricity industry.

7 Currently there exists a Tariff structure that ts applied specifically by the regulated retailer PNG Power Limited, being the regulated retailer applies a uniform tariff across its entire network.

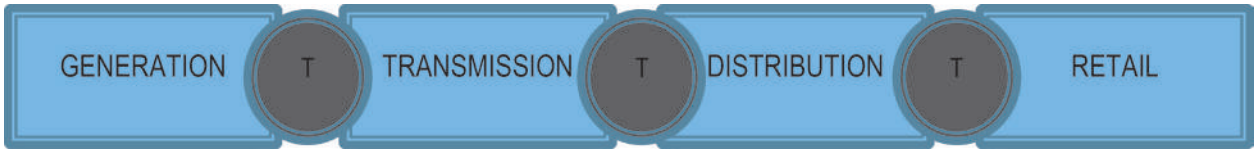
8 Distinctively, there are some price mechanisms currently applicable through third party access that are covered by the Third Party Access Code (TPA). However, in observing how the current pricing mechanism in the industry works, it may not be fully reflective of the different structure of the restructured electricity industry.

9 Therefore, the different tariff structure for different settings of the defragmented sectors of the electricity industry must be established, particularly if PPL eventually moves to a Regional Model, there may be an opportunity to move to a 'cost-reflective' tariff that reduces costs in a region (e.g. Ramu Grid), rather than having the same national tariff, so any cross- subsidisation is made explicit and transparent. In essence, the policy is making provision for the establishment of different tariff structure for different defragmented sectors of the industry and provides provision for adjustment and review of the tariff structures to be on par with the structuring of the industry overtime.

10.7.2 Tariff in Electricity

1 In consideration of the complexity involved in the tariff calculation and design, especially in regards to obtaining of relevant efficient costs inputs of the firms in question, and the asymmetry of information between the regulator and the regulated entity; an efficient market tariff price cannot be easily determined. Nonetheless, regulation of price to mimic the competitive market has continued to be adopted worldwide as the second best option.

2 The current Papua New Guinea electricity tariff setting arrangements can be best illustrated in the following diagram hereunder.



3 T_1 T_2 and T_3 are the three different points at which the tariffs are charged. T_1 is the tariff agreed between the IPP and the Off-taker. T_2 is the potential tariff for a transmission company charged to and bought by the distribution company. T_3 is the retail tariff charged by the distributor to the retail customers.

4 A large proportion of tariff differentials occur at T_3, under price discrimination and segmenting due to the varied customer segments - such as industrial, household and public institutions. Similar price differentials occur at T_1 due to the varied costs structures of the generating firms resulting in different tariff rates if they are IPP's. PPL should also move to explicit tariffs (transfer pricing) over time as it does not currently explicitly recognise the cost of its internally generated power. This is the case given that all firms operating in the industry would not necessarily have similar cost structures.

5 The current electricity tariff pricing regime administered by the Independent Consumer Competition Commission (ICCC) under its own Act (ICCC Act , No 6 of 2002), the economic regulator of the electricity industry focuses on tariffs charged at point T_3 with an oversight on T_1. The principle behind it, is for the firm to recover its efficient costs of investment, with a reasonable return on its investments.

6 Tariff between the IPPs and Off-taker in T_1 remains negotiable between the parties through a Power Purchase Agreement (PPA). However, the ICCC does have an oversight in setting of the Reference Price, agreed to it by the Regulator, based on information supplied to it by the regulated entity (Retailer). This is consistent with the pricing arrangements provided for under the Third Party Access Code (TPA Code).

10.7.3 Pricing Mechanism under the Third Party Access Code

10.7.3.1 The Third Party Access Code

1 The Third Party Access Code and Grid Code were developed through the Electricity Industry Policy. The TPA Code was released by ICCC and became effective on the 1st of January 2014. The objective of the TPA was to facilitate improved access, reliability and affordability of electricity throughout PNG by:

- Improving the reliability of electricity supply by supporting entry by Independent Power Producers (IPPs) to ensure sufficient generating capacity is available for dispatch.

- Helping to ensure that power is more affordable for customers by increasing the range of potential generation options and thereby offering more opportunities for the System Operator to select least-cost generation options.

- Helping to ensure that power is more affordable for customers by increasing the range of potential retailers and thereby offering more opportunities for Large Load Customers to select a least-cost option.

10.7.3.2 Key Components of the Access Code

1 There are three key components of the TPA Code in relation to tariff settings; these are

a] ***Reference Prices*** - which set out the maximum price a regulated retailer will pay for electricity generation.

b] ***Wheeling Arrangements*** - which set out the conditions and charges under which third parties can access PNG Power Limited's transmission networks.

c] ***Connections arrangements*** - which set out the conditions and charges for connection to PNG Power Limited's transmission networks by third parties.

2 The TPA Code, once implemented is expected to:

a] Improve transparency with regards to power purchase contracting between IPPs and Regulated Retailers.

b] Constrains the ability of Regulated Retailers to unfairly discriminate against potential competitors.

c] Protect Transmission Network Operators' commercial interests by clarifying how they are remunerated by Third Parties connecting to and wheeling power through their network.

d] Constrains the ability of Transmission Network Operator that performs System Operator functions from unfairly discriminating against Third Parties.

10.7.3.3 Pricing Mechanisms under the TPA Code

1 The TPA Code and its Pricing Mechanism aligned to the National Energy Policy are expounded as:

i) **i. Power Purchase Reference Pricing and Power Purchase Agreement**

The Power Purchase Reference Price (PPRP) provides for purchasing power at a prudent and efficient cost for the retailer to pass-through to consumers. The power purchase price sets the upper bound for and as a benchmark for retailers purchasing from power producers. It is required under the TPA Code that regulated retailers must submit a statement of power purchase reference price to the regulator for approval. The regulator will assess, approve and do publication of the approved power purchase reference prices for the participants in the industry to apply these references accordingly to the different energy sources.

ii) Wheeling Arrangement and Charges

According to the TPA Code, the Transmission Network Owner must provide non-discrIminatory rights to use or access its transmission network to third parties for the purpose of supplying large load customers. Third parties wheeling power through the transmission network must pay wheeling charges to the transmission network operator.

The transmission network owner or the regulated retailer is also required under the TPA Code to submit a Statement of Wheeling Arrangements and Charges to the regulator to approve before the regulated retailer of the third party is allowed to use transmission network for wheeling.

iii) **Connection Procedures and Charges**

According to the TPA Code, the Transmission Network Owner must provide non-discriminatory connection to its transmission network to any third party but not limited to IPPs for the purpose of;

a] Third party to supply power to the regulated retailer or network owner in order to effect the power purchase agreements between third party and the regulated retailer.

b] Third party to wheel power through the transmission network to a large load customer within the exclusive service areas of the regulated retailer.

2 Before connecting any third party, a Statement of Connection Service (SoCS) procedures and charges must be prepared by the regulated retailer and presented to the regulator for approval.

3 Thus, any third party willing to connect to the network must pay for the connection charges and connection services charges in accordance with the approved SoCS procedures and charges.

10.7.3.4 Challenges Facing Papua New Guinea in Tariff Setting

1 Acute shortage of generation capacity;

2 Transmission constraints and inadequacies;

3 Inadequate generation mix e.g. solar, wind, biomass, coal, etc.;

4 Unacceptable technical and non-technical loss levels; and

5 Information Asymmetry between regulator and regulated entity

6 Lack of publicly available data and information, and

7 Lack of institutional capacity and resources.

10.7.3.5 Tariff Setting Principles

1 The proposed National Energy Authority (NEA) upon setting the tariff, should have regard to ensure that the prices charged by licensees are fair to consumers and sufficient to allow the licensees finance their activities and to allow for reasonable earnings for efficient operation.

2 The proposed NEA, must design an appropriate tariff structure, and set out multiyear tariff for the electricity industry, subjecting it to review at appropriate terms, as it sees fit.

3 An open and transparent public process of consultation is adopted, with a holistic and scientific approach to balancing electricity tariffs to ensure a fair and cost-reflective tariff regime capable of supporting the growth of the industry, whilst attracting new investment into the sector.

