

Strategic National Energy Plan

2006 - 2020



MAIN REPORT

Energy Commission, Ghana

July, 2006



Strategic National Energy Plan 2006 – 2020

Main Report

*Energy Commission
July, 2006*

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EXECUTIVE SUMMARY

Introduction

Since mid-1990s, Ghana has launched two long-term development plans aiming at transforming its low-income developing country status into an upper middle-income one by 2020. The prevailing development plan within the context of the Ghana Poverty Reduction Strategy (GPRS)¹ forecasts an average real GDP growth of 7-10 percent for the period 2003 to 2015 and is expected to achieve a per capita income of US \$1,000 by 2015 from less than US \$400 in 2001. The drivers of the expected economic growth according to the GPRS are agro-based (Agricultural sector), manufacturing (industrial sector) and Information Communications Technology.

With an expanding economy and a growing population, Ghana faces major challenges in providing the required energy in a reliable and sustainable manner having in mind the environmental and economic impacts of energy production and use and the nexus between energy and development.

Energy Production and Usage

Total primary energy produced in Ghana in 2000 was 6.2 million tonnes of oil equivalent², about eleven and half times the yearly average energy generated at Akosombo and Kpong hydroelectric plants. This rose to 7.6 million tonnes of oil equivalent by 2004.

The primary indigenous energy comprised 90-95 percent woodfuels (generally called biomass), 5-10 percent hydro energy and less than one percent solar energy. The hydro energy was supplied from Akosombo and Kpong hydroelectric dams in the form of electricity.

Net energy import was about 1.9 million tonnes of oil equivalent in 2000 increasing to about 2.6 million tonnes of oil equivalent by 2004. It comprised 80-83 percent crude oil and about 15-19 percent petroleum products.

Solar energy was used for the sun-drying of crops; mainly cocoa; cereals consisting of maize, paddy rice, sorghum and millet; vegetables consisting of groundnuts and pepper and other exportable commodities requiring drying. Solar energy for production of electricity was

¹ GPRS 1 and II

² About 69,000 Gigawatt-hour

relatively negligible; about 150 tonnes of oil equivalent.³ The primary energy production and the net import make up the primary energy supply and totalled about 8.1 and 10.2 million tonnes of oil equivalent in 2000 and 2004 respectively.

Biomass was the most dominant primary energy supplied, averaging 69 percent over the period, followed by oil comprising crude oil and products averaging 25 percent.

Final energy supply, i.e., the energy finally reaching the consumer after transportation and transmission was about 6 million tonnes of oil equivalent in 2000 and about 7.1 million tonnes in 2004.

Energy losses totalled about 26 percent of the total primary supply in 2000 but increased to about 30 percent in 2004.

The residential or household sector of the economy accounts for almost 50 percent of the country's energy consumption. The significant residential sector share of the nation's energy demand is due to the high usage of woodfuels comprising mainly firewood (almost 76 percent) and charcoal.

Carbon dioxide emissions as a result of the energy usage rose from 7.7 million tonnes in 2000 to 9.5 million tonnes of carbon dioxide equivalent in 2002 but dropped to 9.2 million tonnes of carbon dioxide equivalent in 2004 with the reduction of thermal power generation at Aboadze evidently due to the suspension of VALCO smelting operations during the period.

Energy and development Nexus

Energy is a major requirement for economic growth and development. There is a direct link between energy use, economic growth and standard of living. At the same time energy supply has serious financial and environmental implications to such an extent that uncontrolled energy consumption will have adverse consequences on the economy and the environment. The best approach to energy supply is therefore a combination of supply and demand option that ensures the least economic and environmental impacts.

Should the Ghana Poverty Reduction Strategy (GPRS) targets to usher the country into a middle income range of US\$1,000 per capita in 2015 be realised, demand for woodfuels would grow from about 14 million tonnes in 2000 to 38-46 million tonnes by 2015, and 54 – 66 million tonnes by 2020 and would put the nation's dwindling forest under undue stress which could culminate into serious deforestation, with serious consequences on climate change, agriculture and water resources, if no significant action is taken.

³ In terms of numbers, solar energy used for largely home lighting is the most populous, numbering over 5,000 systems. In terms of system capacity, the telecom and the water pumping systems are the largest, between one to two kilowatt peak power per system. The largest single installation however is the 50 kilowatt peak solar electric-grid system on the premises of the Ministry of Energy in Accra.

Total petroleum fuel demand is projected to rise from about 1.6 million tonnes in year 2000 and to about 3 million tonnes by 2015 and could reach 4.5 million tonnes by 2020.

Net final grid electricity consumption would grow from about 6,900 Gigawatt-hour in 2000 to about 18,000 Gigawatt-hour by 2015, reaching about 24,000 Gigawatt-hour by 2020.

Ghana imports crude oil and a quantum jump in demand could severely affect the nation's balance of payment. The existing installed electricity generating capacity of 1,760 Megawatt would have to be doubled by 2020 should the nation be assured of secured uninterrupted electricity supply.

In summary, the estimated optimum energy and fuel needed to drive the Ghanaian economy to achieve the US\$1000 per capita by 2015 and consequently, maintain a middle-income status up to 2020 are as follows:

	<u>Unit</u>	2008 (short term)	2015 (medium term)	2020 (long term)
Moderately high economic growth scenario				
Woodfuels	Tonnes	25-31 million	29-35 million	40-50 million
LPG	Tonnes	131,800	160,600	295,000
Kerosene	Tonnes	92,500	89,100	110,300
Jet kerosene	Tonnes	125,500	152,500	226,000
Gasoline	Tonnes	710,400	821,200	1.10 million
Premix Gasoline	Tonnes	69,000	73,000	81,500
Diesel	Tonnes	1.0 million	1.28-1.43 million	1.51-2.0 million
RFO	Tonnes	116,200-124,200	124,800-134,000	147,200 - 156,400
Electricity⁴	Gigawatt-hour	11,300-13,500	13,800-16,300	20,100 - 22,300

Energy Cost

Energy expenditure between 2000 - 2004

Crude oil imports accounted for approximately 80% of the trade deficit in 2001⁵. Cost of Crude oil imports rose from US\$ 280 million in 2000 to over US\$ 500 million by 2004.

The annual tax revenue on the petroleum product sales were equivalent to about 39% of the cost of crude oil import in 2000 and almost 60% in 2004.

Revenue from grid electricity sales tripled from US\$ 214 million in 2000 to about US\$ 620 million in 2004. Reduction and subsequent suspension of the VALCO smelter operations from 2002 – 2004 made more electricity available for distribution.

⁴ This excludes transmission and distribution losses.

⁵ Economic Analysis of Energy Sector by Prof. Bartholomew Armah, 2003, Energy Commission publication.

Woodfuel was the second most expensive fuel to the economy. The nation's consumers as a whole spent between US\$400 – 600 million on woodfuels from 2000 – 2004. Woodfuel share of total national energy cost varied from 29 – 36% from 2000 – 2004.

Cost projections

For the high economic growth scenario, total energy expenditure is expected to rise from about US \$2 billion in 2004 to:

- US \$3.1-3.4 billion, 16-17% of GDP in 2008;
- US\$ 4.3 - 4.6 billion, 13-14% of GDP by 2015; and
- US \$5.2 – 5.6 billion, 8-9% of GDP in 2020.

Expenditure on woodfuels would equally be as high as those for electricity and petroleum products.

Key challenges in the Energy Sector

The key challenges facing the energy sector are the following:

- i. Rapidly growing demand for energy by all sectors due to the expanding economy and growing population.
- ii. Risk of significant imbalance between energy production and indigenous sources of supply.
- iii. Inadequate investments to match the growing energy demand due to lack of capital.
- iv. Risk of over reliance on imports to meet local shortfalls of conventional fuels, which could threaten the country's supply security, making it vulnerable to external pressures.
- v. High levels of end-use inefficiency culminating in waste of final energy forms.
- vi. Inefficient pricing of energy services resulting in poor financial positions of the energy providers, but also high cost of tariff, which would not encourage maximum use of energy for wealth creation and could threaten the country's growth in prosperity and modern way of life.
- vii. Operational inefficiencies of the utilities leading to high energy losses and consequently increasing cost of supply and distribution.
- viii. Over reliance on woodfuels which could threaten the country's forest cover.

- ix. Solar energy, which is relatively abundant, is barely exploited to supplement the commercial energy requirements of the country.

This document presents some historical energy use patterns in Ghana and how the future energy scenery would look like for the period 2006 – 2020. The energy projections were based on GPRS projected economic growth rates. Possible interventions in the energy supply-demand chain, i.e. from energy production and transportation to the demand sectors of the economy have been discussed in the annexes to this main text.

Strategic targets and plans and recommended policies for the energy sector have been provided. Sectoral strategic targets and plans are also available in the annexes.

PREFACE

THE ENERGY COMMISSION is required by law to prepare, review and update periodically indicative national plans to ensure that all reasonable demands for energy are met in a sustainable manner. In conformity with this mandate, the Commission has developed and elaborated a Strategic National Energy Plan (SNEP) for the period 2006 – 2020.

The goal of SNEP is to contribute to the development of a sound energy market that would provide sufficient, viable and efficient energy services for Ghana's economic development through the formulation of a comprehensive plan that will identify the optimal path for the development, utilisation and efficient management of energy resources available to the country.

In developing and elaborating the SNEP, the Energy Commission has since 2000 conducted empirical studies and workshops. Series of stakeholders' consultative meetings were held where Working and Issue discussion groups were formed for the various energy and economic sectors. Members of the discussion groups were drawn from major institutions representing the various sectors of the economy. For sectors where data were not available or outdated, consultants were engaged to collect the data to update and as well fill the missing gaps. Based upon an assessment of the existing institutional framework and energy demand and supply situation, issues papers on the various energy sub-sectors were also prepared by consultants which served as discussion documents at stakeholders' consultative meetings. Consultants' reports were reviewed at the Working Group level and finally by a Technical Committee^{*}.

The energy sector is broadly divided between demand for energy and supply of energy to the economy. The draft SNEP document was therefore divided into two volumes to facilitate ease of discussion:

- Volume One covered the Demand Sectors of the Economy, namely Residential (household); Commercial & Services; Agriculture & Fisheries; Industry and Transport*
- Volume Two covered the supply-side of the energy sector, namely, electricity; petroleum; woodfuels and renewables. Volume Two was further divided into three parts; Part I - Electricity; Part II – Petroleum; and Part III – Woodfuels and Renewables.

The SNEP documents were placed at the website of the Energy Commission to solicit for comments from the wider general public. Key stakeholders were further invited to discuss the

♣ See Appendices 4 and 5

* Within the national economic statistics framework, Transport is a subsector of Commercial & Services. However, the energy utilisation in the transport sector has a significant impact on the economy necessitating it to be treated as a separate demand sector.

draft documents and provide comments as well. The Stakeholder meeting for the Volumes Two Part 1 - Electricity was held on February 15, 2005. It was followed by stakeholder meetings for the Volumes Two Part III – Woodfuels & Renewables and Volumes Two Part II – Petroleum held on 18 January and 26 January, 2006 respectively. Volume One was discussed alongside Volume Two.

About 49 key organisations cutting across the related sector ministries and governmental committees, agencies and regulatory bodies, private and state enterprises, non-governmental institutions, trade unions, consultancy and advocacy groups, educational and research institutions participated in the stakeholder meetings. Individual experts in their personal capacities also attended the meetings. Besides, the specialised stakeholders and the individual experts, the cross-section of the press representing the print and electronic media and from both the public and private media houses actively participated in all the deliberations.

The list of institutions which participated in the SNEP process including the press is also available as an Appendix to the SNEP document^{*}.

All comments have been incorporated in the main unified SNEP document titled STRATEGIC NATIONAL ENERGY PLAN AND *POLICY RECOMMENDATIONS*. The previous Volumes One and Two have been reorganised and presented as Annexes to the main document as follows:

- Annex I of IV: SNEP Energy Demand Sectors of the Economy
- Annex II of IV: SNEP Electricity Plan
- Annex III of IV SNEP Petroleum Plan
- Annex IV of IV: SNEP Woodfuels & Renewables Plan

The Energy Commission acknowledges the financial support, expert guidance and advice that it received from the Royal Danish Government through DANIDA[#] in the early stages of the development of the SNEP. The Danish support, which ended in 2003, was administered by Ramboll, a Danish consultancy firm.

The efforts of the Ramboll and the core professional staff of the Energy Commission who worked on the SNEP are hereby acknowledged.

A. K. Ofosu-Ahenkorah, Ph.D
Executive Secretary

♣ See Appendices 4 and 5

Danish International Development Agency

TABLE OF CONTENT

EXECUTIVE SUMMARY	4
PREFACE.....	9
<i>FOREWORD</i>	14
<i>LIST OF ABBREVIATIONS</i>	18
<i>INTRODUCTION</i>	19
<i>Energy Production and Utilisation</i>	19
Consumption and cost since 2000.....	19
Future demand and cost.....	21
<i>Key Challenges in the Energy Sector</i>	24
<i>Energy policy context</i>	24
Existing socio-economic and environmental policies.....	25
The energy sector linkages with other sectors	27
International linkages to the energy sector	27
<i>Policy vision of the Sector Ministry</i>	28
Broad Objectives.....	29
<i>STRATEGIC PLAN FOR THE DEMAND SECTORS</i>	35
<i>Residential Sector</i>	36
<i>Commercial and Service Sector</i>	36
<i>Agricultural and Fisheries Sector</i>	37
<i>Transport Sector</i>	38
<i>Industrial Sector</i>	39
<i>Energy Efficiency and Conservation</i>	39
<i>STRATEGIC PLAN FOR THE SUPPLY SECTOR</i>	44
<i>Electricity Subsector</i>	44
Fuel supply options to the Osagyefo Power Barge	44
Selected power generation technologies.....	46
Generation mix	47
Job creation	47

Greenhouse gas emissions.....	47
Costs for the Electricity subsector.....	47
<i>Petroleum subsector</i>	48
Upgrade and Increase the efficiency of TOR	49
Import refined petroleum products.....	50
Expand refinery capacity	51
A supply mix of petroleum and liquid biofuels approach	55
The West African Gas Pipeline project.....	57
Favourable Petroleum Exploration and Production Law	59
The Export Market in West Africa	60
<i>Woodfuels and Renewable Energy Subsector</i>	61
Plantations	61
Fuel substitution strategies	62
National Wood fuel Office	65
Renewables for the Energy mix	65
<i>CROSS CUTTING ISSUES</i>	67
<i>Research and Development</i>	67
Information and Awareness creation.....	67
Capacity Building and Development	68
Gender and Energy Use	68
<i>BUDGET SUMMARY</i>	70
<i>POLICY RECOMMENDATIONS - DEMAND SECTORS</i>	72
<i>Residential Sector</i>	72
<i>Commercial and Services Sector</i>	75
<i>Agriculture and Fisheries Sector</i>	77
<i>Transport Sector</i>	79
<i>Industrial Sector</i>	82
<i>Energy Efficiency and Conservation</i>	83
<i>POLICY RECOMMENDATIONS - SUPPLY SECTOR</i>	86
<i>Electricity Subsector</i>	86

<i>Petroleum Subsector</i>	92
Upstream.....	92
Downstream.....	96
<i>Woodfuel and Renewable Energy Subsector</i>	108
Woodfuels.....	108
Renewable energy.....	111
 <i>CROSS CUTTING ISSUES</i>	115
<i>Research and Development</i>	115
<i>Capacity Building and Development</i>	115
<i>Gender and Energy Use</i>	116
 <i>Appendix 1: RECOMMENDED PETROLEUM PLAN</i>	119
<i>Appendix 2: ROAD MAP FOR INTRODUCING BIOFUELS</i>	121
<i>Appendix 3A ELECTRICITY CAPACITY PLAN - OPTION 1:</i>	122
<i>Appendix 3B ELECTRICITY CAPACITY PLAN – OPTION 2:</i>	124
<i>Appendix 3C ELECTRICITY CAPACITY PLAN – OPTION 3:</i>	126
<i>Appendix 4. ENERGY SUPPLY–CONSUMPTION CHAIN</i>	128
<i>Appendix 5. LIST OF PARTICIPANTS</i>	129
<i>Appendix 6. MAJOR COMMITTEES DURING THE SNEP PROCESS</i>	131
 BIBLIOGRAPHY	132
 <i>Annex I of IV: SNEP Energy Demand Sectors of the Economy</i>	135
<i>Annex II of IV: SNEP Electricity</i>	135
<i>Annex III of IV SNEP Petroleum</i>	135
<i>Annex IV of IV: SNEP Woodfuels & Renewables</i>	135

FOREWORD

As the economy grows and becomes more complicated, the adoption of long-term planning approach for energy development is required.