4 The key principles that the National Energy Authority of Papua New Guinea (NEA) need to be cognisant of in terms of setting the tariffs for each of the generation, transmission and distribution (including retail) sectors are:

a] **Cost recovery / financial viability** - regulated entities should be permitted to recover their (efficient) costs, including a reasonable rate of return on capital.

b] **Signals for investment** - prices should encourage an efficient level and nature of investment (e.g. location) in the industry.

c] **Certainty and stability** of the pricing framework is also important for private sector investment.

d] **Efficient use of the network** - generally, this requires "efficient" prices that reflect the marginal costs that users impose on the system and the reduction of cross-subsidies.

e] **Allocation of risk** - pricing arrangements should allocate risks efficiently (generally to those who are best placed to manage them).

f] **Simplicity and cost-effectiveness** - the tariff structure and regulatory system should be easy to understand and not excessively costly to implement (e.g. facilitate metering and billing).

g] **Incentives for improving performance** - the way which prices are regulated should give appropriate incentives for operators to reduce costs and/or increase quality of service.

h] **Transparency/fairness** - prices should be non-discriminatory and transparent. Non-discriminatory access to monopoly networks is also a key prerequisite for effective competition in the contestable sectors.

i] **Flexibility/robustness** - the pricing framework needs to be able to cater for unforeseen changes in circumstances.

j] **Social and political objectives** - the pricing framework needs to provide for the achievement of social policy goals such as universal access, demand-side management and user affordability.

10.7.4 Feed in Tariff (FiT)

10.7.4.1 Overview

1 FiT is a convenient tool for many countries, that is strongly recommended for PNG to encourage renewable energy generation.

2 Feed in Tariffs (FiT) are fixed electricity prices that are paid to Renewable Energy (RE) producers for each unit of energy produced and injected into the electricity grid. The payment of the FiT is guaranteed for a certain period of time that is often related to the

economic lifetime of the respective RE project (usually between 15-25 years). Another possibility is to calculate a fixed maximum amount of full-load hours of RE electricity production for which the FiT will be paid. FiT are usually paid by electricity grid operators, system or market operators, often in the context of Power Purchasing Agreements (PPA).

3 Most RE support schemes, the level of FiT is determined on the basis of a calculation of the levelised cost of electricity (LCOE) produced from RE. This allows the RE investor to recover the different costs (capital, O&M, fuel, financing) while realizing a return on investment that depends on the assumed financing costs. In some cases, FiT has been calculated on the basis of avoided costs for the electricity system or the society, including e.g. environmental externalities such as pollution, displacement of people and loss of land. Thirdly, it is also possible to determine the FiT level by means of a tendering mechanism.

10.7.4.2 Design Options

1 FiT are usually differentiated by technology to reflect the differences in generation costs between the various Renewable Energy (RE) technologies. A second differentiation is also often done for the size of the Renewable Energy project in terms of installed capacity, reflecting the higher generation costs of small and medium scale RE projects. Thirdly, FiT can be differentiated according to the RE resource quality (e.g. average wind speed; degree of sustainability of certification) at different project locations. In this case, FiT for sites with lower RE potential are higher than those for sites with a better RE potential. In general, these options for FiT differentiation can lead to a more heterogeneous mix of different RE projects (in terms of technologies, size and location) but carry the risk of increasing the overall costs of the support scheme (NREL 2010)[8].

2 In many FiT schemes, RE investors are also eligible for the payment of additional bonuses (i.e. an increase of the basic FiT) for the use of certain biomass fuels (e.g. sustainably developed plantation trees; liquid manure), combined heat and power generation (CHP), repowering of older RE installations, provision of ancillary services to the electricity system or specific innovative applications (e.g. enhanced geothermal systems). On the one hand, these bonuses can be useful to achieve certain policy objectives (e.g. technological innovation), on the other hand they also increase the costs of the support scheme.

3 FiT are usually stable during the whole guaranteed payment period after the commissioning of a RE project. In some cases, a higher FiT is paid in the first years of operation and a lower FiT for the remaining years. This “front-loaded” FiT can facilitate the financing of capital-intensive RE projects. In other cases, FiT is increased on an annual basis to compensate for the inflation of operation and maintenance costs.

4 The levels of FiT are usually determined by means of RE legislation or by national regulatory authorities. This means that a revision of the FiT would normally require an additional administrative act. Therefore, many RE support schemes have included an automatic degression mechanism that is applied to the FiT in regular intervals. This degression can be pre-determined (e.g. a fixed annual percentage reduction of the FiT) or it can be responsive, taking into consideration the market development for a specific RE technology.

[8] National Renewable Energy Laboratory (NREL 2010)

5 For the calculation of the degression of the RES remuneration rates, data from international studies with projections about the technological progress, market development and the evolution of the technology costs ("learning curves") are being used. The determination of the right degression rate can be challenging due to uncertainties concerning the technology development and other important factors such as financing costs.

10.7.4.3 Advantages and Disadvantages of Feed in Tariffs

1 Feed in Tariffs are a relatively simple RES policy instrument that provides a good third party code to be combined with specific design elements (in particular tariff differentiation) that allow a fine-tuning of the support and the achievement of different policy objectives (e.g. innovation, climate protection, regional development, etc.). For RES investors and financing institutions, the existence of FiT combined with long-term contracts guaranteed by the Government provides transparency, predictability and security and therefore contributes to towering investment risks and financing costs. The existence of FiT generally also contributes to a more continuous and stable RES market development. FiT provide an incentive to maximize the production of RES electricity because they are output-based. In many countries, they have proven their ability to stimulate rapid and large-scale RES market development as well as the development of less mature RES technologies and the participation of small and medium scale RES electricity producers.

2 The main challenge with FiT has been the definition of remuneration levels which are neither too low to be attractive for investments, neither too high in order to avoid over-compensation ("windfall profits") and a market development that leads to the escalation of costs of the RE support scheme or to technical problems with the electricity system. Therefore, a good knowledge and monitoring of the actual costs of RE projects is required. In many cases, FiT have not been set at the right levels due to the problem of information asymmetry between the public and private sector as well as political influence during the FiT determination.

3 FiT schemes without degression have proven to have a rather slow reaction time to rapid changes in RE costs (e.g. the cost reductions of photovoltaic systems during the past few years). Even if there is a degression mechanism, the degression might be set at a level that does not reflect the actual development of RE costs. FiT also do not provide any incentive for RE operators to respond to price signals of the electricity market. Therefore, FiT schemes do not allow for an effective market integration of RE.

4 Feed in Tariffs have proven to be very effective in stimulating rapid and large- scale development of RES. Feed in Tariffs (FiT) and feed-in premiums (FIP) remain the most widely adopted renewable power generation policy employed at the national and state/provincial levels. As of early 2014, 73 countries and 28 states/provinces had adopted some form of FIT/FIP policy (REN 21 Renewables 2014 Global Status Report). This has been mainly attributed to the high investment security that long-term guaranteed FiT is providing.

5 Papua New Guinea could start with a relatively simple design, such as a technology-specific FiT that is based on power generation costs. Thereby, over certain time period, harness with technological advancement and in consideration of the economies of scale, more sophisticated design options could be added.

10.7.5 Embedded Generation

1 The concept of Embedded Generation in the transmission of renewable energy leads to the idea of exploiting all possible renewable resources at a particular site i.e. the build environment, in an attempt to meet the demand load. They consist of two generating components, Active and Passive renewables.

2 **Active renewables** involves the direct conversion of renewable energy to electricity or heat e.g. wind turbines, photovoltaics, biomass generation, hydroelectric, geothermal, etc.

3 **Passive systems** on the other hand are second-hand energy, obtained from waste heat of PV cells, daylighting or generally energy obtained through any indirect means.

4 Some of the advantages of Embedded Generation include:

a] **Reduction in Transmission Losses.**

Transmission of electricity over long distances can incur transmission losses in the range of 5-7%. This figure includes losses from the transmission lines as well as substations and the associated electrical components. This is seen as savings when the distance of transmission is reduced in embedded generation.

b] **Reduction in Construction Cost**

When the transmission distances are reduced, the construction cost of Substation, Transmission Towers and Right of Way would also be reduced or eliminated altogether. Especially in city centres where transmission is achieved through underground cables, there could be substantial savings involved as the cost of these cables can be 10 - 20 times that of overhead lines.

c] **Environmental Concerns.**

The environmental benefits associated with embedded generation are related to the reduced construction in long distance transmission (substation buildings and transmission towers) as they involve the clearing of land and trees. Also a benefit of embedded generation is the Corona Effect which is associated with overhead transmission lines. This involves noise disturbance and transmission interference to the surrounding population.

d] **Avoid Supplying Excessive Amounts of Electricity to the Grid.**

The national electricity grid is saturated with supplies from existing power generators and by adding in extra amounts of electricity from renewable sources, this would only be wasted in the form of heat. It would be better if this generated electricity is used to satisfy a demand load as in an embedded generation scheme and the total energy consumption is reduced at the point of demand.

e] **Stability and Reliability**

The issue of stability and reliability of supply from the power electronics point of view can be improved in an embedded generation scheme as opposed to the supply of electricity over long distance. This is attained through shorter response time and better controls over the embedded systems

f] **Supply and Demand Matching.**

The ability to design the supply to match the demand as in an embedded generation scheme, again, would reduce unnecessary wastage as the demand profile is better defined for a smaller load than it is for supplying a whole region or country via the grid.

5 Embedded generation offers an excellent option for the transmission of energy at the local level and coupled with the growing interest/research in renewable energy within the build environment, it would make a good combination in the way energy is generated and transmitted in the future.

11 ENERGY EFFICIENCY AND CONSERVATION

11.1 BACKGROUND

1 Energy efficiency and conservation refers to measures aimed at reducing energy consumption without sacrificing comfort, productivity or increasing costs. Energy efficiency and conservation measures have the potential to scale down capital investments needed to provide additional supplies and reduce overall resource use. It also has the potential of reducing cost of production at the end user level.

2 Energy efficiency and conservation reduces energy demand, improves energy security, improves competitiveness and helps to mitigate climate change by lowering GHG emissions.

3 A number of factors have highlighted the importance of, and urgency for, energy efficiency and conservation:

a] **High energy prices** - the continuing increase in the price of energy has significantly contributed to increased interest in energy efficiency and conservation.

b] **Insecurity of supply** - expressed in the growing discomfort about the vulnerability and uncertainty of future energy supplies as well as the volatility of their prices.

c] **Adverse environmental and health impacts** - there is increasing concern about spiralling degradation of the environment as exemplified by increased local air pollution and acid precipitation from ever growing fossil fuel combustion (particularly HFO). Associated with this are global issues such as climate change as a result of GHG emissions.

d] **Depletion of energy resources** - there is growing unease at the rate of depletion of major energy resources. The most used energy resources such as fuel wood and fossil fuels are becoming scarce as demand rises.

4 From the consumer's point of view, energy efficiency and conservation measures yield direct savings on the energy bill. From the national stand point, adoption of such measures would significantly reduce the foreign exchange costs of oil imports. It would also serve to defer additional investment in power generation capacity. Ultimately, improved energy efficiency would boost the competitiveness of PNG products owing to reduced input costs.

11.2 CHALLENGES

1 Inadequate awareness of the potential benefits from efficient use and utilization of energy efficiency and conservation practices, technology and appliances.

2 Consumer apathy. There is a tendency for consumers not to embrace energy efficiency and conservation best practices as long as there is good supply of energy for current use.

3 Limited use of available conservation and new technology tools with increased efficiency leads to energy wastage.

4 High technical losses in the generation, transmission and distribution systems.

5 Limited technical capacity, training and expertise in energy management and conservation.

6 Lack of comprehensive, reliable energy audit data and information covering various sectors and sub-sectors.

7 Slow adoption of conservation opportunities and measures due to socio-economic factors.

8 Inadequate financing owing to challenges in sourcing funds and credit mobilization for energy efficiency and conservation projects are impediments to investment in this area.

9 Insufficient standardized equipment and appliances that would benefit from tax rebates and fiscal incentives.

10 Low awareness of existing fiscal, legal, regulatory incentives, frameworks and mechanisms such as tax holidays, generation plant and equipment tax rebates, emerging credit facilities such as green energy facility grants and loans and carbon credit from the Clean Development Mechanism (CDM).

11 High cost of optimisation technologies in energy development and consumption.

1 1.3 STRATEGIES - ENERGY EFFICIENCY AND CONSERVATION

1 The Government will make necessary amendments to legislations governing fuel use, environment, transport and building to regulate energy use and vests it in the National Energy Authority (NEA).

2 The Government will formulate an Energy Efficiency and Conservation Policy as a matter of urgency and complement it with this Energy Policy.

3 The Government will promote energy efficiency and conservation initiatives in all sectors.

4 The Government will enhance the provision of energy audits and advisory services in the provinces.

5 The Government will establish laboratories for energy efficiency and appliance testing under the NEA.

6 The Government will disseminate information on energy efficiency and conservation to consumers.

7 The Government will provide incentives and penalties to reduce high losses in generation, transmission and distribution systems.

8 The Government will provide appropriate fiscal and other incentives to enhance uptake of energy optimisation technologies.

9 The Government will review energy intensity in all sectors and international best practices so as to enable process improvement.

10 The Government will broaden the scope of energy efficiency and conservation efforts by government agencies responsible for environment and energy matters.

11 Introduce the concept of green design in buildings. This includes solar water heating, natural lighting, ventilation and open office design among others.

12 Promote development of standards and codes of practice on energy efficiency and conservation.

13 Develop and enforce standards for fuel economy through speed limits, efficiency of motor vehicle engines as well as adopting good driving and maintenance practices.

14 Promote mass transportation of passengers and cargo so as to encourage economies of scale and ensuring fuel efficiency.

15 Promote the introduction of new and efficient technologies such as hybrid engines, compressed natural gas (CNG), liquefied petroleum gas (LPG), fuel cell and electric vehicles through demonstration, research and training.

16 Prepare a National Energy Efficiency and Conservation Plan in consultation with relevant stakeholders.

17 Promote efficiency in oil refining in line with modern practices which minimize wastage and encourage heat recovery.

18 Promote efficiency and improvement in conservation, generation, transmission distribution and consumption of energy including incentives to encourage assembly and manufacture of energy efficient equipment.

19 Promote research and development in the field of energy efficiency and conservation.

20 Support preparation of education curriculum on efficient use of energy and its conservation for education institutions and coordinate with them for inclusion of such curriculum in the syllabus.

21 Implement international co-operation programmes relating to efficient use of energy and its conservation.

22 Provide financial incentives for any investment made to replace infrastructure or additional capital investment to improve energy efficiency.

12 LAND, ENVIRONMENTAL HEALTH AND SAFETY

12.1 BACKGROUND

1 Land is a critical resource in the development of energy infrastructure. However, due to competing interest in land utilization, the sector faces challenges in developing its infrastructure.

2 Environmental Management in the energy sector is key to ensuring sustainability in the energy chain. Energy production, transportation and use pose various dangers to human life and the environment. The challenge for players in the energy sector is the provision of affordable, competitive, reliable and sustainable energy whilst upholding people's rights to land, environment, health and safety.

3 The *Environmental Act 2000* is the umbrella legal framework in respect to environmental management in Papua New Guinea. Its implementing agency is the - Conservation and Environmental Protection Authority (CEPA). It recognizes a "Lead Agency" as any Government institution in which any law vests functions of control or management of any element of the environment or natural resource. Lead Agencies therefore play an important role in enforcing compliance with laws and regulations.

4 Environmental Impact Assessment Regulations require that mitigating measures be put in place to minimize the adverse impact of energy projects. Comprehensive environmental impact assessments are conducted for all projects prior to their implementation to ascertain the level of potential environmental damage, the required mitigation measures and associated costs.