The Energy Commission in 2000 initiated the development of the SNEP as part of its mandate provided under the Energy Commission Act 541, 1997. Specifically under section 2 (2a-d) the Energy Commission is to⁶:

- a. Recommend national policies for the development and utilisation of indigenous energy resources;
- b. Advise the Minister on national policies for the efficient, economical and safe supply of electricity, natural gas and petroleum products having due regard to the national economy;
- c. Prepare, review and update periodically indicative national plans to ensure that all reasonable demands for energy are met;
- d. Secure comprehensive data base for national decision making.

The first attempt to formulate an overall framework for the development of the Energy Sector in Ghana was made in 1990 by the erstwhile National Energy Board (NEB), which was established in the mid-1980s to undertake energy planning and policy development for the country. The Energy Board was envisioned at a time when fuel imports accounted for 30-40 percent of the nation's hard currency earnings. The document: **“Issues, Strategies and Programmes in the Energy Sector under the Economic Recovery Programme”** outlined an Action Programme covering five broad areas: Renewable Energy development, LPG promotion, Electricity Sector, the Petroleum Sector and Energy Efficiency and Conservation. The Action Programme was to a large extent implemented in the first half of the 90s, but lost momentum and weakened with time, following the dissolution of the Board in 1991.

In the absence of the Energy Board, ad-hoc and stop-gap measures were taken to sustain the policy direction of the country. The need for the development of a Strategic National Energy Plan for Ghana was necessitated by the power crisis in 1997/98, which occurred at a time when the country's energy supply had been restricted by an over dependence on hydro-power for electricity which failed due to poor rainfall in the catchment areas of the Volta reservoir. This crisis further exposed the absence of a comprehensive energy policy framework. Consequently, the Government of Ghana sought the assistance of the United States Government for an objective analysis of the electricity crisis and recommend actions to put the sector on a successful path to

⁶ For a copy of the Act, visit Energy Commission website www.energycom.gov.gh.

recovery. A report “**An Energy Road Map for Ghana**”⁷ was submitted to Government in 1998 and this resurrected the process of identifying an energy policy framework for Ghana. The report made several recommendations, notable amongst them, the continuation and strengthening of regulatory institutions under the power sector reform programme, which had been initiated in 1994 with the insistence of the World Bank and the need for an independent institution to undertake and develop an integrated energy planning and policy for the country. This major step accelerated the processes of developing a coherent long-term strategy, streamlining the major policy goals of Government and putting them together as a coherent whole that addresses the issues and challenges facing the energy sector.

Upon a request from the Ghanaian Government in 1998 the Danish Government agreed to support the development of such a Strategic National Energy Plan for Ghana. The work took off in 2000 and the Danish support ended in April 2003.

SNEP – Strategic National Energy Plan 2006 - 2020

Conventionally, top-down approach has mostly been used for energy planning and there have been tendencies to make long term forecast based on the supply side projections. However, activities on the supply-side do not necessarily arise as a result of demand and vice-versa. For instance, increasing demand does not necessarily call for investment in generation and transmission without first considering the option of energy efficiency. It thus requires an optimal blend. Moreover, conventional planning has placed more emphasis on commercial grid electricity and imported fossil fuels, relegating to the background the potential of renewables and particularly, woodfuels which comprised over 60 percent of the nation’s energy utilisation. A paradigm shift in energy policy and planning was thus necessary. Broadening the sources and types of energy supply and integrating them into high quality utility service for the total growth of the economy is mainly what SNEP is about.

SNEP is thus a comprehensive way of looking at the available energy sources and resources of the country and how to tap them economically and timely to ensure a secured and adequate energy supply for sustainable economic growth now and into the future.

Energy efficiency measures have also been emphasized in the SNEP and major sectors for energy conservation have been examined in this respect.

Specific objectives of SNEP are to:

- Establish an effective national infrastructure for energy planning; and
- create a consensus reference framework for the development of the energy sector.

⁷ An Energy Roadmap for Ghana: from Crisis to the fuel for ‘Economic Freedom’. A report by a United States Government Interagency Team in response to a request from the Government of Ghana, August 1, 1998.

The goal of energy supply and demand planning under SNEP is extended into the long term since most capital investments in the energy sector are relatively high with lifetime of 20 years or more on the average.

In the case of Ghana, except for woodfuels, almost all the components of the energy technologies are imported. Thus the long-term nature of the SNEP provides the opportunities for the development of viable local industry for the production of components and systems locally, to meet future spare-parts requirements of future investments thereby making savings and ensuring sustainability.

Forecasting and planning tools used for SNEP

Two main computer-based planning tools the LEAP (Long-range Energy Alternative Planning) and IRP (Integrated Resource Planning)⁸ were used for the SNEP analysis.

An analysis of the energy sector starts with the identification of the various demand and supply activities. In depth knowledge of issues in the various energy sectors is crucial for policy formulation, since it helps to unearth the key challenges that must drive the policy. The forecast for energy demand and supply have been carried out using the LEAP computer-based model. LEAP was adopted for the SNEP for its comparatively user friendliness in addition to having sub-programmes to handle both supply-driven and demand-driven forecast at the same time and for ease of comparison.

Almost all the energy related institutions in the country are familiar with LEAP since their representatives had received training in its use or seen demonstration of its capabilities during the SNEP process.

The forecast was primarily based on the projection into the future of economic (demand) sector/subsector outputs and the energy intensities of the end-uses and/or appliances, thus the SNEP uses a ‘bottom up approach’ to energy planning.

Time series analysis was applied for sectors with known planned future production outputs and committed power plants to be commissioned or retired in the future.

Regression analysis was used for projecting sectors with limited data.

Historical data on Prosperity index (inverse of poverty index) of the country was used to project the demand of the Residential sector for the high economic growth scenario.

The principal result of the demand analysis with LEAP was the net final energy demand forecast, that is after bulk transportation or transmission and distribution (retailing) losses have been deducted from the gross energy production.

The IRP methodology was used to rank the supply technologies and the demand-side appliances in terms of generation/production cost, job creation potential and emission of air pollutants. With

⁸ Apart from the LEAP and IRP, two other application programmes – RETSCREEN and MESSAGE were used in some instances for crosschecking and fine-tuning of some the outputs of the LEAP and IRP.

the aid of the IRP, the generation costs of various electricity production technologies have been documented for the SNEP.

VRA and ECG provided support in the analysis for the transmission and distribution expansion scenarios.

The SNEP period covers two decades. Ghana's political elections come off every four years and so the planning period makes it possible for individual political parties to relate the SNEP to fit their terms of office. The years, 2008, 2012, 2015 and 2020 were selected as default for the following reasons:

- 2008 had been the milestone of the Ministry of Energy's petroleum Sector strategic plan since 2003.
- 2012 was originally the government's middle-income target year for Ghana.
- 2015 is currently the government's middle-income target year for Ghana and the milestone for the UN Millennium Development Goals.
- 2020 marks the end of two decades and has been the planning period selected by most international agencies. Ghana's 100 percent universal electrification is set for 2020. A number of countries of which Ghana has been comparing her middle-income development objectives such as Malaysia have 2020 as their development milestone.

The choice of 2000 as the base year was influenced by the fact that in 2000, a national Population and Housing Census was undertaken and that provided a wealth of reliable data on the country's demographics which were very essential inputs for the modelling.

Abbreviation	Meaning
ATK	Aviation Turbo Kerosene
Bbl	Barrel
Billion	1,000,000,000 (10 to the power 9)
BPD / BPSD	Barrel per day / Barrel per stream day
mmBTU	Million British Thermal Unit
CBO	Community Based Organisations
CDM	Clean Development Mechanism
CDU / VDU	Crude Distillation Unit / Vacuum Distillation Unit
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power plant
CNG / LNG	Compressed Natural Gas / Liquefied Natural Gas
ECG	Electricity Company of Ghana
ECOWAS	Economic Community of West Africa States
EIA	Environmental Impact Assessment
GDP	Gross Domestic Product
GPRS	Ghana Poverty Reduction Strategy
GWh	Gigawatt-hour (million units of electricity)
IRP	Integrated Resource Planning
KWh / kW	Kilowatt-hour (one unit of electricity) / kilowatt
LEAP	Long Range Energy Alternative Planning
LCO / LCO	Light Crude Oil / (<i>Also</i> Light Cycle Oil – <i>a heavier diesel</i>)
LDC	Local natural gas Distribution Company
LPG	Liquefied Petroleum Gas
MWh / MW	Megawatt hour (thousand units of electricity) / Megawatt
MMT	Methylcyclopentadienyl Manganese Tricarbonyl
NED	Northern Electrification Department of VRA
NES	National Electrification Scheme
NGO	Non Governmental Organisation
NOx	Oxides of Nitrogen
ppm	Parts per million
PV	Photovoltaic (solar cell)
RFO / AF	Residual Fuel Oil / Atmospheric Residual
RFCC	Residual Fluid Catalytic Converter
SNEP	Strategic National Energy Plan
SOx	Oxides of Sulphur
TAPCO / Tapco	Takoradi Power Company
TICO / Tico	Takoradi International Company
TOE	Tonnes of Oil equivalent
TOR	Tema Oil Refinery
VAT	Value Added Tax
VRA	Volta River Authority
WAGP / WAPP	West African Gas Pipeline / West African Power Pool

NB: Refer to the list of participants for acronyms/abbreviations of most institutions.

INTRODUCTION

1. Ghana has, since the mid-1990s, launched two long-term development plans aiming at transforming its low-income developing country status into an upper middle-income one by 2020. The prevailing development plan within the context of the Ghana Poverty Reduction Strategy (GPRS) forecasts an average real GDP growth of 7-10 percent for the period 2003 to 2015 and is expected to achieve a per capita income of US \$1,000 by 2015 from less than US \$400 in 2001. The drivers of the expected economic growth according to the GPRS are agro-based (Agricultural sector), manufacturing (industrial sector) and Information Communications Technology.
2. With an expanding economy and a growing population, Ghana faces major challenges in providing the required energy in a reliable and sustainable manner having in mind the environmental and economic impacts of energy production and use and the nexus between energy and development.

Energy Production and Utilisation Consumption and cost since 2000

3. Total primary energy produced in Ghana in 2000 was 6.2 million tonnes of oil equivalent⁹, about eleven and half times the yearly average energy generated at Akosombo and Kpong hydroelectric plants. This rose to 6.8 million tonnes of oil equivalent by 2004.
4. The primary indigenous energy comprised 90-95 percent woodfuels (generally called biomass), 5-10 percent hydro energy and less than one percent solar energy. The hydro energy was supplied from Akosombo and Kpong hydroelectric dams in the form of electricity. Solar energy was used for the sun-drying of crops; mainly cocoa; cereals consisting of maize, paddy rice, sorghum and millet; vegetables consisting of groundnuts and pepper and other exportable commodities requiring drying. Solar energy for production of electricity was relatively negligible; about 150 tonnes of oil equivalent.¹⁰
5. Net energy import was about 1.9 million tonnes of oil equivalent in 2000 increasing to about 2.6 million tonnes of oil equivalent by 2004. It comprised 80–83 percent crude oil and about 15-19 percent petroleum products.

⁹ About 69,000 Gigawatt-hour

¹⁰ In terms of numbers, solar energy used for largely home lighting is the most populous, numbering over 5,000 systems. In terms of system capacity, the telecom and the water pumping systems are the largest, between one to two kilowatt peak power per system. The largest single installation however is the 50 kilowatt peak solar electric-grid system on the premises of the Ministry of Energy in Accra.

6. The primary energy production and the net import make up the primary energy supply and totalled about 8.1 and 10.2 million tonnes of oil equivalent in 2000 and 2004 respectively.
7. Biomass was the most dominant primary energy supplied, averaging 69 percent over the period, followed by oil comprising crude oil and products averaging 25 percent.
8. Final energy supply, i.e., the energy finally reaching the consumer after transportation and transmission was about 6 million tonnes of oil equivalent in 2000 and about 6.4 million tonnes of oil equivalent in 2004.
9. Share of woodfuel however increased from about 60 percent in 2000 to almost 67 percent in 2004. Electricity dwindled from about 11 percent to 6 percent during the same period. Petroleum product share also dropped from about 29 percent in 2000 to 27 percent in 2004 (figure 1).

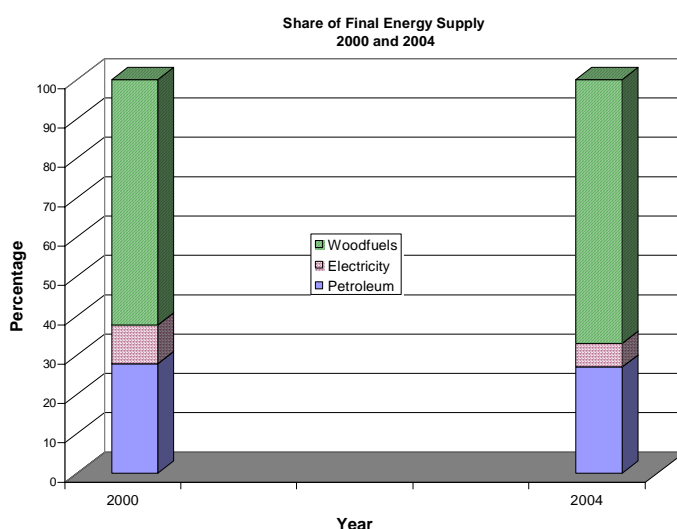


Figure 1: Final Energy Supply Shares for 2000 and 2004

10. Energy losses totalled about 26 percent of the total primary supply in 2000 but increased to about 30 percent in 2004.
11. The residential or household sector of the economy accounts for over 50 percent of the country's energy consumption. The significant residential sector share of the nation's energy demand is due to the high usage of woodfuels comprising mainly firewood (almost 76 percent) and charcoal (table 2). The rise in residential share from about 50 percent in 2000 to almost 56 percent in 2004 was due to the significant increase in woodfuel consumption share in the energy supply mix.

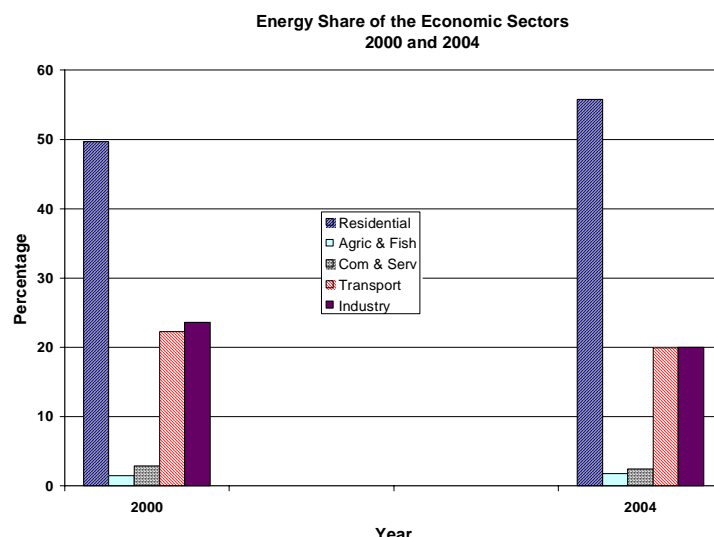


Figure 2: Demand sector fuel consumption share

12. Oil imports accounted for approximately 80 percent of the trade deficit in 2001¹¹. Cost of oil imports rose from US\$ 561 million in 2000 to about US\$ 766 million in 2004¹².
13. The annual tax revenue on the petroleum product sales were equivalent to about 39% of the cost of crude oil import in 2000 and almost 60% in 2004. Revenue from grid electricity sales tripled from US\$ 214 million in 2000 to about US\$ 620 million in 2004.
14. The revenue share of final electricity (distribution) however grew from about 40 percent in 2000 to around 50 percent in 2004. Reduction and subsequent suspension of the VALCO smelter operations from 2002 – 2003 made more locally produced hydroelectricity available for distribution.
15. Woodfuel was the second largest fuel expenditure within the economy after petroleum imports. The nation's consumers as a whole spent between US\$400 – 600 million on woodfuels from 2000 – 2004. Woodfuel share of total national energy cost varied from 29–36% between 2000 – 2004.