5 Other authorities that have regulatory mandate in the energy sector in terms of environment, health and safety under the auspices of the Occupational Health and Safety Services (OHSS) under the *National Health Administration Act 1997*, *Public Health Act 1973* and thus the Industrial Safety, Health and Welfare Regulation of 1965, and the Water PNG Limited respectively under the *Water Resource Act of 1982, National Water Supply & Sewerage Act 1986* and the National Maritime Safety Authority (NMSA) under the *Merchant Shipping Act 1975 and Merchant Shipping (Safety) Regulations of 1975.*

6 Vision 2050 acknowledges that land is a vital factor of production in the economy together with its aesthetic, cultural and traditional values. Some key initiatives envisioned to address environmental problems which relate to the energy sector are:

a] Sustainable management of natural resources.

b] Pollution and waste management.

c] Disaster risk management.

d] Use of incentives for environmental compliance.

7 The National Constitution of Papua New Guinea under Section 53 offers protection of right to property in which citizens are protected from unjust deprivation of their properties. Energy sector players, to whom land access and utilization is critical, must be aligned to this fact. In addition, Section 61 provides basic rights and freedom whereby every person has a right to a clean

and healthy environment, thus the Constitution also declares that sustainable development amongst the values and principles of governance which bind all State agencies, officials and any person implementing public policy.

8 The trans-boundary impact of environmental pollutants has necessitated international cooperation in order to prevent, minimize and mitigate pollution. A substantial portion of the risks arise from operations in the energy sector, amongst them transportation of petroleum products, disposal of hazardous waste, handling and management of radioactive materials. Several multilateral environmental agreements/treaties have been developed globally with Papua New Guinea ratifying and implementing a number of them. The Constitution provides that any treaty or convention ratified by Papua New Guinea forms part of the laws of Papua New Guinea. It is necessary to develop guidelines to ensure the application and compliance of the relevant conventions in the energy sector.

12.2 ENERGY SUPPLY SIDE ENVIRONMENTAL CONCERNS

12.2.1 Fossil Fuels and Renewable Energy

12.2.1.1 Exploration and Production

1 Exploration and production activities can have negative environmental impacts and therefore should be conducted in a way that protects the environment. Offshore and onshore exploration effects can be minimized by limiting the exploration duration and activities as well as employing newer technologies.

12.2.1.2 Petroleum

1 Major environment, health and safety concerns in the petroleum industry are fire outbreaks and oil spills. In other countries, incidences have occurred, which a number of incidents involving petroleum products has led to loss of life and property. However, Papua New Guinea can avoid such accidents through adoption of international best practices in handling safety concerns in the sub-sector and ensuring strict compliance and enforcement of the regulations.

2 Personnel handling petroleum products are exposed to the risks associated with inhalation of product fumes and thermal contact. These concerns can be addressed through use of high standard equipment and repeated use of personal protective equipment.

12.2.1.3 Clean Coal

1 Concerns in the coal industry as experienced by coal-producing countries include emissions which contribute to global warming and acid rain. However, if Papua New Guinea harnesses and develops coal, modern technologies such as Clean Coal Technology (CCT) can be applied to reduce pollution significantly.

2 Clean coal energy can be harnessed chemically without combustion with air by capturing 99% of Carbon Dioxide ($C0_2$).

12.2.1.4 Renewable Energy

1 Generally, renewable energy is considered as an environmentally friendly option for energy development. However, some concerns exist raising the need for mitigation measures to be incorporated in projects to ensure minimal impact and also ensure sustainability.

12.2.1.5 Geothermal

1 Geothermal power generation involves drawing fluids at high temperature from deep in the earth. These fluids carry a mixture of gases which contribute to global warming, acid rain, and noxious smells if released.

2 To mitigate these, the plants are equipped with emission control systems to reduce the

exhaust. In addition, the practice of re-injecting these fluids into the earth in order to stimulate production helps to reduce the environmental risk. Other mitigation measures include extraction of excess materials for industrial use.

12.2.1.6 Large Hydro

1 The major concern for large hydros is the displacement of people and wildlife where a reservoir is located. Large reservoirs result in submersion of extensive areas upstream, destroying ecologically rich and productive land, riverine valley forests, marshlands and grasslands.

2 Dams also have an impact on aquatic ecosystems both upstream and downstream by disrupting the reproductive cycle, e.g. fish whose spawning grounds are normally upstream. Submerged vegetation - decomposes anaerobically producing methane, a potent greenhouse gas multiple times worse than $C0_2$. Other risks of hydros include dam failure which may be caused by sabotage, or structural failures, and siltation. Appropriate mitigation measures should be adopted to counter these and other potential negative effects.

12.2.1.7 Biomass

1 Use of indigenous forest for biomass has significant negative environmental impact in the form of deforestation so needs to be avoided.

2 Biomass development that utilise newly developed plantations in a sustainable manner should be encouraged, particularly if internationally certified as sustainable.

12.2.1.8 Electricity

1 The construction and operation of electricity projects have a direct impact on the quality of the environment either by the emission or discharge of pollutants, poor waste handling, or by changing the ecological systems. The degree of pollution and other ecological impacts are dependent upon the nature of the technology in use as well as the size and the general location of the plant.

2 A health and safety concern with electricity grid systems and consumer installations is the danger of electrocution and electric shocks. Electricity also has the potential to significantly improve the quality of life so needs to be balanced by other concerns.

12.2.1.9 Nuclear Energy

1 The global, traditional challenge of nuclear energy remains the management of radioactive waste. However, as a result of continued research in the area, radioactive waste management is now well within manageable levels. Spent fuel rods can either be safely stored until the radioactive levels reduce to non-toxic levels or be reprocessed and reused in generation of nuclear energy. The waste also requires special handling and storage facilities to reduce the risk of exposure to employees, the public and the environment.

2 A nuclear meltdown may cause release of radioactive materials which can have a negative impact to environment, health and safety of persons. However, further research has led to development of advanced reactors with enhanced security and safety mechanisms that greatly diminish the possibility of a nuclear accident.

12.3 DEMAND SIDE ENVIRONMENTAL CONCERNS

1 Some solid fuels or biomass fuels are less efficient than oil, natural gas or LPG. It can take larger quantities of peat, wood, or coal to do the job and they will produce larger quantities of smoke when they are burned. Solid fuels produce less heat for the amount of fuel consumed and produce more pollution. This is described as the energy ladder.

2 The conversion efficiency of modern biomass power plants is approximately the same as that of gas turbine altitudes observed in much of Papua New Guinea. In addition, modern biomass power plant technology results in less smoke and much less other pollution than liquid fuel sources such as oil, diesel or fuel oil.

3 Some solid fuels lead to increased indoor air pollution which leads to Upper Respiratory Tract Infections (URTI). The challenge is to move consumers up the energy ladder recognizing that biomass, which is at the bottom of energy ladder provides 60% of cooking energy needs in Papua New Guinea.

4 Kerosene is widely used in households for lighting and cooking, mainly by rural masses in the country. In 2008 about 300 thousand cubic metres were used, up from 200 thousand cubic metres consumed in 2003 according to the UN Human Development Indictor. However, this causes indoor air pollution leading to cases of URTI, in addition to the risk of explosions of lamps and stoves leading to injuries, loss of lives and property. There is need to move consumers from the consumption of kerosene to LPG and natural gas.

5 PNG Biomass has an initiative where it is rolling out low-smoke wood-fired cooking stoves which can also provide electricity and light, and be used to charge portable electronic devices such as mobile phones.

12.4 CLIMATE CHANGE ISSUES

1 Papua New Guinea was a signatory to the Kyoto Protocol, a treaty signed in 1997, to lower anthropogenic emissions of Carbon Dioxide ($C0_2$). However, Papua New Guinea is not among the Annex I countries, which have emission reduction targets since its emissions are low - compared to emissions from developed (Annex I) countries and MDCs and LDCs. However, under the protocol, there are opportunities to benefit by selling Certified Emission Reductions (CERs) through the Clean Development Mechanism (CDM). Papua New Guinea has developed a National Strategy on Climate Change.

2 Although Papua New Guinea has ratified the Kyoto Protocol, it has not benefited much from the CDM since potential projects may have not been approved, developed or fully made operational, though, the projects proposals may have been submitted for consideration under CDM.

3 With such results of whether, there are investments and or not being proposed, approved and developed, on a scale of between 100 points (highest) and 0 points (lowest), Papua New Guinea is rated to have an ‘inadequate’ climate for CDM investment. It however needs to move from ‘Satisfactory’ to ‘Good’ categories to improve opportunities to attract investments.

4 PNG is now a signatory to the Paris Climate Accord (COP21).

12.5 DISASTER PREPAREDNESS AND MITIGATION

1 Natural disasters may be triggered by adverse weather and climate conditions, whereas manmade disasters may be due to sabotage, human error or technological failure. Government therefore recognizes the need to establish appropriate disaster preparedness and mitigation mechanism within the energy sector.

2 The following hazards are a constant threat that must be taken into consideration in planning and management of the energy sector:

a] Climate and weather hazards including floods and droughts.

b] Geophysical hazards including earthquakes, faults, volcanic eruptions, subsidence, landslides, blowouts and mud flows.

c] Environmental hazards including soil erosion, siltation and desertification.

d] Industrial accidents, oil spills, human negligence, sabotage can occur through terrorism and other deliberate acts and infrastructural systems failure.

3 The challenges are mainly in setting up and making operational capacity for disaster preparedness, management and mitigation. However, this can be addressed through proper disaster preparedness and management mechanisms and practices.

12.6 LAND AND SOCIO-ECONOMIC IMPACTS

12.6.1 Background

1 Energy development projects have various impacts on communities where the projects are implemented. Key among these is both economic and physical displacement. Physical displacement of project affected people is particularly prevalent in projects such as hydro power plants requiring water reservoirs, acquisition of way leaves during construction of transmission lines and pipelines. Others include the concern by local communities that they will not benefit from these projects.

12.6.2 Challenges

1 **Absence of a Resettlement Action Plan (RAP)** Framework: Currently, all projects receiving support by World Bank or IFC are required to develop RAPs. These should be replicated for all projects and a national framework developed. The State shall develop Resettlement Plan Framework for all hydro projects that causes shifting and relocation of settlements.

2 **Access to and acquisition of land:** Difficulty in the acquisition of sites, way leaves, rights of way and easements to facilitate energy infrastructure development is an impediment to fast tracking the improvement and upgrading of the energy systems. Further, legal and regulatory provisions in the energy sector governing land acquisition and access are inadequate. The State shall pursue all avenues to secure land through outright purchase or long term lease from the landowner for purposes related to the projects including right of way and establishment of infrastructures of the hydro projects.

3 **Absence of a comprehensive and fair compensation mechanism** for focal communities in line with the national constitution. The State shall promote equity and benefits sharing with the State, the Developers and the landowners.

4 **Vandalism of energy sector infrastructure** continues to cause immense losses as well as supply interruptions.

5 **The need to enhance regional, gender and environmental considerations** in energy planning and development. The State shall promote equal gender participation across all age group and the vulnerable communities.

6 **Land access and permit** where exploration blocks fall on private land or cultural heritage areas including game parks and reserves. The developer shall take all necessary precaution to minimise collateral' damage to neighbouring property including all reserves area in the cause of its operation. The State shall promote good stewardship and protection of reserved areas and exercising environment rehabilitation and restoration measures.

7 The State shall ensure the right of way and access thereof and all national corridors to be kept open at all times.

12.7 STRATEGIES - LAND, ENVIRONMENT, HEALTH AND SAFETY

12.7.1 Land and Socio-Economic Issues

1 Align all energy projects with the National Land Policy, which provides a framework for access to planning and administration of land in the country. The National Land Commission and the Land Titles Commission is to ensure that planning for utility services and public private infrastructure under *Land Act 1996 and Physical Planning Act 1989* for State Leases and *Land Titles Commission Act 1962* and *Land Group Incorporation Act 1974* respectively on customary land, includes planning for energy utility services namely way-leaves, infrastructure development, transmission, distribution and pipeline corridors.

2 Make provision for waivers in respect to any charges for utilization of resources owned by other public bodies critical to the development of energy infrastructure and service provision such as way-leaves, easements and rights of way. Any compensation for interest in land under the *Land Act 1996*, *Land Group Incorporation Act 1974* and Section 54 of the Constitution shall be at market rate as determined by a registered Land Valuer, where there is no dispute. The Government shall initiate compensation within a reasonable period. However, where there is a dispute, the Government Valuer(s) shall provide opinion to ensure uniformity and fairness.

3 National Government to determine rates payable for compensation in respect of damage caused by the energy sector players including clearing way leaves among others.

4 Seek for amendment/repeal of any legislation that impact negatively on the energy sector.

5 Make provision to allow the right of access to survey and use of land for energy infrastructure development purposes including but not limited to prospecting for petroleum, gas and coal, storage, transmission, laying of petroleum pipelines and electricity supply infrastructure, dams and geothermal development.

6 Provide that where energy infrastructure and ancillary apparatus are removed, the surface of the land shall forthwith be restored to its former condition as far as possible and in default thereof, the owner of the land may carry out the restoration, and the costs thereof shall be recoverable from the licensee.

7 Empower communities and landowners to manage the infrastructure including provision of security and participate in any spinoff benefits. Details of this is captured under the chapter on indigenous participation.

12.7.1.1 Strategies - Land and Socio-Economic Issues

1 Provide for in legislation the following;

a] Provide for restoring, repairing damage or making good loss caused by a licensee's operations in respect to laying of energy infrastructure or extraction of energy resources in accordance with the Constitution and other legislations covering the regulatory aspects of developments.

b] The National Executive Council (NEC) may gazette or not to gazette all land held by public entities for energy infrastructure.

c] A licensee may erect, install, break up or lay energy infrastructure and ancillary apparatus upon, under, over or across any public streets, road, railways, tramways, rivers, canals, harbours, game parks, water ways, forests or Government property, in the manner and on the conditions as will be provided from time to time. A licensee may repair, alter or remove any such infrastructure and ancillary apparatus so erected, laid or constructed, provided that the person having the control of such street shall have a prior right to break up and repair such street with reasonable dispatch upon payment to him of a reasonable charge by the licensee.

d] Where a licensee faces constraint in accessing any natural resource including land and water for development of energy infrastructure, the licensee may prevail upon the national government to access the State own resources or to mediate access to traditional landowners resources or access portions of existing water bodies for such purposes.

e] Whenever a licensee carries out any work authorized his license or permit, he shall comply with the regulations of the Provincial Governments concerned and shall complete that work within reasonable time and reinstate the street broken up and remove any debris or rubbish occasioned thereby and shall, while the street is broken up or obstructed, cause the works to be, at all times, fenced and guarded and during the night, adequately lit.

f] Where a public institution in the energy sector requires the compulsory acquisition of land for use, the institution may apply to the NEC to acquire the land on its behalf.

g] Provide for the right in cases of emergency to clear obstructions to infrastructure installations by any licensee in the energy sector. Where necessary, the entity can obtain an order from the National Energy Arbitration Tribunal (NEAT) under the auspices of the NEA, thus allowing for access to the area.

2 Provincial Governments shall set aside suitable land for energy infrastructure development purposes, including but not limited to projects recommended in the indicative National Energy plans.

3 Provide for the following offenses:

a] Illegal acquisition of interest in public land set aside for energy infrastructure projects through encroachment or grabbing and include punitive penalties for either offence;

b] Trespass on or encroachment of energy installations, infrastructure and way-leaves, way-leaves trace.

c] Infringement in respect of blasting, quarrying, dumping of materials, structures erection and any other activity that compromise distribution services.

d] Develop a Resettlement Action Plan (RAP) Framework for energy related projects; including livelihood restoration in the event of physical displacement of communities not in compliance thereof.

e] Provide for access to land where exploration blocks fall on private land, community land and cultural heritage areas including game parks and reserves.

f] Full acquisition of all project sites and way leaves to prevent occupation and potential disaster including relocation of existing occupants to prevent encroachment.

12.7.2 ENVIRONMENT HEALTH AND SAFETY

12.7.2.1 Strategies - Environment. Health and Safety

1 Provide a procedure for enforcement of environmental rights under *Environment Act 2000* and specifically provide for notification of breach and giving time to remedy the breach.

2 Provide a mechanism for management of oil spills including clean-up and penalties in consultation with other statutory authorities.