Future demand and cost

Demand projections

16. Should the Ghana Poverty Reduction Strategy (GPRS) targets to usher the country into a middle income range of US\$1,000 per capita in 2015 be realised, demand for woodfuels will grow from about 14 million tonnes in 2000 to 38-46 million tonnes by 2012, and 54 – 66 million tonnes by 2020 and would put the nation's dwindling forest under undue

¹¹ Economic Analysis of Energy Sector by Prof. Bartholomew Armah, 2003, Energy Commission publication.

¹² Source: Bank of Ghana Statistical bulletin. C.i.f. value.

stress which could culminate into serious deforestation, with serious consequences on climate change, agriculture and water resources, if no significant action is taken.

17. Total petroleum fuel demand is projected to increase from about 1.6 million tonnes in year 2000 and could exceed 3 million tonnes in 2015 and could reach 4.5 million tonnes by 2020.
18. The net final grid electricity¹³ consumption of the economy will grow from about 6,900 Gigawatt-hour in 2000 to about 18,000 Gigawatt-hour by 2015, reaching about 24,000 Gigawatt-hour by 2020. Quantum jump in demand could severely affect the nation's balance of payment since Ghana imports crude oil. The existing installed electricity generating capacity of 1,760 Megawatt would have to be doubled by 2020 if the nation is to be assured of secured uninterrupted electricity supply.
19. The total energy requirement will grow from about 7 million tonnes of oil equivalent (69 Terawatt-hours equivalent) in 2004 to about 22 million tonnes of oil equivalent (255 Terawatt-hours equivalent) by 2020 (figure 3).

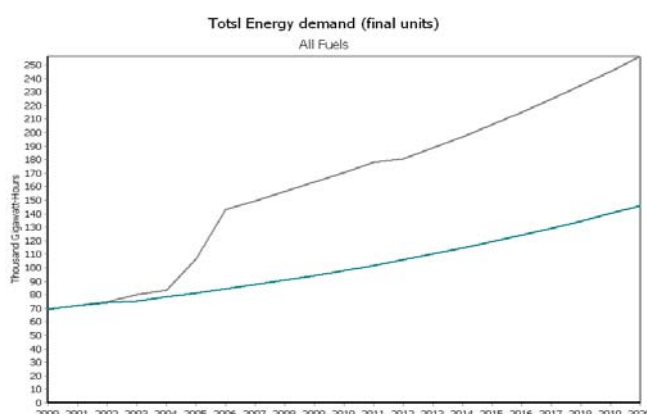


Figure 3: Projected Total Energy Demand by the Economy up to year 2020

20. Woodfuel share in the energy supply mix will continue to increase if constraints (challenges) in the supply of electricity and petroleum products are not tackled (figure 4).

¹³ This excludes ECG technical losses

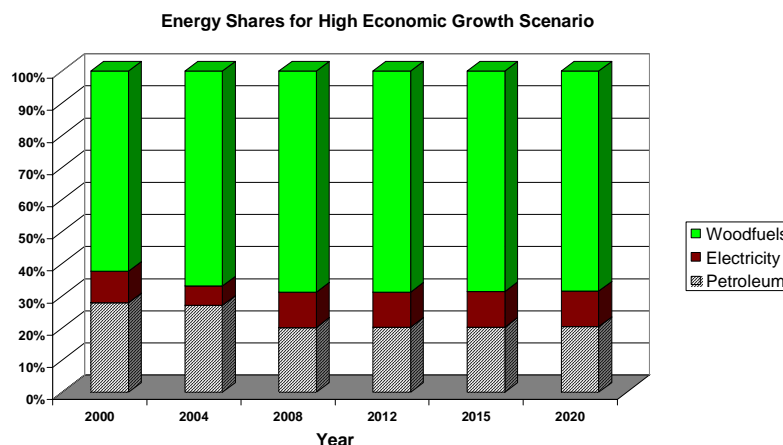


Figure 4: Projected shares in the fuel supply mix

Cost projections

21. For the high economic growth scenario, total energy cost is expected to reach:
 - US\$3.1-3.4 billion, 16-17% of GDP in 2008;
 - US\$ 4.3 - 4.6 billion, 13-14% of GDP by 2015; and
 - US\$5.2 – 5.6 billion, 8-9% of GDP in 2020.
22. Expenditure on woodfuels will equally be as high as those for electricity and petroleum products.
23. The high economic growth energy expenditure share of the GDP is estimated at 16 – 17 percent in 2008 but it is expected to drop to about 8 percent by 2020, assuming that the average market price of crude oil per barrel drop from the US \$60 range to about US \$45 range by 2020.
24. Expenditure on woodfuels will equally be as high as those for electricity and petroleum products.

Capital investment

25. Total capital investment is estimated at US\$4.3-5.4 billion for the period 2006 - 2020 with investment in the electricity subsector taking over 70% of the total.

Key Challenges in the Energy Sector

26. The key challenges facing the energy sector are the following:

- i. Rapidly growing demand for energy by all sectors of the economy and growing population.
- ii. Risk of fundamental imbalance between energy production and indigenous resource, which is evident for all the major energy forms.
- iii. Risk of over reliance on imports to meet local shortfalls of conventional fuels, which could threaten the country's supply security, making it vulnerable to external pressures.
- iv. High levels of end-use inefficiency culminating in waste of final energy forms.
- v. Inefficient pricing of energy services resulting in poor financial positions of the energy providers but also inadequate incentives to conserve, which do not encourage optimum use of energy for wealth creation. This threatens the country's growth in prosperity and modern way of life.
- vi. Operational inefficiencies of the utilities leading to high losses and consequently increasing cost of supply and distribution.
- vii. Over reliance on woodfuels, which could threaten the country's forest cover.
- viii. Solar energy, which is relatively abundant, is barely exploited to supplement the commercial energy requirements of the country.
- ix. Inadequate investments to match the growing demand due to lack of capital.

Energy policy context

27. Energy is a major requirement for economic growth and development. There is a direct link between energy use, economic growth and standard of living. At the same time energy supply has serious financial and environmental implications to such an extent that uncontrolled energy consumption will have adverse consequences on the economy and the environment. The best approach to energy supply is therefore a combination of supply and demand option that ensures the least economic and environmental impacts.
28. Defining the contextual framework within which the SNEP operates is imperative. There are local and international factors that could significantly influence policy decisions. The SNEP energy policy framework has thus been formulated within the following settings:
 - i. The existing socio-economic and environmental policies;

- ii. The linkages of the energy sector with other sectors
- iii. International linkages of the sector.

Existing socio-economic and environmental policies

Socio-economic Framework

28. The Government launched the GPRS with the following priority developmental objectives¹⁴:
 - i. Bringing down the cost of living.
 - ii. Creating jobs within the economy.
 - iii. Providing more affordable health care.
 - iv. Improving access to quality education.
 - v. Alleviating poverty.
29. Providing more affordable health care, improving access to quality education and considering the needs of the vulnerable and the excluded imply making health services, education and other essential social services accessible to all citizens, the rich and the poor, the vulnerable segments of the society, including women and children, HIV/AIDs victims, orphans the handicapped and the aged even at the remotest part of the country.
30. Reaching these segments of the society in communities inaccessible to the national electricity grid means providing an alternative, decentralised sustainable energy system that can easily be deployed in such remote and deprived communities into the overall national energy mix.
31. Preservation of vaccines for child immunisation programmes in remote and off-grid parts of the country has been possible using solar vaccine refrigerators.
32. High quality lighting and television reception for health and educational workers in off-grid communities have also been possible using stand-alone solar power systems.
33. Schools in off-grid communities are able to participate in the television programmes of the Presidential Special Initiative (PSI) on Distance Education owing to decentralised solar energy systems.
34. Rural energy systems such as cultivation of physic nut plantations, deployment of multifunctional electromechanical platforms (MFP) for multiple application of grain

¹⁴ Energy for Poverty Alleviation and Economic Growth....., Ministry of Energy, Republic of Ghana, November, 2001.

milling, battery charging for example, promote poverty alleviation and improve living conditions of the poor in remote communities.

35. Provision of energy services in general, can contribute in a number of ways, directly and indirectly to poverty alleviation. For instance, Energy sector interventions can provide:
- i. New, higher quality and cost competitive energy services to the poor, for cooking, transport, water heating and other home appliances thereby directly improving the living standards, productive time as well as productivity and ultimately alleviating poverty.
 - ii. Energy services to support small-scale, local, income generating activities thereby elevating individual incomes, improving employment opportunities and alleviating poverty.
 - iii. Jobs in the construction and operation of power plants, biomass energy farming, etc.
 - iv. Jobs in industries that result from macroeconomic growth that is enabled by access to energy services, infrastructure, technical capacity.
 - v. Productivity improvements through increased energy efficiency.

Environmental Framework

36. Energy operations worldwide have bigger environmental impacts than most other sectors of the economy. Large hydropower projects inundate fertile agricultural lands and in most cases affect human settlements. The emissions of global warming and acidic gases into the environment - and the effects of large hydropower projects transcend political and regional boundaries into global issues. Accordingly, they have become major subjects for international politics, debate and regulation.
37. Ghana has a National Environmental Action Plan, which defines the environmental framework for various economic sectors including energy. Large-scale energy projects require full environmental impact assessment.
38. Ghana is one of seven African countries now using unleaded fuels. Lead laden vehicular smoke is noted for its health hazards such as low mental development in children.
39. Furthermore, Ghana's energy demand is dominated neither by electricity nor petroleum but traditional woodfuels of firewood and charcoal. Unsustainable use of woodfuels leads to serious forest degradation. Uncontrolled emission of acidic gaseous pollutants of sulphide oxides (SO_x) and nitrogen oxides (NO_x) into the atmosphere are later rained back to earth to acidify poorly buffered soils and freshwaters.
40. Poverty thus can be exacerbated by the impacts of serious land degradation due to unsustainable charcoal burning and firewood extraction, secondary effects of acid rains

and displacement of poor households from fertile lands due to inundation by large hydropower dams, etc.

41. Therefore, the least cost of energy production would not be the only key-determining factor for energy investment in the country, but job creation potential and environmental friendliness of the technologies would also be considered. Optimal generation cost that takes into account all these considerations and impacts, shall therefore be the guiding factor.
42. The Energy Commission and the National Petroleum Authority require Environmental Permits from the EPA before it grants construction permits and operational licences to prospective energy developers.
43. In cognisance of these environmental issues, in 2002, a team including the Ministry of Energy and the Energy Commission, led by the EPA as part of Ghana's commitment to UNFCCC, catalogued Ghana's climate change technology needs.

Strategic Environmental Assessment

44. Fundamental laws of science suggest that there is hardly an energy technology without risks, wastes and interaction with the environment; from material production for energy systems to extraction and production of energy; and from transportation or transmission to distribution. Strategic Environmental Assessment (SEA) tool will therefore be used to appraise the sustainability of the policy recommendations and the SNEP as a whole to mitigate potential impacts before field implementation.

The energy sector linkages with other sectors

45. The SNEP takes cognisance of related policies in allied sectors such as industries and commerce. For instance, a policy for rural electrification would not solve rural energy poverty on its own. Complementation with policies and programmes, such as forestry, education and job creation will be needed in order to achieve the desired effects. Policies to address biomass fuel supply would require support of the Food and Agriculture sector ministry.
46. Adoption of unleaded fuels by Ghana opens up the opportunity for the use of catalytic converters in vehicles. Catalytic converters fitted in vehicular exhausts break down acid forming NO_x pollutants in the vehicular emissions into direct health-harmless compounds of simple nitrogen, water and carbon dioxide. Promoting the use of catalytic converters in the country cannot be successful without the active participation of the Environment sector ministry and the EPA.

International linkages to the energy sector

47. Ghana needs to improve the living standard of its citizens and consequently, reduce poverty significantly but without compromising its environment. Hence meeting national

goals without compromising the ability of future generations to meet their needs is of ultimate importance. International protocols of similar aspirations such as the United Nation's Millennium Development Goals¹⁵, Clean Development Mechanism under the Kyoto Protocol and the Global Environment Facility where the country could source assistance to develop its energy resources are of paramount importance. Ghana is already a signatory to the United Nations Framework Convention for Climate Change (UNFCCC) and has ratified the Kyoto Protocol.

48. SNEP thus takes cognisance of international and regional energy trends, especially in areas of energy investment and donor support, pricing and global impacts.
49. The involvement of private finance in the energy sector is becoming increasingly important world over. The need therefore, to create an energy policy that attracts funding, while ensuring the achievement of overall national policy objectives is very crucial.
50. On an international perspective the Government is a signatory to several conventions on climate change, biodiversity, land degradation and other environmental issues.
51. Within the West African sub region, ECOWAS, of which Ghana is a key member, is promoting regional energy cooperation and integration. The West African Gas Pipeline (WAGP) and West African Power Pool (WAPP) offer considerable opportunities for inter country trade, cross-border infrastructure in energy and sharing of knowledge in areas of common interest. Thus co-operation between neighbouring countries and international bodies is vital for development and economic growth. There is however, a challenge to maximise the potential gains from the regional and international energy trade and co-operation as a way of enhancing cost-effectiveness, collective reliance and security of energy supplies.
52. The ECOWAS Energy Protocol therefore calls for stronger and closer interaction between the energy planning agencies in the ECOWAS member countries.

Policy vision of the Sector Ministry¹⁶

53. SNEP reiterates the sector Ministry's vision which is to develop an '**Energy Economy**' that would ensure sustainable production, supply and distribution of high quality energy

¹⁵ ¹⁵ The United Nation's Millennium Development Goals (1), (7) and (8), i.e.:

- o Eradicating extreme poverty and hunger
 - § *Sustainable energy and environment policies will sustain jobs, protect the interest of future generation and invariably help to uplift the standard of living of people living on less than a dollar a day.*
- o Ensuring environmental sustainability
 - § *Integrate the principle of sustainable development into country' policies and reverse the loss of environmental resources.*
- o Developing a global partnership for development

¹⁶ Adapted from Policy Framework for Ghana's Energy Sector, Ministry of Energy document, 2001

services to all sectors of the economy in an environmentally friendly manner for Ghana's future while making significant contribution to the country's export earnings.

Broad Objectives

54. *In responding to the Energy Vision the following ten(10) broad objectives of the sector ministry are addressed by the SNEP energy policy:*

- **Objective 1;** Stimulate economic development by ensuring that energy plays a catalytic role in Ghana's economic development.
- **Objective 2;** Consolidate, improve and expand existing energy infrastructure.
- **Objective 3;** Increase access to modern energy services for poverty reduction in off-grid areas.
- **Objective 4;** Secure and increase future energy security by diversifying sources of energy supply.
- **Objective 5;** Accelerate the development and utilization of renewable energy and energy efficiency technologies.
- **Objective 6;** Enhance private sector participation in energy infrastructure development and service delivery.
- **Objective 7;** Minimize environmental impacts of energy production, supply and utilisation.
- **Objective 8;** Strengthen institutional and human resource capacity and R & D in energy development.
- **Objective 9;** Improve governance of the Energy Sector.
- **Objective 10;** Sustain and promote commitment to energy integration as part of economic integration of West African states.

55. **Objective One**

- *To stimulate economic development by ensuring that energy plays a catalytic role in the economic development of the country.*

Strategies

To achieve this objective, the Government through the Ministry of Energy intends to:

- i. Encourage competition within the energy markets to achieve efficiency.
- ii. Attract investments in energy services provision by providing appropriate incentives.
- iii. Ensure energy supply security and reliability.

- iv. Enhance productive uses of electricity in rural areas. This activity is expected to be undertaken as part of the Rural Electrification Programme and is intended to ensure that electricity is used to support economic activities in order to create employment and reduce poverty in rural areas.
- v. Enhance Government revenue generation through efficient taxes and levies on energy supply and distribution.
- vi. Generate employment by developing the indigenous energy resources particularly, solar, bio mass, wind and the medium –to- minihydro dams.

56. **Objective Two**

- *To consolidate, improve and expand existing energy infrastructure*

Strategies

To achieve this objective, the Government through the Ministry of Energy is:

- i. Encouraging public-private sector partnership** by securing private sector investment in partnership with the public sector for re-capitalisation of the energy supply system by timely:
 - a) Expanding the electricity generation capacities
 - b) Reinforcing and expanding the electricity transmission and distribution networks.
 - c) Upgrading and expanding the oil refinery capacity of the country.
- ii. Ensuring efficiency in management** of the existing energy infrastructure through
 - a) Restructuring of the public utilities to attract private participation
 - b) Unbundling of the electricity supply system to break the public monopoly and introduce competition by improving regulatory transparency as well as ensuring a “level playing field” for fair competition.
 - c) Deregulation of the downstream petroleum sector to promote competition and efficiency.
 - d) Restructuring of the existing upstream petroleum sector to attract more private investment for intensified exploratory activities.
- iii. Creating adequate strategic reserves for petroleum products** to cater for unexpected supply shocks.