3 Promote sustainable development as provided for under National Goals & Directive Principles (NGDP) of the Constitution be incorporated in the proposed *National Energy Authority Bill.*

4 Develop and implement Environmental Impact Assessment (EIAs) and other guidelines for the energy sector. Monitor their implementation through Environmental Management Plans (EMP).

5 Facilitate the development of standards for equipment, products, protective equipment, facilities and operating practices in the energy sector to ensure safe operations. Where there are no local standards, relevant international standards shall apply.

6 Provide for measures which act as a catalyst for consumers to move up the energy ladder including fiscal incentives on LPG appliances, construction of import handling facilities for LPG, and introduction of cleaner fuels and technologies.

7 Develop guidelines to ensure the application and compliance of relevant conventions in the energy sector.

8 Enhance sectoral, regional, gender and environmental considerations in energy planning and development.

9 Strengthen ENERCOMs capacity to provide leadership and enforce environmental health and safety requirements, environmental disaster risk management and response in the energy sector in consultation with other statutory authorities.

10 Enhance and strictly enforce penalties for vandalism of energy sector infrastructure, equipment and materials.

11 Establish a competent data monitoring, processing and management facility within an institution for all data and information relating to water and environment.

12.7.3 CHANGE MITIGATION

12.7.3.1 Strategies - Climate Change Mitigation

1 Support the development of the national position on climate change and participation in international climate change negotiations to improve the investment climate for climate change energy projects.

2 Collaborate with other stakeholders on climate change on energy issues to address the challenges.

12.8 SECTOR SPECIFIC EHS STRATEGIES

12.8.1 Electricity

12.8.1.1 Strategies - Electricity Sector EHS Concerns

1 Put in place mechanisms to mitigate negative effects of generation, transmission and distribution of electricity.

2 Introduce proper public walkways in metropolitan areas and encourage the use of bicycles, motorcycle, scooters and other energy efficient transport systems and designs.

12.8.2 Fossil Fuels

12.8.2.1 Strategies - Environment, Fossil Fuels EHS Concerns

1 Carry out rapid urban air quality assessments on energy sector emissions and identify key problem sectors/areas that need to be prioritized in tackling air pollution by energy sector emissions.

2 Develop strategies to reduce transport emission, including:

a Adoption of low sulphur fuels and clean vehicles programs within the timelines agreed by Ministers at the Better Air Quality Regional Policies and Strategies Fossil Fuels EHS Concerns.

b Setting up and or revamping vehicle emission inspection and maintenance programs for existing vehicle fleets.

3 Continuously update and enforce the specifications standards for supply of clean fuels.

4 Ensure that all energy generation plants adhere to emission standards and further employ more efficient technologies. The Government shall ensure dissemination of standards, provide public sensitization on dangers of vehicle emissions and promote choice towards clean fuels and vehicles, public transport and non-motorized transport.

5 Provide incentives for acquisition of fuel efficient technologies in motor vehicles.

6 The Government to develop and promote alternate energy source in households as a means for elimination of kerosene in households by 2030.

12.8.3 Renewable Energy

12.8.3.1 Strategies - Nuclear Electricity EHS Concerns

1 Actively support and promote the uptake of renewable energy technologies.

2 Ensure sustainable production and use of wood fuel resources.

3 The Government shall ensure promotion of modern production technologies, introduce a regulatory framework for wood fuel and support commercial woodlots.

4 The Government shall support the national tree cover policy aimed at increasing the national tree cover to 10% and above[9] .

5 Promote the development, commercialization and widespread utilization of renewable energy technologies. In addition, the price of charcoal and wood should also reflect the cost of replenishing raw materials.

6 Ensure compliance with international standards for plant siting construction operation and decommissioning and waste management to ensure proactive preventive approach to managing the environment health and safety risks.

[9]CEPA

12.8.4 Conservation of Catchment Areas

12.8.4.1 Strategies - Conservation of Catchment Areas

1 Support conservation initiatives and ensure proper coordination of all relevant statutory authorities.

2 Ensure effective management of the catchment areas to safeguard both the installed capacity and potential power generation sites.

3 Identify and map out water catchment areas boundaries and gazette them as protected areas.

4 Support hydro power generators in catchment area conservation initiatives through both fiscal and other mechanisms.

5 The Government shall declare hydro dams and reservoirs as controlled catchments. By this provision all activities in the catchment are regulated.

6 Empower the institution that administers controlled catchment regulating to prosecute personnel or agencies that contravene the controlled catchment provisions.

7 The Government shall make it mandatory that Cumulative Impact Assessment be undertaken by developers of small hydros to minimise and mitigate destruction to catchment areas.

12.8.5 Disaster Prevention and Management

12.8.5.1 Strategies - Disaster Prevention and Management

1 Strengthen existing emergency institutions to specifically deal with Energy disasters.

2 Using climate, weather information and data, the maximization of safety factor for hydro dams, power stations, geothermal power stations, fuel oils depots, and petroleum production areas should be taken on board in all future developments. This is especially so in areas with high risk and/or high hazard rating.

3 Mainstreaming weather, climate and environment data and information particularly hydrology to the sector's core activities.

4 Develop mechanisms for provision of security for all energy installations including weather, climate and environment monitoring installations, which shall be treated as national protected zones.

5 The sector will develop information and database on weather, climate and hydrological factors at national level and at specific site levels.

6 The following broad policy measures will be undertaken by all the energy sector entities:

a] Incorporation of disaster preparedness and mitigation into energy policy and management planning.

b] Establishment of early warning systems in all energy production and delivery systems and networks.

7 Develop mechanism for provision of security for all energy installations, which shall be treated as national protected zones.

8 The following strategies will be used for risk reduction and adoption:

a] **Information Base:** The sector will develop information and a database on weather and climate factors at national level and at specific site levels. Specific sites here refer to sites that continually understudy the interaction between weather and climate on the system and other stress monitors that relay vulnerability. One important factor here is accuracy of information and reliability.

b] **Risk zoning:** Zoning and mapping helps to enhance of evaluation risk and vulnerability. Risk mapping shall be a continuous exercise updating risk assessment results in the maps and subsequent zoning.

c] **Disaster response plans:** Using the information on climate and weather and risk prone points of a system, detailed disaster response plans will mitigate vulnerability. The plans shall include rapid reaction activity plans and initial attack or emergency steps.

d] **Disaster plans and costing centres:** Up to date disaster management plans are key in reducing risk and vulnerability.

9 Promote the concept of resilience: that is the ability at every relevant level to detect, prevent, and, if necessary, to handle disruptive challenges while minimizing damage to humans, infrastructure and the environment.

13 PROPOSED INSTITUTIONAL ARRANGEMENT

13.1 OVERVIEW

1 Since PNG achieved its Independence in 1975 a coherent National Energy Policy was non-existent. The National Energy Policy was eventually workshopped in March 2006, this followed on from an AusAid funded technical assistance (TA) facility called AusAid Advisory Service Facility (ASF) II and was part of the GoPNG ongoing Public Sector Reform in September 2003.

2 Despite several such reviews in the past by various organizations such as AusAid in 2006, Secretariat of The Pacific Community (SPC) in 2009, and DPE in 2006 very little progress occurred. The aim of the National Energy Policy was to merge all aspects of energy planning and delivery in a rationale and coordinated manner. The long term objective now is to establish an overarching National Energy Policy with an Energy Plan in order to deliver the Government's aspirations on national development. This will be in consistent with the MDG, the DSP 2010 to 2030 and Vision 2050.

3 While the SPC study reviewed the PNG's Energy Security, the ASFII reviewed the following objectives:

a] to evaluate and review current energy policies with the view to identifying issues and priorities associated with policy development and implementation;

b] to evaluate capacity building including the establishment of an overall mission statement for the Energy Wing in the Department of Petroleum and Energy.

c] Assessment of specific short, medium and long-term objectives of Energy Wing.

d] Develop indicative strategies and draw up a twenty year work plan for policy review, development and implementation support.

e] Review several policy issues relating to midstream and downstream petroleum processing of the Energy Wing.

4 The Division of Energy had also gone through three (3) decades of transition and transformation to what is now the Energy Wing of the Department of Petroleum and Energy. It was established in 1997 as Department of Energy Development with the following mandate;

a] Promote a nation-wide program of rural electrification through improvement of existing rural electrification facilities as well as implementation of our projects using environmentally sound energy conversion technologies.

5 The Department of Energy Development (DED) however, was abolished in 1995 and transformed into an Office of Energy Development within Department of Mining and Petroleum (DMP). When the Department of Petroleum and Energy was established after the abolishment of the Department of Mining and Petroleum in August 1997, the Office of Energy Development was renamed as

Division of Energy but retained most of its function of 1997 with additional functional responsibilities such as the formulation and implementation of the National Energy Policy as well as promotion of non-fossil and renewable energy.

6 Following the National Executive Council (NEC) Decision No. NG 141 of 2011 endorsement of the Electricity Industry Policy (EIP) these led to the establishment of Energy Wing, which was then mandated to undertake the technical regulatory functions of the electricity industry in the country. This will require the establishment of four (4) Regional offices located in Port Moresby (Southern Region), Lae (Momase), Mt. Hagen (Highlands Region), and Kokopo (NGI Region). This will enable the transfer of the technical regulatory functions of PPL to DPE Energy Wing, with consultations from the Independent Consumer Competition Commission (ICCC). Furthermore the Energy wing has been directed to formulate and implement the National Electrification Rollout Plan (NEROP) for the country in an endeavor to meet the 70 percent electrification access by households by year 2030 under the Development Strategic Plan (DSP) and Vision 2050.

7 Note: NEC Decision 145 of 2013 of 3rd of May directed the abolishing of the Department of Petroleum and Energy and creation of the Petroleum and Energy Authority was not implemented. The Ministerial Determinations G615/2017 was also not implemented.

8 Several additional responsibilities of the Energy Wing are as follows:

a] Monitor, review and provide recommendations on fuel pricing, electricity tariffs , and Government charges and subsidies, in order to ensure that the full and correct prices signals are conveyed to consumers when convenient.

b] Negotiate, develop and maintain its capacity to monitor and evaluate the equivalent landed price of petroleum products, the petroleum company costs elements, the pricing formula and Government charges so as to negotiate and maintain equitable pricing and proper contractual arrangements for petroleum products.

9 These therefore indicate and highlight the fact that the Energy Wing's responsibilities covers both midstream to downstream aspects of petroleum production, supply and consumption in PNG.

13.2 PROPOSED INSTITUTIONS

1 The institutional arrangements of the energy sector will be streamlined to encourage efficiency, access and affordabitity of electricity to domestic, commercial and industrial users. The energy regulatory functions, both technical as well as economic will be brought under the proposed National Energy Authority.

2 The proposal for the establishment of the NEA emanates from the Government's decision to create a new Ministry of Communication Information Technology and Energy.

3 The establishment of the Ministry means that a new Energy Policy and institutional arrangements supporting this policy must be established. The Department of Petroleum and Energy must be re-structured in order to build institutional capacity to manage the midstream to downstream activities of the Petroleum sector, as part of the overall National Energy Policy and Rural Electrification. A specific policy is contemplated for the upstream and midstream petroleum sector.

4 The Department of Petroleum and Energy will be restructured into the following entities:

a National Energy Authority (NEA).

b Energy Regulatory Commission (ENERCOM).

c Community Service Obligation (CSO) Company.

5 For capacity and financial reasons, ENERCOM will initially be housed under NEA until it assumes all regulatory functions.

6 ENERCOM should then be established as a separate entity to protect its mandate as a regulator for energy.

13.3 RESOURCING OF NEA AND ENERCOM

1 Initially the NEA would require establishment cost to be borne by the Government under a bridging fund arrangement until the Authority is self-financing.

2 Part of this transition and establishment cost will include redundancy and recruitment.

3 The operational cost will come from normal government budgetary appropriation.

4 The revenue for the NEA will initially come from licensing, regulation fees and other revenue measures within this policy framework.

5 The NEA and its subsidiaries will proactively participate, engage or be involved in commercial arrangements including but not limited to Joint Ventures (JV), Public Private Partnership (PPP) and projects with Provinces and Districts to implement government policies.

6 The NEA to be the Chief Implementer of Energy Projects in consultation with other relevant Government Agencies and Development Partners.

7 In the long term the NEA should endeavor to use and develop state of the art technology to develop new energy products for local and international markets.

13.4 FUNCTIONS

1 National Energy Authority (NEA)

Mandate:

To regulate and promote the development, dissemination of information regulation and licensing relating to all forms of energy, including non renewable and renewable energy sources; and to do all things necessary and desirable for the achievement of its objectives and functions.

Purpose:

NEA will be the overarching body responsible for all energy related matters, so far as it involves the development, conversion and transportation of energy for direct uses and for further downstream processing of the resources. It will also be responsible for encouraging the development of all renewable resources for conversion into consumer and industry uses. It will report to the Minister for Petroleum and Energy.

Function:

i Develop and implement the National Energy Policy, sub-policies and plans.

ii Maintain registry of all players in the energy industry.

iii Maintain the resource inventory for the Oil and Gas energy reserves and assets.

iv. Promote and encourage R&D into all forms of energy sources including coal and nuclear energy research.

v. Collect and disseminate data on energy sources and encourage downstream development of the resources.

vi Plan and support the rollout of electricity throughout the country through National Energy Consolidation Funds.

vii. Technology researching and prototype tests.

viii. Oversee the issuance and enforcement of regulations and licensing.

ix. Identify areas and declare reserve zones for energy security and related purposes.

x Conduct exploratory work on petroleum blocks, undertake research and development of the industry's best practices and technology and also for related purpose.

xi. Regulate and issue licenses to players in the non-renewable and renewable energy sector.

xii. Any other things necessary to the achievement of its objective.

2 Energy Regulatory Commission (ENERCOM)

Mandate:

To promote a competitive energy industry, enforce safety standards in electricity supply and consumption, setting tariffs, including safety of; electrical appliances for consumers, and to do all things necessary and desirable for the achievement of its objectives and functions.

Purpose

ENERCOM will be created to regulate and issue licenses to players in the Electricity Services Industry, setting tariffs for the electricity, enforce electrical standards and compliance in consultation with the ICCC in so far as consumer electrical goods are concerned.

Function:

i Registering industry participants.
ii Developing, administering, monitoring and enforcing the Electricity Industry Participation Code.
iii Monitoring compliance with the national electricity law, national electricity rules and national electricity regulations.
iv. Establishing service standards for transmission and distribution networks.
v Setting tariffs for generation, transmission and distribution.
vi Monitoring the electricity market and jointly promote competitive conduct, including, instituting and conducting enforcement proceedings for breaches of the law.
vii Investigating breaches or possible breaches of provisions of the national electricity law, rules and regulations,
viii Facilitating market performance through information, best-practice guidelines and related services; and
ix Undertaking energy sector reviews.
x Any other things necessary to the achievement of objective.