57. **Objective Three**

- *Increase access to modern energy services for poverty reduction in off-grid areas.*

Strategies

To achieve this objective, the Government through the Ministry of Energy is:

- i. **Intensifying execution of the national electrification programme** from both grid extension and decentralised sources where appropriate. Where it makes economic sense, provide decentralised power systems to communal facilities like schools and health posts which do not have access to electric power and as such rely on kerosene for lighting. Targeting such remote communities with decentralised electricity will improve access to distance education programmes, communication link to regional health centres and eventually raise the quality of education and health delivery in remote rural communities.
- ii. **Ensuring full cost-recovery in energy supply** through efficient pricing of all energy services.

58. **Objective Four**

- *Secure and increase future energy security by diversifying sources of supply.*

Strategies

To meet this objective, the Government through the Ministry of Energy is:

- a) **Supporting** the expansion of the existing capacity and promoting the exploitation of alternative sources.
- b) **Ensuring** the timely completion of the West African Gas Pipeline project.
- c) **Ensuring** the development of indigenous and renewable energy resources.
- d) **Seeking** to intensify hydrocarbon exploration in Ghana under a more attractive package for the private sector bearing in mind the competition within the sub-region.
- e) **Supporting** the development and implementation of West African Power Pool (WAPP).

59. **Objective Five**

- *Accelerate the development and utilization of renewable energy and energy efficiency technologies so as to achieve 10 percent penetration of national electricity and petroleum demand mix respectively by 2020.*

Strategies

- i. Government recognises the advantages of indigenous and renewable energy resources to complement the existing conventional and traditional energy mix of the country.
- ii. The nation therefore target 10 percent of renewables in the electricity supply mix in terms of installed capacity and 10 percent of renewables in terms of petroleum fuel supplies by 2020.
 - a) The renewable energy for electricity is expected to come mainly from solar, small and medium sized hydro plants, wind, biomass and municipal solid wastes.

- b) Renewable energy to supplement petroleum supplies is expected to come from bio-fuels.

60. **Objective Six**

- *Enhance private sector participation in energy infrastructure development and service delivery.*

Strategies

Private sector investment is a critical ingredient in the development of all aspects of the energy sector. In this regard the Government is;

- i. Pursuing the requisite legal and regulatory reforms and mechanisms to facilitate the participation of Independent Power Producers in electricity delivery.
- ii. Establishing 'Access Code' that will guarantee open access to electricity transmission infrastructure. This could be done either as public-private partnership project or a wholly private sector investment.
- iii. Facilitating the expansion of electricity supply capacity in the sub-region under the West African Power Pool (WAPP) protocol.

61. **Objective Seven**

- *Minimize environmental impacts of energy production, supply and utilisation.*

Strategies

To manage energy-related environmental impacts, Government is:

- i. Ensuring that only investments with permits from the Environmental Protection Agency (EPA) are granted Construction Permit and or operational licence.
- ii. Supporting complementation of viable environmentally friendly energy supply sources in the electricity generation mix as well as in the transportation fuel mix.
- iii. Promoting the shift from crude oil and distillate oil to natural gas wherever it presents a viable substitute.
- iv. Sensitising energy suppliers and users about the environmental issues associated with energy.
- v. Supporting and actively participating in international efforts and cooperation to ensure sustainable delivery of energy to mitigate climate change.
- vi. Monitoring international developments and as well participate in negotiations on the environment in order to balance its environmental responsibilities and developmental needs whilst taking advantage of opportunities available to participating countries.

62. **Objective Eight**

- *Strengthen institutional and human resource capacity and in energy research and development.*

Strategies

To satisfy this objective, the Government is:

- i. Implementing of the institutional reforms in the energy sector, namely the Power Sector Reform and the Deregulation of the Petroleum Sector.
- ii. Strengthening the existing regulatory agencies, namely the Energy Commission and the Public Utility Regulatory Commission (PURC) to enhance their capabilities.
- iii. Supporting the training of Ghanaians in all fields of energy development and management.

63. **Objective Nine**

- *Improve governance of the energy sector by ensuring that the relative roles and functions of the regulatory bodies and the utility companies are more accountable and transparent in order to attract private sector participation.*

Strategies

To achieve the above objective the Government is implementing the energy sector reforms, which involve the Power Sector Reform and near-total deregulation of the petroleum sector.

64. **Objective Ten**

- *The Government will continue to be committed to the WAPP and WAGP concepts and will cooperate with the ECOWAS Secretariat and other member countries to the realisation of the full benefits of the concepts.*

Strategies

- i. Regional integration of energy infrastructure, notably the interconnection of national electricity grids leading to the establishment of the West Africa Power Pool (WAPP) and the development of the West Africa Gas Pipeline (WAGP) are both expected to improve the energy supply situation and hence the economies of the member countries in the sub-region.
- ii. The electricity shortfalls were also felt by countries in the sub-region, which relied on Ghana for part of their electricity needs. This under-scored the need for a regional approach to solving electricity supply security.
- iii. The need for ensuring security of supply of electricity first came to light in the early 1980s when Ghana suffered a major drought resulting in reduced inflows to the Volta hydropower reservoir, thus disrupting electricity supplies and adversely affecting the performance of the overall economy. Plans to secure electricity through thermal complementation of the hydro-based generation therefore became prominent on Government's priority list for the electricity sub sector. Since then the Volta Lake has suffered two other drought. Though relatively minor, these did result in serious supply shortfalls.
- iv. Besides the natural gas expected from Nigeria through the WAGP, there is also the possibility of natural gas supply from la Cote d'Ivoire and possibly from

indigenous sources. These could provide supply security in the event of unforeseen interruptions with the natural gas from Nigeria.

- v. In this respect, the Government is committed to:
 - a) Sustaining and reinforce the grid interconnection links with la Cote d'Ivoire and Togo.
 - b) Extending the transmission line to Burkina Faso to facilitate the proposed West African Power Pool.
 - c) Pursuing the full realization of the WAGP concept by supporting the construction of a gas pipeline from la Cote d'Ivoire to Ghana to link up with the West African Gas Pipeline project and develop the Tano Gas fields in the nearest future.

*STRATEGIC PLAN
FOR THE ENERGY SECTOR*

STRATEGIC PLAN FOR THE DEMAND SECTORS

Residential Sector

Access to Electricity

65. *National goal is to achieve 100% universal electrification by 2020. Sixty (60) percent access is estimated for now. Connection however has largely been by grid.*
66. Strategic Targets:
- i. To achieve 15% penetration of rural electrification by decentralised renewable energy complementation by 2015 expanding to 30% by 2020.*
 - ii. To reduce the average electricity intensity per urban household by 50% by 2020.*
67. *Decentralised renewable energy penetration is less than 1% at present. The energy efficiency measure can free about 5,000 GWh nationwide by 2015 expanding to about 8,000 GWh by 2020.*

Energy for Cooking

68. Strategic Targets:
- i. To reduce the average woodfuel energy intensity per urban household by 30% by 2015 and by 50% by 2020.*
 - ii. To reduce firewood intensity per rural household by 10% by 2020.*
69. *These measures can reduce the annual wood requirements for the production of charcoal by 50% by 2020. Woodfuel share of cooking fuels for urban household averaged about 90% since 2000. Share of LPG, a potential substitute for woodfuel for cooking in urban households, was just about 6% in 2000.*

Commercial and Service Sector

70. **Objective:** *To reduce the energy consumption in general and woodfuel consumption in particular, by introducing energy efficiency programmes and cleaner energy alternatives.*

Electricity

71. Strategic Targets:
- i. To reduce electricity consumption of military and police barracks, residential halls and hostels of public tertiary institutions by 50% by 2015.*

ii. To achieve 1% penetration of solar energy in hotels, restaurants and institutional kitchens using solar water heaters by 2015 and 5% penetration by 2020.

72. Defence and security together is the third highest consumer of electricity in the this sector, though the share has fallen from about 15 percent in 2000 to a little less than 10 percent per annum in recent times. The Education subsector comprising the tertiary and secondary institutions, etc had its share of electricity drop from 10 percent in 2000 to around 5 percent on the average in recent times. Even though the impact on the nation is not expected to be significant, the strategy will benefit the institutions by reducing their annual energy bills by 50%.

73. Solar energy for now is completely absent.

Cooking

74. Strategic Targets:

i. To increase LPG penetration by 20% by 2015 and 30% by 2020.

ii. To curtail woodfuel share of energy at 50% by 2015 with subsequent reduction to 40% by 2020

iii. To achieve improved efficiency cookstove penetration of 5% by 2015 and 10% by 2020.

iv. To achieve 1% penetration of biogas for cooking in hotels, restaurants and institutional kitchens by 2015 and 2% by 2020.

75. LPG is just about 6-9% share of energy for cooking. Restaurants are responsible for over 75% of LPG consumed by the sector. “Chop-bars”, which are small local kitchens serving traditional dishes, take on the average about 13% share every year. Most of the energy used in these “chop-bars” had come from woodfuels (over 65%). Cleaner energy alternatives, using biogas produced from liquid wastes, as heating source in restaurants, institutional laboratories and kitchens will be encouraged. For now biogas use is almost negligible.

Agricultural and Fisheries Sector

76. **Objective:** *To increase the penetration of modern energy into agriculture for increased agricultural production, to help achieve the nation’s food supply security objectives.*

77. Strategic Targets:

i. To achieve 2% penetration of biodiesel by 2015 and 10% by 2020.

ii. To achieve 20% penetration of solar energy by 2020.

iii. *To increase electricity penetration to 2% by 2015 and 5% by 2020.*

78. The objectives are to:
- Encourage the substitution of diesel with biodiesel in agricultural mechanization.
 - Encourage more drying of exportable farm produce such as pepper with solar dryers.
 - Displace the use of diesel for irrigation with grid electricity and mechanical wind pumps.
 - Encourage large-scale commercial poultry farmers to meet at least 10 percent of their electricity needs from biogas, using the droppings from the birds.
79. For now, biodiesel use in this sector is non-existent. Solar energy use is about 13% on the average. Electricity consumption is less than 1% on the average.

Transport Sector

80. **Objective:** To reduce the dependence on imported fossil fuels for transport.
81. *Strategic Targets:*
Achieving fuel consumption per GDP growth of 1:1 by 2015 and sustaining it up to 2020¹⁷.
82. The immediate objectives are to encourage fuel efficiency measures in the transport sector.
83. The transport sector accounted for about 85% and 99.7% of diesel and gasoline consumption in the economy respectively. With the increasing world crude oil prices, such an efficiency strategy will have positive impact on future demand.
84. To help promote energy efficiency in the transport sector, there would also be the need to deregulate the railway system to permit private sector participation in urban passenger and long distance freight railways systems. Also, provide incentives for the promotion of nationwide mass transit systems.

¹⁷ from about 2:1 at present.

Industrial Sector

85. **Objective:** To ensure sufficient, cost effective but affordable high quality energy supply to meet the increasing demand of an efficient and expanding industrial sector. Light or non-energy intensive industrialization will be encouraged.
86. Strategic Targets:
- i. Achieving high quality and reliable (95% uninterrupted) electricity supply to the industrial sector per annum by 2015 and improving reliability to 98% by 2020.*
 - ii. Achieving an average of 95% power factor per annum in the industrial sector by 2015, increasing to 98% by 2020.*
 - iii. Introducing pollution charges in high-energy intensity industries to encourage efficiency by 2015.*
 - iv. Developing a local market for the industrial use of natural gas when the WAGP project is complete, including displacing all fuel oil use by 2015.*
 - v. Providing a competitive bulk electricity price to all primary industries (including VALCO) by 2012 to maximise wealth creation.*
87. Average power factor in the industrial sector is still less than 90% at present. At present, no pollution charges exist so there are no incentives for primary industries to further improve their energy use efficiencies. The nation expects to see a natural gas market for the first time in 2007.

Bulk tariff varies across large industrial users, even though some of the rates are unsustainable. In the end the poor tax payer is compelled to absorb the deficits.

Energy Efficiency and Conservation

88. Strategic Targets:
To reduce the average electricity intensity in the Residential and Commercial sectors from an average of 2-2.4:1 to 1.5:1 by 2015 and maintaining the ratio up to 2020.
89. Energy efficiency and conservation besides saving energy will also be encouraged as a means towards cleaner production and pollution control measures in industries. Energy audits in the industrial and Commercial/Service Sectors will continue to be supported.
90. The regulatory institutions would be encouraged to implement performance benchmarks for energy producers.
91. To ensure that energy is used efficiently in industry, commerce and in residential facilities, a law – the Energy Efficiency and Conservation Act – that would spell out mandatory energy management practices, building codes, requirements on energy

efficiency levels of energy consuming equipment, energy audit regimes for formal industries and commercial entities such as hotels should be instituted to give legal support to energy efficiency initiatives.

92. Support provided by Government in the introduction of Standards, Legislation and labels is highly commended. This would help ensure that inefficient energy consuming devices and appliances are not dumped on the Ghanaian market. The labels would help inform consumers about the choice of energy consuming appliances.
93. However, to reduce government recurrent expenditure, lessen pollution and set precedence for good practice, it would be prudent for Government to make it mandatory for all equipment bought for government facilities and educational institutions to meet minimum energy efficiency standards/specifications, set by the Ghana Standard Board.
94. For the same purpose, Energy Management in government buildings and educational facilities as well as vehicular fleets should be instituted.

Proposed activities

Energy Efficiency Standards and Labels

95. Standards and labelling programmes are essential elements in any government's portfolio of energy-efficiency policies and climate change mitigation programmes. Labels play the public education part and deliver the efficiency information to the consumers and standards transform the market by eliminating the most energy inefficient products. Separately, they each can stimulate the development of cost-effective, energy efficient technology and its diffusion into the marketplace.
96. Subsequently, the first Legislative Instrument (LI) enforcing standards for Room Air Conditioners and CFLs was passed by Parliament in 2006. A Testing Facility to test and certify the energy efficiency of Room Air Conditioners and CFLs is being built. Testing and full enforcement of standards commence in 2007.
97. It is estimated that compliance with the standard could save about 950GWh per year by 2020, freeing up to nearly 250MW of generating capacity that can be used for other productive purposes.
98. The Energy Efficiency Standard and Labelling would be extended to cover other appliances like electric fans, televisions, refrigerators and deep freezers in the nearest future. Penetration of fans in the residential sector is estimated at over 90 percent. Fans consuming between 20 – 30 percent less electricity than average fans are available. Some television sets consume about 20 Watt power and some as low as 2 Watt at standby mode.

Monitoring and Targeting (M&T) Energy Management Scheme

99. The concept of Monitoring & Targeting is based on the principle that, efficiency performance can be measured only when the amount of energy used per unit output is known.

100. Computer based M&T was introduced to 10 companies in 1997-98 while five Energy Service Companies were trained to provide this service to industry. Some of the pilot industries have reported malfunctioning of the meters that were purchased for the project. There is therefore the need to revisit the programme to replace the meters and software as well as consolidating the gains and eventually extend the service to other industries.

Electrical Load Management

101. Detailed Electrical Load Management studies completed for 30 large industrial firms with maximum demand of 500kVA or more in late 1990s, identified opportunities for industries to reduce their peak electricity demand and shift loads to off-peak periods. Energy Foundation has therefore recommended the introduction of a Time of Use (TOU) tariff for this category of consumers and has communicated the survey results to PURC.
102. The introduction of TOU tariffs would enable such industries as metal smelting, cement milling, electrical heating operations that operate 24 hours a day to shift some of their energy intensive operations from the peak electricity demand period (6.00pm to 11.00pm) This could improve overall national load factor and system efficiency during the peak periods. There would however be the need to install load controllers and monitoring devices in industries once the TOU tariff is implemented.

Electric Motor Improvement Project

103. Feasibility study into the establishment of one-stop motor repair and sales centres to serve as outlets for energy efficient motors and drives in various parts of the country was completed in 1999. The study recommended the development and implementation of motor testing procedures, minimum efficiency standards and labels as well as the establishment of a local motor manufacturing facility to produce small electric fan and pump motors which are in high demand in Ghana and the ECOWAS region.

Energy Management in High-rise Buildings

104. The number of high-rise office buildings is gradually increasing in the cities of Ghana. Such buildings are high-energy demand centres with maximum demand of 1-3MW, especially since all of them have air conditioning.
105. A nationwide project to retrofit all government facilities, including about 500 secondary school buildings with energy efficient lamps and sensors where necessary is being proposed.

Industrial Co-generation and Fuel Substitution

106. The expected introduction of natural gas into Ghana's energy mix in 2007, offers immense opportunities for Ghanaian companies to displace their more expensive industrial heating oils. Enterprises that use both heat and electricity could also benefit from combined heat and power (CHP) production technologies, which can greatly enhance fuel use efficiency and reduce the environmental impact of energy production and consumption.
107. The oil palm and wood industries that generate combustible residues and wood wastes (renewables) could use the residues for both power production and process heat for operational purposes.

Reactivating the IEAC and other energy centres

108. An Industrial Energy Assessment Centre (IEAC) has been established at the College of Engineering of KNUST¹⁸. The centre trains students in energy auditing and energy management and is supposed to produce skilled manpower in energy management for industries. The Centre since 1997 has trained over 40 students and has conducted over 18 energy audits in industries in the Kumasi and Accra-Tema industrial zones.
109. The Energy Commission intends to rally support for the energy centre to enable it enhance its energy efficiency, conservation and renewable energy activities. The Commission also intends to support the centre to develop capabilities for verification of greenhouse gas emissions for national candidate projects under the CDM.

Increase Energy Fund levy or set up a special purpose fund for promotion of energy efficiency and conservation

110. The Government may have to set up a special purpose fund to enhance the capacity to provide credits for financing the energy efficiency and conservation projects. Such a special purpose fund can be established through collaboration with donors and the private sector.
111. Local sources to the fund could include special levies on inefficient equipment imported into the country, power factor surcharge already in operation, donations and grants.
112. Such a special purpose fund could also be farmed out of Energy Fund if the prevailing levy is increased significantly.
113. Further financial resources for the development of energy efficiency projects could be sought through the development of projects that would reduce greenhouse gas (GHG) emissions and therefore qualify for funding under the Clean Development Mechanism (CDM) and other Climate Change mitigation initiatives.

Impact of DSM on total electricity demand

114. Impact of DSM on energy demand is expected to be significant. For instance, should the DSM in the electricity subsector be implemented by 2007 and sustained up to 2020, an average of about 21% savings in electricity consumption per year by 2012 and about 16% per year by 2020¹⁹. This translates to an average of about 3,500 GWh yearly savings by 2020 equivalent to a 500 MW thermal power plant (figure 5).

¹⁸ With the assistance of the US-Department of Energy under a Ghana - US technical cooperation agreement, signed in 1997.

¹⁹ Valco improved efficiency from 16.2 GWh/tonne to 15 GWh/tonne of cast aluminium metal freeing 415 GWh equivalent to about 60 MW open cycle thermal plant a year. Most Industries improved efficiency in power factor liberating about 20 MVA equivalent to about 100 GWh a year. Using CFLs to replace incandescent bulbs; 20W CFL replacing 60W incandescent onion bulb. Penetration based on a cycle of average of 8 million CFLs to introduction every 4 years beginning with 6 million in 2007. Liberating

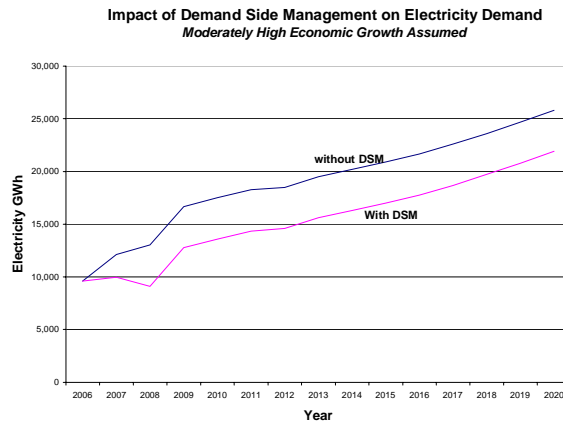


Figure 5. Projections of electricity demand with and without DSM

equivalent of about 2,000 GWh a year. 6 million 20W CFL replacing 60W incandescent onion liberates 240 MW demand equivalent to generating about 1,640 GWh.
 Enforcing standards and labelling for air-conditioning and CFLs.
 Introducing efficient refrigerators and freezers nationwide and phasing out old inefficient brands.

STRATEGIC PLAN FOR THE SUPPLY SECTOR

Electricity Subsector

Security of supply

115. **Objective:** To produce adequate, high quality, reliable and efficient power supply to meet economic and social development needs of Ghana and for export.
116. **Strategic Target:**
Secure and increase future energy security by diversifying sources of supply, including increasing access to renewable energy technologies so as to achieve:
- *10% penetration in terms of installed capacity by 2020²⁰.*
 - *30% penetration of rural electrification via renewable energy technologies by 2020.*
117. Three alternative expansion plans for meeting the electricity supply requirements have been provided:
- Option One is an expansion plan based on natural gas and 10 percent renewable energy by installed capacity by 2020.
 - Option Two is an expansion plan based on natural gas, Bui Hydropower project and 10 percent renewable energy by installed capacity by 2020.
 - Option Three is an expansion plan based on natural gas, Bui Hydropower project, nuclear power and 10 percent renewable energy by installed capacity by 2020.
118. 10 percent penetration of renewables in the generation mix is the optimum proportion that will maintain the average generation costs of all the options at about the same level.

Fuel supply options to the Osagyefo Power Barge

119. Extending the WAGP to Effasu at the moment appears to be the most reasonable option in the medium to long term, because developing the Tano fields assuming funds are available today, will take between 3 – 5 years. The extension could help increase the consumption of the WAGP natural gas and consequently reduce the unit cost of the WAGP gas at the gate.

²⁰ Computation for renewable energy share shall not include existing hydropower stations of Akosombo and Kpong generation stations.

120. Natural gas could also be brought from la Cote d'Ivoire²¹ to fire the Osagyefo Barge and at less or almost the same period it would take to develop the Tano gas fields. The regional nature of the project however could enhance la Cote d'Ivoire's chances of getting connected to the WAGP project²².
121. Technically, the barge could be moved to Tema and get connected to the WAGP instead of extending the latter to Effasu and could be the quicker option. However, preparing the site at Tema to receive the barge could cost about US\$ 50 million which is about the cost of installing a new 100MW single cycle gas turbine plant. Furthermore, considering that infrastructure²³ has been laid at Effasu, the indigenes, the opinion leaders and their chiefs have been promised the project assuring them of job creation, they in turn having embraced the project, the social cost could be immense and repercussion uncertain taking cognisance of the civil unrest in the neighbouring country – la Cote d'Ivoire. A compensation package deemed adequate for the communities would have to be worked out through careful negotiation with the aggrieved communities.
122. In the context of ECOWAS, extending the WAGP to Effasu will draw closer the dream of having a pipeline stretching from Nigeria to Gambia and eventually serving all the ECOWAS member countries. Therefore, a decision based not only on technical feasibility, but social and in the regional context appears to be more sustainable.
123. The second favourable option is the development of the Tano fields as originally envisaged by GNPC²⁴ for the barge. Development of the Tano fields has the following advantages:
 - i. The associated oil deposit will help deflate the cost of the project.
 - ii. Secondly, since the gas is raw, potential exists to separate the heavy molecular formulae during its exploitation to process into LPG for the domestic market. Comparatively, the natural gas from WAGP has to be dry to avoid the potential safety and operational problems associated with the condensation of liquids in the pipeline.²⁵
124. In the short term and for it to be operated for few days, the barge could also be readied and made part of the country's power reserve by filling the barge's storage system and the four (4) bulk road tankers procured for it with distillate oil. Even though, it could easily come on line, in times of crisis but would be the most expensive option. It is not sustainable since the trucks would have to make a number of trips to transport fuel if the barge is to operate for a number of days.

²¹ Kudu and Ibex fields in la Cote d'Ivoire, near the Tano fields in Ghana.

²² La Cote d'Ivoire envisages joining the WAGP in the long term

²³ Estates have been built, the harbour for the barge has been readied, and the national transmission network has been extended to barge site.

²⁴ Ghana National Petroleum Corporation

²⁵ It is therefore not practical for bottling to supplement local LPG demand.

Selected power generation technologies

125. Detailed assessment of the technical feasibility including an evaluation of the costs and a demonstration of the overall net benefits accruing to the economy is provided in the supporting document to the SNEP titled Least Cost Assessment of Power Generation Technologies and Demand-Side Appliances: An Integrated Resource Planning Approach²⁶
126. The assessment of power generation technologies carried out by the Commission as part of the SNEP suggests that coal-fired steam turbines and combined cycle gas turbine running on natural gas are the most competitive sources of centralised grid electricity, followed by simple-cycle gas turbines and the power from the 'Osagyefo' barge²⁷ (at Effasu) running on natural gas.
127. For decentralized grid systems, electricity from closed engineered landfill²⁸ power plant is the least expensive, combined heat and power (CHP) based on sawdust and wood residues is next followed by wind based power.
128. The most expensive means of generating grid power is by grid connected solar photovoltaic (PV) system, followed by waste incineration and wood plantation in that order.
129. Even though, conventional thermal plants based on natural gas would provide the least expensive grid power, infusing indigenous renewable energy based electricity besides the traditional hydropower in the generation mix helps to improve the balance of payments and also reduces the greenhouse gas emissions of the country, recalling that Ghana is a signatory to the Kyoto Protocol.
130. Extracting and utilising the gas generated from landfill sites create a significant benefit for the environment as the methane (gas) a very potent greenhouse gas is prevented from entering the atmosphere. Wind and solar power systems however do not emit any harmful gases or particulates into the environment. Solar power also emits no noise no noise during operation making it ideal for office and wildlife environments.
131. Whilst conventional thermal generating systems are most sensitive to fuel prices, renewables including hydropower are the least sensitive to variations to fuel prices. Renewables like biomass-fired CHP plants, landfill, waste-to-energy (incinerators), could have highest supply security, since once they are installed or constructed; fuel is largely indigenous. Hydropower plants may be threatened by severe droughts in their catchments, solar resource is assured almost daily, even though, intensity may vary.
132. Indigenous natural gas once discovered and exploited could on the other hand, provide high supply security to the thermal plants, since it would shield the latter from external influences.

²⁶ Published by the Energy Commission, 2004. Also, see the Bibliography for more reference materials.

²⁷ Same as Effasu Barge, originally built by the Ghana National Petroleum Corporation.

²⁸ Excludes cost of constructing the landfill.

133. Biomass plantation-based power production has the highest job creation, mainly since labour will be needed for the plantation and its management. Local employment generated from the investment costs would only last during the construction period, whereas employment generated from operation and maintenance as well as fuel costs would last during the lifespan of the power plant in question.
134. Nuclear technology including the power plants and the fuel would be the most difficult to acquire and thus provides the least security of supply in terms of external factors. However, once acquired and installed, it tends to have high security of supply; smaller quantities of fuel can last far longer periods than the same quantity of oil or natural gas. Another major drawback with nuclear power technology is that it would be the most difficult to attract funding, due to nuclear proliferation concerns, long construction periods and long pay-back times.

Generation mix

135. Generation mix of the expansion options by installed capacity is as follows:

Average generation mix by installed capacity of the expansion plans			
	Option 1	Option 2	Option 3
Hydropower	39 - 41 %	46 - 49 %	44 - 46 %
Thermal	51 %	43 - 46 %	41 - 43 %
Nuclear	0 %	0 %	3 - 8 %
Renewables	8 - 10 %	5 - 11 %	7 - 8 %

Job creation

136. Construction of the Bui hydropower project could create as many as 21,000 jobs. The development of the Tano gas fields and the construction of the nuclear power plants will also create significant number of jobs. These make the Option Three the highest job creator. The infusion of renewable energy technologies in general creates most of the operation and maintenance jobs due to their higher local content, decentralised and localised nature.

Greenhouse gas emissions

137. Option One gives the highest carbon dioxide emissions due to its large thermal component in its generation mix.

Costs for the Electricity subsector

138. Option Three tends to be the most capital-intensive due to the inclusion of the Bui hydropower and the nuclear power projects.
139. Snapshot of the cost, job creation potential and the carbon dioxide

emissions of the options by 2020 are as follows:

	Option 1	Option 2	Option 3
Cost in billion US dollars	5.7 – 6.8	6.1 – 6.2	6.5 – 6.6
Investment in power plants	33–37%	43–45%	46–48%
Operation, maintenance, fuel	73–77%	55–57%	52–54%
Transmission cost in billion US dollars		0.17 – 0.27	
Distribution cost in billion US dollars		0.65 – 0.90	
Direct jobs created during construction in man-years	18,500-24,500	43,000 – 44,000	54,100 – 57,000
Direct jobs created during operation and maintenance in man-years²⁹	247,000	277,000	286,000
Carbon dioxide emissions during operation in million tonnes	85 - 86	72 - 77	68 - 73

140. It is commendable that the Government has passed the enabling legislation for the creation of the new entities and also, the modification of mandates of the existing entities to facilitate the implementation of the power sector reform.
141. It is recommended that the New VRA manages the Volta Lake and secures the integrity of large hydropower dams in the country.
142. Large hydropower projects compare to thermal, takes relatively longer time to construct, require relatively larger infrastructure development, involves environmental issues that could be controversial such that they hardly attract private investors without Government participation, unless the rate of return is relatively very high. High rate of return on the other hand makes the intended generation costs of the hydropower projects very uncompetitive. The technical lifetime of the hydropower plants is about 50 years compared to the usual economic lifetime of 20 – 30 years used for most analysis. They could become very attractive in the long run when their investments have been paid for. In addition, construction of hydro plants creates more jobs and they have less operation and maintenance costs than thermal plants.
143. However, without an entity such as new VRA, it will be almost impossible to develop the remaining hydropower resources. The new VRA with hydro as focus has the advantage to look for overseas development assistance, governmental loans and government (public)-private partnership investment funding.
144. Furthermore, it should be emphasised that without the transmission ownership separated from VRA system ownership and an Independent System Operator appointed, it will be very difficult to envisage a fair competition for would-be future generators. Consequently, the expected private sector participation in power generation could hardly be realised without an Independent System Operator.

Petroleum subsector

²⁹ Rounded to the nearest 1000

145. **Objective:** To produce adequate and high quality liquid fuels to meet economic and social development needs of Ghana and for export.
146. *Strategic Targets:*
- i. *Ghana achieves 10% penetration of liquid fuels by renewable and alternative fuel complementation by 2015 expanding to 20% by 2020.*
 - ii. *Ghana becomes self-sufficient in petroleum products by 2015 and net exporter by 2020*
 - iii. *Replace manganese³⁰ additive with ethanol as performance enhancer in gasoline by 2015.*
 - iv. *Reduce sulphur content in gas oil (automobile diesel) from the prevailing 2000 ppm to*
 - i. *1000 ppm by 2015*
 - ii. *500 ppm by 2020*
147. The options for meeting the future petroleum supply requirements of the country include:
- i. Upgrading and increasing the efficiency of the Tema Oil Refinery (TOR).
 - ii. Expanding the total national refinery capacity, which will comprise expansion of the Tema Oil Refinery as well as construction of a new refinery (within the Export Processing Zone).
 - iii. Introducing renewable energy fuels (gasohol and biodiesel) and natural gas in the supply mix.
 - iv. Encouraging the deployment of efficiency improvement devices in vehicles.
 - v. Enacting a more investment-friendly Petroleum Exploration and Production Law to attract more investment in the petroleum upstream activities and consequently intensifying exploration activities in the country.
 - vi. Maintaining adequate strategic stocks for the country.

Upgrade and Increase the efficiency of TOR

148. Losses occur at the Tema Oil Refinery (TOR) due to the low capacity of the aged premium reformer, low capacity of the aged utility units and losses at the refined product-loading gantry. The low capacity utilisation factor also leads to operational inefficiencies in the refinery's operations. TOR's limited capacity to blend various crude oils is also denying the refinery the flexibility to take advantage of more available but less expensive heavier crude oils on the international market.