14 ACRONYMS & GLOSSARY OF TERMS USED & LEGISLATIONS

i) Organizations (Existing & Proposed)

APEC	Asia Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
CEPA	Conservation & Environmental Protection Authority (formerly Department of Environment & Conservation)
COADEVCO	Coal Development Company (SOE)
DLPP	Department of Lands & Physical Planning
DMP&GM	Department of Mineral Policy & Geo-Hazards Management
DNPM	Department of National Planning & Monitoring
DPE	Department of Public Enterprises
DP&E	Department of Petroleum & Energy
EECA	Energy Efficiency & Conservation Authority
EITI	Extractive Industries Transparency Initiative
ENERCOM	Energy Regulatory Commission
GEODEVCO	Geothermal Development Company (SOE)
GoPNG	Government of Papua New Guinea
HFO	Heavy Fuel Oil
IAEA	International Atomic Energy Agency
ICCC	Independent Consumer & Competition Commission
IFC	International Finance Corporation
IPPs	Independent Power Producers
IPBC	Independent Public Business Corporation
JICA	Japanese International Cooperation Agency
KPL	Kumul Power Limited
MRA	Mineral Resource Authority
NBPOL	New Britain Palm Oil Limited
NDOC	National Disaster Operations Centre
NEA	National Energy Authority of Papua New Guinea
NEDC	National Energy Data Centre
NEDRU	National Energy Disaster Response Unit
NEF	National Energy Fund
NELECTA	National Electrification Authority
NGDP	National Goals & Directive Principles (PNG Constitution)
NISIT	National Institute of Standards & Industrial Technology
NMSA	National Maritime Safety Authority
NPCP	National Petroleum Company of Papua New Guinea
OCCD	Office of Climate Change & Development
PPL	PNG Power Limited
PNG EDL	PNG Energy Development Limited
PNG SDP	PNG Sustainable Development Program Limited
NEC	National Executive Council
RERC	Renewable Energy Research Centre

RERAC	Renewable Energy Resources Advisory Committee
RPNGC	Royal Papua New Guinea Constabulary
UNITECH	PNG University of Technology

ii) Others

BOT	Built Operate & Transfer
CBM	Coal Bed Methane
CCGT	Combined Cycle Gas Turbines
CCfS	Capturing Carbon for Storage
CCT	Clean Coal Technology
CERs	Certified Emission Reductions
CDM	Clean Development Mechanism(s)
CNG	Compressed Natural Gas
C02	Carbon Dioxide
3D	3Digital
CSG	Coal Seam Gas
DGR	Domestic Gas Reservations
EAS-U	Energy Access Scale-Up
EBR	Energy Balance Report
EIA	Environment Impact Assessment
EMP	Environmental Management Plan
ERNADOR	Economic Regulation, Negotiated Access & Operational Regulation
ESI	Electricity Supply Industry
FTG	Full Tensor Gradiometer
FID	Final Investment Decision
FiT	Feed in Tariff
FLNG	Floating Liquefied Natural Gas
GDP	Gross Domestic Product
GHG	Green House Gas
GtL	Gas to Liquids
HVDC	Hides Valley Development Corporation
ICT	Information Communication & Technology
ISO	Independent System Operator
JV	Joint Venture
LNG	Liquefied Natural Gas
MCC	Mining Code for Coal
MDC	Mining Development Contract(s)
MMDC	Model Mining Development Contract(s)
MW	Megawatts
NETF	National Electrification Trust Fund
NEROP	National Electrification Roll-Out Plan
NNGB	North New Guinea Basin
NW	North West
OHSS	Occupational Health & Safety
OIEP	Oil Exploration & Production
OMC	Oil Marketing Companies
OPEC	OPEC - Organization of Petroleum Exporting Countries
PB	Papua Basin

PSC	Production Sharing Contracts
PRoF	Pacific Ring of Fire (a seismically active zone)
PGK	Papua New Guinea Kina
PNG	Papua New Guinea
PPA	Power Purchase Agreement
PPF	Petroleum Processing Facilities
PPP	Public Private Partnership
PRAEC	Petroleum Resource Area Economic Corridor
RAP	Resettlement Action Plan
RD&D	Research, Development & Dissemination
REMC	Renewable Energy Mapping Centre
REP	Rural Electrification Program
RES-E	Renewable Energy Sources - Generated Electricity
SE	SouthEast
SMR's	Small & Medium Size Reactors
SOE	State-Owned Enterprise
SOT	Service Operation Transfer
SPV	Special Purpose Vehicle
SPV	Solar Photo Voltaic
SWF	Sovereign Wealth Fund
TPNG	Telikom Papua New Guinea Limited
UNHDI	United Nations Human Development Indicator
URTI	Upper Respiratory Tract Infections
USA	United States of America
USD	US Dollars

iii) Constitution

- The National Constitution of Papua New Guinea

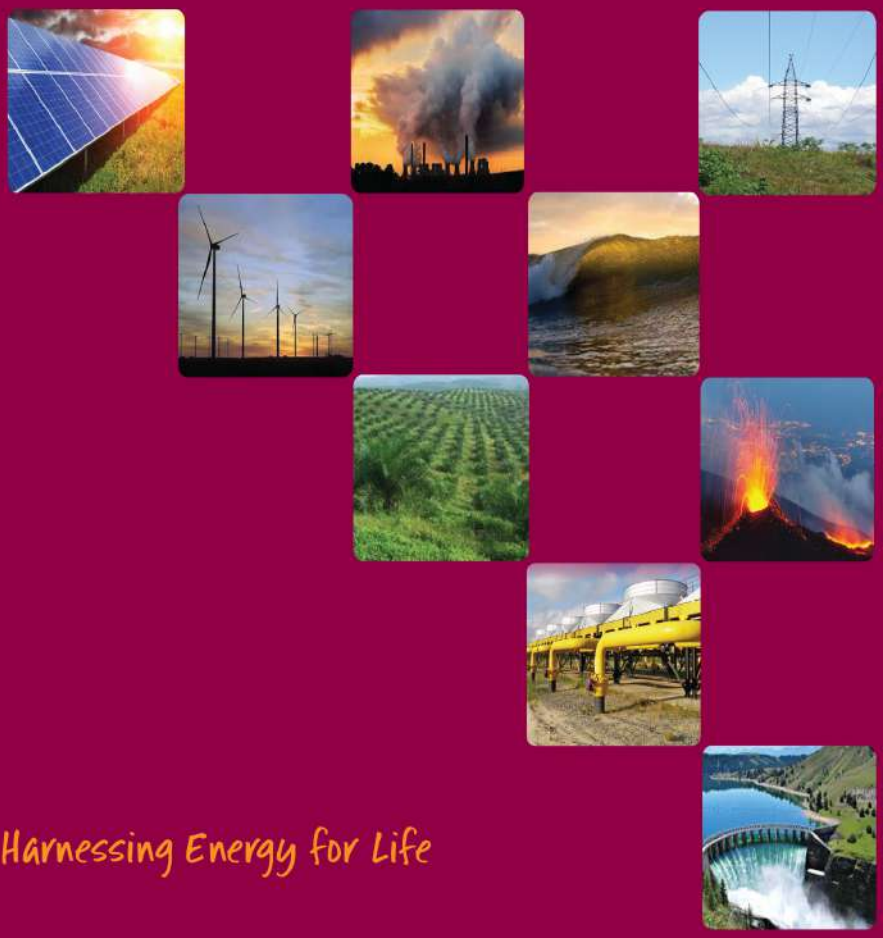
iv) Principal Legislations

- CA 1997 Companies Act 1997
- EIA 2002 Electricity Industry Act 2002
- ESA 2002 Essential Services Act 2002
- MA 1992 Mining Act 1992
- ICCC Act 2002 Independent Consumer & Competition Commission Act 2002

v) Other Legislations

- EA 2000 Environment Act 2000
- EC(P)A 2002 Electricity Commission (Privatization) Act 2002
- ECR 1966 Electricity Commission Regulation 1966
- ES(GPS)A 1970 Electricity Supply (Government Power Stations) Act 1970
- ES(GPS)R Electricity Supply (Government Power Stations) Regulation
- GA 1951 Goods Act 1951
- GSTA 2003 Goods & Services Tax Act 2003

• IPBC Act 2002	Independent Public Business Corporation Act 2002
• ITA 1959	Income Tax Act 1959
• LA 1998	Lands Act 1998
• LGIA1974	Land Group Incorporation Act 1974
• LRA 1998	Land Registration Act 1998
• LTCA1962	Land Titles Commission Act 1962
• MDA 1955	Mining Development Act 1955
• MRA Act 2005	Mineral Resource Authority Act 2005
• MSA 1977	Mining Safety Act 1977
• NCDC Act 1990	National Capital District Act 1990
• NCDC Act 2001	National Capital District Act 2001
• NISITA 1993	National Institute of Standards & Industrial Technology Act 1993
• OGA 1996	Oil & Gas Act 1996
• OLPLLG	Organic Law on Provincial & Local Level Government
• PFMA 1995	Public Finance Management Act 1995
• PSMA 2014	Public Service Management Act 2014
• PPA1989	Physical Planning Act 1989



Harnessing Energy for Life

Department of Petroleum & Energy
Papua New Guinea

ISBN: 978-9950-909-84-8

Design & Layout : Graphics Designs Consultants