³⁰ MMT in gasoline

Catalytic Reformer

149. The Catalytic Reformer unit will have to be rehabilitated and revamped from the existing capacity of 5,000 barrels per day to about 8,000 barrels per day in order to enable it process all the naphtha produced in the Crude Distillation Unit (primary conversion unit).
150. Revamping and keeping the reformer unit in good working condition will eliminate the export of the naphtha produced during the primary refining process. This will improve the financial gains. There is less gain in the prevailing situation where the naphtha is exported at relatively low prices and the proceeds used in importing high cost finished products.

Utility System

151. Rehabilitating and revamping the utility unit will guarantee the supply of the required steam and electricity to improve the efficiency of the refining process. This could reduce prevailing internal consumption and losses of the refinery by 50 percent. The excess flue gas and the cracked residual oil are enough to produce energy to run the refinery and as well sell excess power to the national grid, under the feed-in tariff for embedded generation under consideration by the PURC³¹.
152. Revamping of the catalytic reformer and the utility system is thus essential to reducing losses in TOR and consequently improving the efficiency of the refinery.

Import refined petroleum products

153. Refined petroleum products are utilised directly whilst crude oil has to be refined. If the crude oil price is compared with those of refined products the average ratios are as follows:

International Price Scale: Ratio of prices of refined product against crude oil		
Products	F.O.B	C.I.F
Crude oil	1.0	-
Gasoline	1.3	1.5 – 1.6
Diesel	1.25	1.3 – 1.4
Kerosene/ATK	1.35	1.4 – 1.5
RFO	0.6 – 0.7	0.8 – 0.9
LPG	1.4	1.5 – 1.7

154. Using the ratio of product price/crude oil factors above and assuming the refinery is operating at maximum capacity, importing the underlisted quantity of projected product shortfalls will cost as follows:

³¹ Public Utility Services Commission, a sister regulatory institution of the Energy Commission responsible for financial regulation.

	2008	2012	2015	2020
	Average shortfalls in tonnes			
LPG	80,400	112,000	218,000	324,000
Kerosene +jet fuel	-	-	46,000	93,000
Gasoline	126,400	238,000	378,000	518,300
Diesel	246,700	746,700	1.25 million	1.76 million
RFO	124,100	140,300	161,000	182,300
<i>Total import cost³²</i>	<i>US\$303 million</i>	<i>US\$611 million</i>	<i>US\$900 million</i>	<i>US\$1,187 million</i>

155. Import cost of petroleum fuels was from US\$ 100-156 million between 2000 – 2003 reaching about US\$ 206 million in 2004.

Expand refinery capacity

156. If all the petroleum requirements of the nation are to be met from local refining, the total refinery capacity is projected to reach at least 115,000 barrels of oil per stream day by 2020. This can be achieved by expanding the Tema Oil Refinery to the required size by 2020, if only space is available at the existing site.
157. On the other hand, a new refinery of total refining capacity of at least 70,000 barrels per stream day will have to be built, expandable to 100,000 barrels per stream day if significant export is guaranteed.
158. It must be noted that the profitability of refinery operations is very sensitive to the capacity utilisation; 85 percent capacity utilisation has been accepted as benchmark for economic operations of most refineries. It would therefore not be economically wise to build a 70,000 – 100,000 barrel per day refinery in the short term, where capacity utilisation will be less than 80 percent, unless an export market is guaranteed.
159. In this stance, locating such a 70,000 – 100,000 barrel per day refinery plant in the Export Processing Zone with export market as the initial target makes sense.
160. Furthermore, the cost of a new refinery is about US \$1000 – 5,000 per BPD capacity. The lower the capacity the lower the unit BPD cost.

First step

161. Before expanding the refinery capacity of the country, the first step will be to improve the efficiency of the existing refinery and complete the single buoy-mooring project. Improving the efficiency of the Tema Oil Refinery is to rehabilitate and expand its secondary and utility units, i.e.

³² Assumed crude oil price at US\$70 per barrel for 2008; US\$65 per barrel for 2012; US\$55 per barrel for 2020

- i. Rehabilitate and revamp the Catalytic Reformer unit
- ii. Rehabilitate and revamp the Utility unit to enable it fire the CDU, RFCC and the Reformer unit concurrently.
- iii. Rehabilitate and revamp the storage facility.
- iv. Revamp the loading gantry

Completed and on going projects

- 162. The just completed Single Buoy Mooring (SBM) besides providing dedicated docking point will also enable the use of bigger vessels to deliver crude oil, which will lower the delivery cost of crude oil.
- 163. TOR will however not enjoy the full benefits of the SBM in terms of freight due to the limited crude oil storage capacity. TOR therefore intends to build about 168,000 metre-cubed capacity for additional crude oil storage.
- 164. To improve its reliability, TOR is embarking on a project to revamp its utility system capable of generating at least 215 tonne per hour of steam and 16 MW of electricity. TOR envisages selling initial spare capacities to the grid when practicable.
- 165. TOR intends to automate the loading gantry at its premises to reduce the human intervention as a way of reducing, if not to eliminate the losses at the gantry. The initial works have started with the installation of a tank gauging system on all the storage tanks in the refinery.

Second step

- 166. The second step is to expand the Tema Oil Refinery by at least 30,000 barrels per day to bring the total capacity to at least 75,000 barrels per day by 2008. Otherwise, a new 30,000 barrels per day refinery should be built preferably, in the Western Region within economic reach of the Takoradi seaport.
- 167. Merely constructing a 30,000 BPD refinery facility without the right configured secondary units will not be able to provide sufficient products to meet the supply requirements.
- 168. Since the Tema Oil Refinery already has a catalytic reformer for the production of premium gasoline and a bimetallic-based residual fluid catalytic cracker, it may be of strategic importance for future refinery expansion or new refinery capacity to be
 - i. an isomerisation unit instead of a catalytic reformer; and
 - ii. a hydrogen-based catalytic cracker (hydro-cracker) instead of a bimetallic as alternative technologies.

169. Even though, it is a matter of cost, the flexibility of an isomerisation unit³³ allows many different products to be produced to meet customers' requirements. The isomerisation unit is able to rearrange lighter gaseous byproducts to form value-added products. It is connected to the crude distillation unit to achieve higher octane numbers from the straight-run petroleum.
170. Bimetallic catalyst, which happens to be solid-liquid based catalyst, as evident in the RFCC, becomes inactive after a number of runs, due to excessive carbon contamination. The disused catalyst in the RFCC presents quantities of solid and liquid wastes to be disposed off which at times becomes a bother.
171. Hydrogen-based cracker uses hydrogen but also uses a catalyst for its reactions. It operates at slightly lower temperatures but much greater pressure to produce the lighter value-added fuels. Even though, more sophisticated to operate it yields much more value-added lighter fuels than RFCC.
172. The 30,000 BPD facility thus could have a minimum configuration of 30,000 BPD crude distillation unit, 6,000 BPD of a reformer or isomerisation unit and a 10,000 BPD residual hydro-cracker.
173. Suggested refinery configuration for 2008, 2015 and 2020 are as follows³⁴:

Year	Primary unit	Secondary unit	
2008	30,000 BPD Crude distillation unit	6,000 – 8,000 BPD isomerisation or reformer unit	10,000 BPD cracker
2015	45,000 BPD Crude distillation unit	8,000 – 10,000 BPD isomerisation or reformer unit	14,000 – 15,000 BPD cracker
2020	70,000 BPD Crude distillation unit	12,000 BPD isomerisation or reformer unit	22,000 BPD cracker

Fuel refining slate flexibility

174. Sweet and light crude oils are environmentally friendlier than sour and heavier crude oils because they yield products with fewer pollutants when refined. They are also easier to process than the latter. Hydroskimming refineries for processing sweet (<0.5% sulphur) and light crude are less expensive to build. Also, historically more light crude oil has been produced worldwide. For these reasons, companies built more refineries to process light and sweet crude oils worldwide than for sour and heavy crude oils.
175. However, in recent years, environmental regulations have become more stringent, not only in developed countries but worldwide. Also, new crude discovery slate is becoming heavier and sourer and the rate is projected to surpass light crude discoveries by 2020. So, refineries are being demanded to produce more and more lighter, cleaner products while their crude supplies are becoming heavier and sourer. Accordingly the trend has

³³ someriser converts straight chain hydrocarbon into branch chain type. Even though it has the advantage of higher octane numbers, there is relatively huge environmental problem associated with the disposal of the disused catalysts

³⁴ BPD – Barrels per stream day

been to invest in technologies such as hydrocracking and coking. Coking refineries are however more expensive to build and therefore relatively few. Heavy crude oils are lower priced than light and sweet crude oils and the gap continues to widen as demand for lighter and sweeter crude grows³⁵.

176. The growing demand for light products has contributed to increasing the price of light crude oil and creating shortage of light crude refining capacity. Average refinery capacity utilization worldwide has exceeded 90% in 2004-2005.
177. Sour and heavy crude oils are thus becoming more available and the price is dropping over time. Investors are therefore taking advantage of the dropping heavy crude prices to invest in vacuum distillation units (VDU) and cokers, a situation which is also helping to raise refining margins.
178. High refining margins and the increasing global fuel demand are encouraging more capital inflow into building refining capacity worldwide. Supply however is not expected to exceed demand adequately until about 2011. According to industry consultants, \$150 billion in real terms are expected to be invested mostly in hydrocracking and coking refineries by 2015³⁶. Therefore, refineries capable of processing heavy and sour crude oils will enjoy high margins.
179. Crude oil supply is expected to remain tight as it is not expected to exceed demand significantly until after 2011. Coupled with market speculations, prices of sweet and light crude will thus remain relatively high in the foreseeable future. With this background, it is recommended that Ghana should consider its ability to access heavy crudes and incorporate hydrocracking, vacuum distillation³⁷ and eventually coking capacity in the expansion of the nation's refinery capacity in the medium to long term to maximize value-addition and to introduce fuel supply versatility in the nation's refinery capacity expansion. Otherwise, as more refineries build hydrocracking and coking capabilities, demand for heavier crudes will increase and hence its price in the longer term. The ability to produce varieties of fuel configurations can position the country to access the regional and the more matured international markets as well.
180. Coke, the by-product of coking refining is largely used as fuel for power generation and heating similar to coal. It is also used in the production of carbon anodes and as clinker in the production of cement. In Ghana, VALCO at present imports coke for the production of carbon anodes for its smelting operations. VALCO may therefore not need to import, if coke can be obtainable locally at competitive cost.

³⁵ Average worldwide heavy/Sour to light/sweet crude price: 1:1.4-1.5 and keeps widening (Purvin & Gertz, (2006)

³⁶ Shenoy, B., Gülen, G., (2006), Oil Refining Future Strategies, *Chartered Financial Analyst, March 2006*, 51

³⁷ Vacuum distillation can be coupled to the primary distillation unit. The VDU (vacuum distillation unit) processes the residuals or heavy crude into light heavy and residual heavy where the latter is further processed by a coker.

Stock Exchange No timetable yet has been drawn up. Break down of funding sources and arrangements are available in the TOR Corporate Plan 2006 – 2009 available from Tema Oil Refinery.

Strategic Response at TOR³⁸

181. In response to the gradual paradigm shift in global refining sustained by the high spread between sweet and sour crude oils, TOR has resorted to blending sour and sweet crude oils to mitigate the ever rising cost of sweet crude oils. This makes economic sense since it has no heavy oil capability. TOR is installing mixers on crude oil and fuel oil tanks to meet the technological challenge in the short term. It has also installed an injection equipment to treat light cycle oil to facilitate blending with diesel (gas oil) to improve high value fuel yield from the RFCC³⁹.
182. TOR was designed to process light and low-sulphur crude oils at a time crude oil prices were very low and tenable in neighbouring Nigeria. The properties of RFO feeding the existing RFCC unit were also based on residuals from light and sweet crude oils.
183. TOR intends to increase its crude processing capacity from 45,000 BPSD to 105,000 BPSD. It is looking at 60,000 BPSD and an 18,000 BPSD cracker based on either of the following configurations:
- CDU + catalytic reformer + fluid cracker (RFCC)
 - CDU + regenerative reformer + VDU
184. TOR also plans to make bitumen and lubricants significant components of its production slate by 2020. It is considering producing 60,000 tonnes of bitumen on a dedicated CDU or VDU by 2020⁴⁰.

A supply mix of petroleum and liquid biofuels approach

185. The main objectives are:
- To produce alcohol for commercial blending of gasohol to complement gasoline use in vehicles.
 - To produce plant oil (most likely jathropa oil) for commercial blending of biodiesel to complement diesel use in vehicles.
 - To introduce liquid biofuels as alternative transport fuels in the country's energy mix thereby improving supply security as well as improving the local air quality.

³⁸ To ensure the required improvement at TOR as well as to attract private capital for its expansion, the Government of Ghana, the sole owner has declared its intention to privatize Tema Oil Refinery. According to TOR, the Government plans to retain 30 percent of the shares and give 35 percent to a strategic investor. The remaining 35 percent will be off-loaded to the local market and the general public through the Ghana

³⁹ Light Cycle Oil also using the same acronym LCO as Light Crude Oil is one of the middle distillate products from the RFCC. The LCO is potentially a gasoil except that it turns dark on exposure to light due to the presence of unsaturated organic compounds in it. By treating it with an additive, a blend of 95% Gas Oil and 5% stabilised LCO is achieved.

⁴⁰ Source: Tema Oil Refinery Corporate Plan 2006 – 2009.

Clean Air Quality

186. Ghana is a party to the African Clean Air Agenda⁴¹ which sets out conditions for realising better air quality to protect the health of its people as well as the ecology. Ghana has been able to phase out lead additives from gasoline, which had serious health implications particularly on infants. Lead also poisons catalytic converters in vehicles and thus destroys their efficacy in removing nitrogen oxides from vehicular exhausts. MMT, a manganese additive has replaced lead as performance enhancer in gasoline fuel. Thus, in order to maintain the octane performance of gasoline, Ghana has introduced MMT, but it is still a heavy metal and equally has serious health effects on infants and therefore has the potential to attract protests from environmentalists.
187. Ethanol in gasoline eliminates the need for the poisonous and controversial enhancers such as MMT and MTBE⁴² Both MMT and MTBE are being phased out in the developed world where they are being replaced with ethanol.
188. To reduce sulphur emissions by diesel vehicles, low-sulphur (less than 50 ppm or 0.005% sulphur) diesel has been introduced in most developed countries. Ultra-low sulphur (less than 15 ppm or 0.0015% sulphur) has started to appear on the fuel menu of these advanced countries. Africa is meeting the low-sulphur challenge by introducing its own specification series; AFRI-1 (10,000 ppm or 1% sulphur) to AFRI-5 (50 ppm 0.005% sulphur); the aim is to achieving progressively decreasing sulphur content from AFRI-1 to AFRI-5⁴³.
189. Diesel in Ghana is about 2,000 ppm (below AFRI-3; 2,500 ppm or 0.25% sulphur) due to the largely sweet crude oil it obtains from Nigeria. The country's poverty level and relative vehicular intensity compared to any developed country, constrain the urgency to embark on rapid switch to AFRI-5 (50 ppm or 0.005% sulphur). Ghana may have significant carbonate (limestone) bedrock to buffer potential acidic rain at least until middle-level developing income status is achieved and so a more modest target of say AFRI-4 (500 ppm or 0.05% sulphur) can be achieved by 2020.
190. However, a less expensive route to reducing emission of sulphur and heavy metals in the local environment is to introduce biodiesel and ethanol alongside regular diesel and gasoline in the transport fuel mix. A likely significant advantage is that both biofuels can be produced locally.
191. Supplementing diesel and gasoline consumption with biodiesel and alcohol that can be produced locally is therefore highly recommended. Ghana can take cues from Brazil where the alcohol is blended with gasoline to produce gasohol to supplement gasoline consumption. Ethanol accounts for 40 percent of Brazil's transport fuels. India Railways has embarked on a large-scale cultivation of physic nut plant for the production of biodiesel to supplement its diesel requirements, a lesson that Ghana Railways Company could adopt.

⁴¹ Clean Air Agenda set out by the African Refiners Association

⁴² MMT is methylcyclopentadienyl manganese tricarbonyl. MTBE is methyl tertiary-butyl ether; a compound of methanol and isobutylene.

⁴³ The African Refineries Association has not provided a timeframe yet for the low-sulphur goal.

192. Also, with the Kyoto Protocol in force, such switching or complementation of liquid biofuels into the petroleum subsector stands a greater chance of attracting funds under the Clean Development Mechanism (CDM). This can be considered as a source of funds to encourage biofuel production.
193. Prevailing retail cost of ethanol on the world market ranges from 15-35 US cents per litre. Comparably, gasoline price delivered at the pump in Ghana was between 49-50 US cents per litre from 2003 – 2004 and it is currently over 70 US cents per litre.
194. Up to B20 (a blend of 20 percent biodiesel and 80 percent standard diesel by volume) and E10 are widely accepted because they do not require retuning of the engines. Also, their long-term real world operations have been proven to be problem-free. The optimal approach is to start with the
 - i. Introduction of B5 and E10 dispensing at filling stations by 2008, under voluntary programme for the oil marketing companies.
 - ii. From 2008 – 2015, B10 and E20 are introduced along side the B5 and E10. Oil marketing companies are mandated to dedicate a pump each for B5 and E10 dispensation at their stations.
 - iii. From 2015 – 2020, make mandatory B10 and E10 use nationwide. Then encourage more gasohols up to E85 dispensation at the pump and use in the country. .
195. Biodiesel has an added advantage that besides being used as fuel for vehicles, it can also substitute for diesel use in rural areas for grain-milling (popularly called corn-mills), agriculture machinery and in cottage industries. Even in its crude form, biodiesel is being used to run a sheabutter milling plant on demonstration project in northern Ghana.
196. The maximum land area that will be required for both the sugarcane or cassava and the jatropha cultivation is about one million hectares. In comparison, cocoa utilises 1.2 million hectares. However, the land requirement will be seen as no threat if considered in the context that Ghana has about 55 percent of its agricultural land size of 13.6 million hectares unutilised.
197. Furthermore, the residues after large-scale commercial starch production such as in the Government's PSI⁴⁴ for cassava can be used to produce alcohol and this could be exploited to support the proposed gasohol programme.

The West African Gas Pipeline project

198. The government in its effort to reduce the severe impact of the high cost of the importation of crude oil and petroleum products on the balance of payment is seeking to diversify its hydrocarbon based energy resources to include natural gas supply from Nigeria via the West African Gas Pipeline (WAGP). The WAGP project would make

⁴⁴ President's Special Initiative

available to the country and the sub-region natural gas from estimated reserves of over 120 trillion cubic feet (3.4 trillion cubic metres) in the delta region of Nigeria.

199. The use of natural gas will displace light crude oil for thermal electricity generation at the Takoradi Thermal Power Station. The long-term expectation is that the natural gas would displace some gasoline as transport fuel and some LPG, gas oil and residual fuel oil (RFO) as heating fuel for industrial and commercial entities.

Prospects for gas complementation in the petroleum supply mix

200. Even though, the main target of the expected natural gas from Nigeria is for electricity generation, it opens the doors for other applications. In the industrial sector, it has the potential to displace fuel oil use for heating. When compressed into CNG (compressed natural gas) and or liquefied into Liquefied Natural Gas (LNG), it can complement or displace some diesel and gasoline as a vehicular fuel in the transport sector.

Natural gas as an industrial heating fuel

201. Natural gas combustion reduces air pollution compared to residual fuel oil (RFO). However its adoption as a heating fuel to displace RFO oil will depend on cost. The natural gas from Nigeria will cost between US \$4.26 – 5.84 per mmbTU⁴⁵ yielding between US\$ 100 – 114 per tonne on the low-side and US \$ 140 – 150 per tonne on the high-side.
202. Prices of RFO are over US\$ 200 per tonne for crude oil price of above US\$ 60 per barrel. Thus, a switch looks more attractive, if crude oil prices remain above US \$35 per barrel.
203. Tema and Takoradi with their concentration of industrial activities, including Tema Oil Refinery (TOR), VALCO⁴⁶ and Ghana Cement Works (GHACEM) are most likely to switch early to natural gas in the market development process. To serve major customers in Tema and Takoradi, two separate pipeline networks of roughly 20 - 25 km each will be sufficient in the early stages. Except for 4-5 km transmission line (main trunk linking to WAGP) which is assumed to be steel and brings the gas onshore from the WAGP that parallels the shoreline under the sea; the rest could be small diameter high density polyethylene (HDPE) distribution pipes.
204. Different studies in the past have estimated the business-as-usual natural gas demand in Tema and Takoradi to be up to 10mmscfd for Takoradi and up to 20mmcf for Tema by 2020 .Separate distribution networks of the steel and plastic pipelines of carrying capacities of up to 20 million cubic feet per day (mmcf) for Tema and up to 10 mmcf for Takoradi are estimated to costs US\$2 million and US\$1 million respectively. A nationwide natural gas distribution master plan taking into consideration potential consumption at the mining centres and Kumasi will of course cost more.

⁴⁵ Million British Thermal Unit

⁴⁶ VALCO is an aluminium smelting facility

Natural gas as vehicular fuel

205. Compressed Natural Gas (CNG) is rapidly becoming the alternative fuel of choice for vehicles where the gas infrastructure exists. CNG vehicles have been found to be 10 percent more efficient than gasoline vehicles and as equally efficient as diesel fuelled vehicles. Fuel cost is 10-15 percent less than diesel in places where again gas infrastructure already exists.
206. It is estimated that carbon monoxide emissions are reduced by 97%, NO_x emissions by 39% and carbon dioxide emissions by 25% when CNG is used instead of gasoline vehicle. Advantages of CNG include reduction in wear due to the cleaner combustion, reduced contamination and less air pollution leading to longer engine life.
207. The major disadvantage of CNG vehicles however, is the increased weight of the vehicle. Also, as with almost all gas fuels, operation and maintenance costs of the vehicles tend to go up by 30-40%, particularly for retrofitted vehicles. Operation and maintenance costs reduce for built CNG vehicles (i.e. if not retrofitted) but the cost of such CNG vehicles are relatively higher. Furthermore, CNG fuel, provides less torque than diesel for articulator trucks which implies loss in engine power. Torque improves with LNG but LNG vehicles and filling stations are far more expensive than those of CNG. For ordinary trucks other than articulators, pick ups, buses and small cars CNG provides the same torque qualities as diesel fuel.
208. In India, a law is in place making it obligatory for all diesel vehicles in cities to switch to CNG. In the United States and Sweden, a number of public buses and waste-trucks run on CNG.
209. To convert from gasoline/diesel use to CNG, the vehicle needs to be retrofitted with a cylinder, and other kits at a cost of US\$1,450 – 2000 labour included⁴⁷. The capital cost of a CNG filling station with a capacity of 500 cubic metres (111,000 imperial gallons), including compressors, installation, and training is estimated at US \$1 million. The total refuelling and distribution cost is between US\$ 4-6 per Gigajoule, i.e. US\$100–155 per tonne, compared to prevailing diesel and gasoline prices of over US\$300 per tonne and US\$400 per tonne respectively.
210. With the impending availability of natural gas in 2007 and beyond, it is recommended that at least three pilot stations should be installed in Takoradi, Tema and Accra by 2012. Full commercial operations in major coastal cities of Ghana should be possible by 2020⁴⁸.

Favourable Petroleum Exploration and Production Law

211. Three key ingredients to attract investments from international oil companies are; Stable political and social situation, good geological conditions and favourable economic conditions

⁴⁷ Compressed Natural Gas Vehicles: Motoring Towards a cleaner Beijing, Applied Energy Vol.56, p395-405, 1997, Elsevier Science, UK.

⁴⁸ If CNG stations are installed in Winneba junction, Mankessim and Cape Coast, a Takoradi bound truck can fuel in Tema or Accra refuel or top-up at Winneba junction, Mankessim station, or Cape Coast, and vice versa.

212. Oil is relatively easy to transport compared to gas and so there is easy access to global market. Gas, however, unless converted to LNG is more difficult and consequently more expensive to transport to international market. For oil, most companies often look at the tax royalty agreements and the fiscal terms of the Production Sharing Contract (PSC), whilst for gas, access to domestic market is equally important.
213. Even though, natural gas from Nigeria is reaching Ghana via the West African Gas Pipeline, it is still in the interest of the country to continue to try and develop a domestic gas supply to at least, help with the country's balance of payments and as well provide security in case of disruption of supply.
214. To encourage development of domestic gas supply, attractive tax royalty agreement and or, good fiscal terms in Production Sharing Contract (PSC) will be necessary. A more competitive and flexible fiscal regime⁴⁹ would enable Ghana to attract investments from companies with the requisite financial and technological capabilities.

The Export Market in West Africa

215. Total refinery capacity in the West Africa sub-region is estimated at 600,000 – 625,000 BPD (26.8 – 27.7 million tonnes every year). However, only about 64-66 percent is utilised since 2001.
216. Nigeria for instance, has four refineries⁵⁰ with cracking facilities of total capacity of between 430,000 – 445,000 BPD (about 20 million tonnes) but production has been below 50 percent capacity due to operational problems. Nigeria is capable of meeting its annual product need of about 12 million tonnes and the remainder exported, should the refineries be operating at the designed capacities. In order to address her product shortages, a new refinery of about 100,000 BPD (expandable to 200,000 BPD) is being constructed. In addition, as of 2002, the Nigerian government had granted licences to about 18 private companies to build refineries.
217. Targeting the Nigerian market for product export could be a bit tricky since it is not obvious.
218. Equatorial Guinea, which has approached Ghana for refining services⁵¹, consumes only about 2,000 BPD of products. This seemingly, is not enough to attract significant capital investment.
219. On the other hand, total consumption in non-refinery countries⁵² in West Africa is between 76,000 - 80,000 BPD (3.4-3.6 million tonnes). Apart from Senegal, almost all the refineries in West Africa are operating below their designed capacities. Ghana (Tema Oil Refinery) has about 84 – 88 percent capacity utilisation.

⁴⁹ The following elements make up the fiscal regime; Royalty, GNPC Initial interest, Petroleum income tax, GNPC Additional interest, Additional Oil Entitlements (AOE).

⁵⁰ As of 2004

⁵¹ Ministry of Energy, 2003.

⁵² Benin, Burkina Faso, The Gambia, Guinea Bissau, Equatorial Guinea, Liberia, Niger, Mali, Mauritania, Togo

220. Political instability in la Cote d'Ivoire is likely to retard the smooth functioning of its refinery.
221. Sierra Leone has just emerged from civil war, meaning it will take some time for their markets to peak.
222. Ghana could quickly use its comparative advantage to revamp the Tema Oil Refinery to make it more efficient whilst it makes plans as well to construct new refineries to meet local demand as well as targeting the countries without refineries in the sub-region, at least, capturing 50 percent market share by 2020.
223. Since, building a new refinery takes between 2 – 4 years, such a capability in Ghana can be ready by 2010 if construction starts by 2007.
224. Implementation plan and road map for the SNEP recommended option and biofuel complementation are in Appendices 1 and 2.

Woodfuels and Renewable Energy Subsector

225. Strategic Targets:
 - i. *To reduce the wood intensity of charcoal production (ratio of wood input to charcoal) from existing 4:1 to 3:1 in the Savannah zone and from 5-6:1 to 4:1 in the forest zone by 2015.*
 - ii. *To ensure that the energy share of traditional biomass (woodfuels) in the national final energy mix is reduced from about 60 percent at present to at least 50 percent by 2015 and eventually to 40 percent by 2020.*
 - iii. *To increase the supply of renewable energy and modern biomass in the Ghanaian final energy supply to achieve at least 10 percent penetration by 2020.*
226. Ways recommended for meeting the future woodfuel supply requirements of the country include
 - Expanding forest plantation cover.
 - Promoting fuel substitution in households and commercial cooking.
 - Setting up a national agency dedicated solely to woodfuel production and marketing issues along the same lines as VRA and ECG for Electricity, and GNPC and GOIL for petroleum issues.

Plantations

227. It is possible to meet the wood demand required for firewood and charcoal production under moderately high economic growth scenario by expanding the nation's artificial forest plantations from the current 750,000 hectares to:
 - i. About 1 million hectares in 2008;
 - ii. over 3 million hectares in 2015 and

iii. over 6.5 million hectares by 2020.

and complemented by nationwide promotion of energy efficient stove and conservation programmes to reduce the wood demand by one – two million tonnes every year.

Fuel substitution strategies

In the informal Industrial and Commercial/Service Sectors

228. The astronomical wood demand for energy by the GPRS high economic growth scenario is driven by the energy demand of the informal manufacturing and commercial/service subsectors of the economy.

229. Encouraging these informal industries and commercial/service entities to switch to alternative fuels like LPG will lessen the pressure on the country's forests.

230. The total LPG requirements for the industrial and commercial/service sectors to substitute for the woodfuels though, will be immense and are as follows:

2008	4 million tonnes
2012	5 million tonnes
2015	6 million tonnes
2020	7 million tonnes

231. This LPG demand will be practically impossible to achieve in the short-to-medium term and will put immense pressure on the country's refinery capacity. Nonetheless, it will encourage the private sector to invest in refinery secondary conversion units configured to produce largely LPG and cracked RFO.

232. The industrial opportunity for gas cylinder manufacturing will also be enormous.

233. However, since wood remains the least expensive heating/cooking fuel, it is likely that significant proportion of the informal industries and commercial/service entities will be reluctant to make a switch unless the LPG supply is supported with some kind of incentives.

234. Promotion of improved firewood stoves to reduce indoor pollution and firewood consumption as well, in the informal industries and commercial/service subsectors should be considered in greater depth.

Residential Sector

235. Encouraging a shift from firewood to charcoal and then to other cooking fuels such as LPG, kerosene and electricity will depend on cost.

236. Costs involved in the various cooking modes are as follows:

Device	Initial Investment cost	Total cost per year
	US Dollars	US Dollars ⁵³
Three stone –mud firewood stove	0	44 – 62
Traditional charcoal stove	1.5 – 3	67 – 80
Improved ‘Ahibenso’ charcoal stove	10	37 – 43
LPG (one-two burner) cooker	30 – 50	83 – 98
Electric (one-two burner) cooker	20 – 50	81 – 93
Kerosene (one-two burner) cooker	17 – 25	138 – 161

237. Even though, there is no initial capital investment in making a three-stone or mud firewood stove particularly, in rural areas, it is more expensive to use when compared with improved charcoal stove in cases where firewood is purchased.
238. Otherwise, the three-stone or mud firewood stove is the least expensive cooking device and has the lowest life-cycle cost as well.
239. For health reasons however, it will be wise to encourage a switch from firewood stove to charcoal stove usage but that involves an initial capital investment.
240. On the environmental front, charcoal usage consumes more wood than firewood and for that matter not an attractive option for CDM and other large climate change related financial facilities. Charcoal usage leads to higher greenhouse gas (*here methane*) emissions because it takes between four – six units of wood to make a unit of charcoal, whilst firewood is used directly from the field.
241. A nationwide promotion of more efficient improved charcoal stoves such as Ahibenso could shave off the wood demand by half. Even though, investment cost of average improved charcoal stove is about three times that of the traditional charcoal stove, the total expenditure per year is US \$20 equivalent or less.
242. A switch from woodfuel usage to kerosene for cooking is the most expensive option in terms of annual expenses. Secondly, kerosene is a fossil fuel and so the shift is not environmentally attractive.
243. A switch from woodfuel to electricity for cooking presents the cleanest option in terms of indoor pollution. However, it is not global-warming friendly, if the electricity is thermal-based generation. Carbon dioxide emission from woodfuels is neutral in terms of global warming whilst emissions from fossil fuels are non-biogenic. There is also the issue of availability since national electricity coverage is still less than 50 percent.

⁵³ This is life cycle cost per year. Lifetime, efficiency and fuel cost have been considered in the calculation.

244. The most advocated option is the switch from woodfuels to LPG use, since the latter is 'environmentally' friendly. LPG is a cleaner fuel in terms of indoor pollution, with far less emissions of particulate matter, acidic and other pollutants.
245. A switch from charcoal to LPG use will make the capital investment of the former insignificant and consequently, require a subsidy of US \$30 – 50 per appliance. Incremental cost per year will be about US \$20 per appliance on the average. A switch of all urban charcoal users to LPG gas will require total incremental cost of at least,
- i. US\$ 17- 18 million a year up to 2008; then
 - ii. US\$ 18 – 19 million a year from 2008 – 2012;
 - iii. US\$19 – 20 million a year from 2012 – 2015; and
 - iv. US\$20 – 22 million a year by 2020.
246. The LPG required to substitute for the woodfuel will be as follows:
- i. 500 thousand to 1.8 million tonnes by 2008;
 - ii. 750 thousand to 1.9 million tonnes by 2015; and
 - iii. 950 thousand to 2.8 million tonnes by 2020.
247. This additional LPG demand is likely to put a lot of pressure on the crude oil refining capacity of the country as well as the configuration of potential refineries, unless the LPG shortfall is imported. On the positive note, it is an opportunity to increase the refinery capacity of the country. It will as well boost gas cylinder manufacturing in the country.
248. Introducing LPG to rural users however will require an efficient distribution network and back-up support to combat potential gas accidents associated with it and occasional shortages due to distances from retailing centres.
249. Mobile LPG retailers exist but have higher premium than stationary retailers. For rural areas, it will be a significant extra payment to make, unless rural supplies are targeted and subsidised.
250. Promoting cultivation of energy forest plantations, re-introduction of improved charcoal stove programme,⁵⁴ and improved charcoal production kilns stand a greater chance of attracting climate change related fundings.
251. In addition, such a programme will create massive jobs for rural communities involved in the plantations. It will also create jobs for artisans involved in the fabrication of charcoal and firewood stoves. In other words such a programme promotes sustainable development

⁵⁴ Woodstove programme was first launched in 1990 by the erstwhile National Energy Board, but was abandoned by mid 1990s.

National Wood fuel Office

- 252. Ghana as a developing country will still have wood as the most widely used fuel for the foreseeable future, even if the country achieves a middle-income status in the next decade.
- 253. Charcoal production accelerates wood consumption; one unit of charcoal requires 4 – 6 units of raw wood.
- 254. Wood or forest plantations are sinks for greenhouse gases.
- 255. The use of improved charcoal and firewood stoves are greenhouse gas abating technologies.
- 256. In spite of the relative importance of the traditional fuel, the woodfuel subsector has not received any significant direct public investment and there has not been any major direct policies targeted at its growth and development over the last ten years. There is relatively little investment made to formalise the woodfuel sub-sector compared to the electricity and the petroleum sub-sectors.
- 257. The woodfuel subsector operates as an informal sector, it lacks human resource capacity at all levels of governance to develop, implement and monitor policies on woodfuels and there are poor institutional linkages among the various agencies involved in this traditional energy sub-sector.
- 258. Regularizing the subsector will allow the sector to be regulated and be monitored in a sustainable manner.
- 259. In summary, formalising the subsector by setting up a dedicated agency like a National Woodfuel office to manage the traditional fuel subsector and to ensure a sustainable woodfuel industry is highly desirable

Renewables for the Energy mix

Landfills

- 260. Tapping power from closed landfills will be encouraged. Even though, usually in the ranges of 1 – 2 MW installed capacities per site, it is potentially the cheapest source of grid electricity for closeby communities. Engineered landfills are proposed for all regional centres and large urban centres where they could serve as sources of supplementary power to the centralised grid for these urban communities.

Wind

- 261. Ghana has some wind resources that could be tapped to supplement her energy requirements. For now, the potential is confined to the coastline and the most economic exploitation based on current technology is at 50 metre-height with average wind speeds between

6.0 – 6.3 metres per second (m/s). The corresponding wind power density range from 185 - 210 Watt per square metre at 1.225 kilogramme per cubic metre (kg/m³) air density. 300 – 400 Megawatt power can reliably be tapped for now and the maximum energy that can theoretically be tapped from the available wind for electricity using today's technology is about 500 – 600 Gigawatt-hours every year⁵⁵. 200 MW providing about 400 GWh per year is conservatively being proposed.

Solar energy

262. Solar energy particularly for electricity, and to some smaller extent crop drying and water heating has seen some use over the years. It is estimated that photovoltaic electric (PV) systems installed in the country are well over 5000 with installed capacity of about one megawatt generating between 1.2 – 1.5 Gigawatt-hours every year.
263. A promotional programme such as ‘Solar power for every home’ can target urban homes with a minimum of 100Wp system for basically lighting per home with some incentives. An advantage is that individuals will be investing in power reserves for the country with their own finances, whilst public funds could be used to support rural electrification. A government programme to provide a set of solar-television systems (each consisting of a solar power unit and a television set) for basic schools in off-grid locations is commendable, since it offers pupils in deprived schools the opportunity to participate in the Presidential Special Initiative for Distance Education based on radio and television.

Agro biofuel wastes

264. Biomass for electricity generation would come from logging and wood processing residues, agrofuels and municipal by-products, as well as plantations. Almost 2 million tonnes of wood residues are available in the country annually for energy and other purposes and this is expected to reach 2.5 million tonnes as the Agriculture sector grows, increasing to about 3 million tonnes by 2020. For electricity, most reliable data suggests that at least 95 Megawatt capacity providing about 600 Gigawatt-hours annually could be tapped from farm-wastes, sawmill and logging residues between now and 2010.

Small – minihydros

265. Small to mini-hydro sites total around 25 MW but dispersed over 70 sites with Dayi River cascades (2,000 – 5,300 kWp) in the Volta Region as the most attractive. Small–minihydro could be promoted as decentralised power systems for commercial agricultural projects and tourist sites. It could also be tied to the grid to serve as supplementary power units. The small hydro power proposed for development is the Dayi River cascades which can be developed and connected into the distribution grid.

⁵⁵ A theoretical maximum installation is expected to be in the order of 100 – 200 units with a spacing of at least 500 m in one line, corresponding to about 300 – 400 MW

CROSS CUTTING ISSUES

Research and Development

- 266. Appropriate Research and Development (R&D) efforts lead to technological innovations and consequently, support economic growth. Local knowledge, though in most cases taken for granted, provides the key platform for indigenisation of research and long term solutions to challenges in our economic environment.
- 267. It is important therefore to strengthen the research institutions to not only look at international contracts but to investigate the science and the technical know-how of some of the local developments.
- 268. Increasing cost-sharing in funding proposals, upgrading equipment and instrumentation as well as coordinating activities to avoid duplication of efforts and waste of limited resources are also vital to maximise the impact of research results.
- 269. National energy congresses, seminars and symposia where results and innovative concepts are announced and published should be re-activated and supported. These used to be organised by the Energy Research Group and supported by the Energy Commission and the sector Ministry.
- 270. Significant contributions by individuals, institutions and organisations to the growth of the energy sector should be acknowledged and honoured through annual or biannual awards to serve as morale boosting to young professionals to attract new brains to the energy sector.
- 271. In addition to domestic experiences, collaboration with international organisations to acquire information on other new emerging energy technologies must be coordinated.

Information and Awareness creation

- 272. Efficient energy information database is essential for planning and policy formulation. For instance, to build a viable market for renewable energy technologies, awareness of renewable energy technologies as an alternative to conventional and traditional energy systems must be created.

National Energy Information Centre

- 273. A major step in this direction will be the establishment of National Energy information Centre at Energy Commission to disseminate available information on Energy matters to the public, researchers and other stakeholders.
- 274. There is an urgent need for establishing an efficient energy information system that will mobilize the required database to feed the interested public as well as the stakeholders in the sector for effective implementation of the recommended policies for the sector.

Capacity Building and Development

275. *Strategic Target:*

Ghana increases local content of energy projects to at least, 20% by 2020.

276. Overcoming the challenges for a sustainable energy sector is dependent on the appropriate development of the human resources of the sector. Sustainability, in accordance with the classic definition, is the ability to meet today's needs without diminishing the capacity of future generations to meet theirs.
277. Initial investments for most energy projects are huge, it is therefore important to consider the benefits of helping to develop the local content of projects in the initial stages. Increasing local participation in the energy value chain provides excellent opportunities for Ghana's goal of 'middle income' status. Apart from woodfuel cookstoves which are almost entirely produced in Ghana, the existing levels of local value capture for most energy projects are no more than 10%. In the 1990s, a majority of medium tension wooden poles for national electrification were imported due to local unavailability. Today, cables, transformers and switching gears are almost entirely imported for Ghana's targeted '2020' national electrification programme.
278. Government policies and programmes supported by initiatives of existing multinational companies, organizations and agencies and those willing to operate in Ghana could encourage national capacity building through education and training, employment of Ghanaian nationals through partnership with local companies and institutions, while maintaining their international competitiveness, commercial and social integrity. Education, training, social and business enterprises developed at the operating level of the energy sector have the potential to promote the development of human capital and the private sector as Ghana diversifies its economy away from the over dependence on traditional primary produce of cocoa and gold for the country's hard currency earnings.
279. The question for working partners of Ghana is not only 'what we can do with existing local capacity' but 'how can we assist Ghana meet the projected demand, so as to enhance local capability and to capture more value in the energy chain in the future.

Gender and Energy Use

280. A gender balanced human resource development for the energy sector is vital, if all issues related to energy usage by both sexes are to be captured and addressed. Looking at gender issues from both the demand-side and supply-side of energy, men and women have different demands on energy due to the existing socio-cultural and traditional roles. Women do most of the cooking. They are also heavily involved in fuelwood collection and charcoal production.
281. In the power and petroleum subsectors, it is clear that women are under-represented at all levels of energy production, transportation or transmission and distribution. Since issues of power and petroleum have dominated the energy sector, it has led to a gender imbalance at various levels of decision-making, i.e., planning, policy formulation and implementation.

282. Traditional use of firewood has negative effects on women's health such as respiratory diseases, eye irritation, etc. Gender division of labour and environmental degradation are increasing women's time burdens.
283. Women are less involved in decision-making on fuel use, even though, they have different needs as a result of their roles in society and within the household. Energy for water pumping for instance has gender dimensions. Pumping water for irrigation is mostly related to men's work in agriculture, whereas water pumping for domestic purposes is usually related to women's work.
284. Efforts at promoting technologies have generally not been gender sensitive. Consider the provision of agricultural equipment for large-scale commercial agriculture. The tractors are in most cases operated by men and replaces the hard task of hand or bullock ploughing, typically men's work. The remaining other agricultural tasks of weeding and harvesting are usually left to be done manually and predominantly by women. Thus, although, the tractor may improve the family's overall income, the new balance in the work leaves the women still with their heavy burden.
285. Attention to gender can help limit such unintended effects, or unearth actions to mitigate them. Much of women's energy use involves woodfuel, which is considered informal even though, commercially traded now in cities. These biomass flows are hardly recorded, let alone taxed and so remain invisible.
286. Energy in the past has also been seen as "technical matter" and gender neutral and therefore no appropriate gender analysis tool has been developed to capture women's energy needs. Households are often taken as homogenous units, without recognising that roles of men and women regarding energy use differ in most societies. These perceptions must change.

BUDGET SUMMARY

287. Capital investment in the energy sector is estimated to range from about US\$4.3 – 5.4 billion⁵⁶. Minimum cost range could escalate to around US\$6 billion depending upon the sophistication of the intended oil refineries to be built. The breakdown is as follows⁵⁷:

SUBSECTOR	ACTIVITY	2006-2008 ⁵⁸	2009-2012	2013-2020
		US \$ Million		
Electricity	Expansion of TICO to 330MW			
	Construction of new power plants including Bui hydro and renewables	480-672	720-780	1,780-1,824
	Transmission and distribution		820 – 1,300	
Petroleum	Revamping/ rehabilitation of storage, secondary and utility units of Tema Oil Refinery	70 - 75		
	ATK pipeline (Tema to Accra airport)	4 - 6		
	National natural gas transmission and distribution pipelines	5 - 10	10	
	strategic stocks storage tanks ,	60	35	60
	New Refinery (s) (100,000 BPD)	90 - 135	70 – 105	120 - 175
	<i>New Refinery (100,000 BPD⁵⁹)</i>		500	
	Seed money to kick-start the National Biodiesel and Alcohol Programmes	10	2	
	CNG Demonstration	3	5	4
Woodfuels & Renewables	Promotion and dissemination of improved cookstoves, kilns, setting up of institutional structures	5	20	5
	Promotion and dissemination of proven solar dryers and water heaters	5	45	10
Energy Efficiency & Conservation	Procurement of 8 million CFLs to support on-going DSM activities	4	12	
	Retrofitting of public buildings, purchase of load controllers for industries, promotion, etc	5	25	3
	Standards testing laboratory	2		
	Natural gas and renewables distributed /Grid connected co-generation (CHP) activities.	1.0	3.5	
	Strengthening of existing institutions for training	0.2	0.3	
Total⁶⁰		744 – 993.2	947–1042.8	1982–2081
Grand Total⁶¹		4,263 – 5,387 (4,963-5,887)		

⁵⁶ It does not include operation and maintenance costs.

⁵⁷ Refer to the Annexes for full breakdown for each subsector.

⁵⁸ Some disbursements have already started. For instance, construction of the storage tanks for the strategic stocks.

⁵⁹ Cost of the refinery when built at a go.

⁶⁰ Excluding transmission and distribution costs.

⁶¹ Including transmission and distribution costs. Costs in brackets include building a refinery at a go.

RECOMMENDED POLICIES

POLICY RECOMMENDATIONS - DEMAND

SECTORS

Residential Sector

Electricity

Policy

288. It is recommended that

- i. Government continues to improve access to modern energy services to all income groups of the country.*
- ii. Schemes that support the provision of electricity services to communal facilities in rural areas will be encouraged.*
- iii. The Government supports the setting up of a 'one-stop shop', which will serve as a resource centre to coordinate activities of utility agencies and the physical planning agencies regarding power extension for real estate development.*
- iv. Government supports the promotion of pre-paid meters in urban centres.*
- v. Government supports the sustaining of on-going energy efficiency programmes.*

289. Implementation measures

- a) Continue the extension of the national grid to all communities where appropriate.**
- b) Provide solar electric systems in small⁶² populated off-grid communities as a kind of pre-grid quality electrification facility.**
- c) Provide minigrid systems in off-grid but remote large populated areas using biomass-to-power plants and wind, whichever is applicable.**
- d) Provide communal facilities like schools, health centres in off-grid locations with sustainable and environmentally friendly distributed power systems.**
- e) Use NGOs, community based organisations (CBOs), independent commercial service providers and District Assemblies as key facilitators⁶³.**

⁶² Population of 1,000 or less. Number of homes/customers 100 or less.

⁶³ NGO is Non-governmental organisation. CBO is Community-based organisation.

- f) Support the energy efficiency activities of Energy Foundation.

A key concern of poorer income households is the issue of communal sharing of metering facilities. Even though, lifeline subsidy is targeted to help the poor, poorer families hardly enjoy this subsidy owing to the sharing of communal metering in compound houses.

Sharing of communal metering in compound houses causes the units of electricity consumed by these poorer households to fall into the high unit cost bands of the current progressive tariff structure. This could ultimately place them in the maximum tariff bracket of 1,018 cedis /unit (kilowatt-hour) compared with a charge of between 300–400 cedis /unit being the lifeline tariff for consumption up to a maximum of 50 units⁶⁴. Thus, communal use of meters increase electricity bills particular for the poor.

Policy

290. **It is recommended that**

The distribution utilities and PURC provide guidelines on equitable bill-sharing systems for use in compound houses.

291. **Implementation measures**

- a) The utilities make available and accessible more meters.
- b) Since compound house dwellers are generally familiar with the ‘point’ system, the utilities and PURC should share with the consumers, information on advantages of own meter.
- c) Utilities should experiment with voltage or current limiters in compound houses since they are less expensive than meters.

Kerosene

Kerosene is used mainly for lighting in rural and non-electrified communities. However, the quality of kerosene lighting is inferior compared with lighting by electricity or solar lamp. Moreover, 65 – 70 percent⁶⁵ of rural households spend as much as US \$10 or more equivalent per month on kerosene and dry cells for lighting.

It will however cost US \$8 – 13 per month to provide better quality lighting including opportunity to also operate a radio/cassette player using just a 50 Watt peak solar PV home system; the low-side being DC (battery-type) power and the high-side being AC (mains-type) power⁶⁶.

As the off-grid community is provided with electricity or better lighting source such as solar energy, the kerosene consumption is expected to reduce.

Poor electricity services in urban areas give rise to kerosene being used as back-up lighting source. Kerosene consumption as back-up energy source in grid connected areas averaged 5,000

⁶⁴ Power tariff as at 2006

⁶⁵ Study conducted between 1999 – 2001.

⁶⁶ DC – Direct current and AC – Alternating current

tonnes per annum from 2000 – 2004. Increasing interest in solar lamps as back up lighting systems could displace the kerosene, which could be diverted for production of more valued added jet kerosene to support aviation traffic in the country.

Policy

292. It is recommended that

- i. *Government in the short term continues to improve access to kerosene in rural areas.*
- ii. *Government in the medium-to-long term accelerates the rate of rural electrification to improve the quality of lighting in rural communities and consequently, reduce the kerosene consumption per home in the communities.*

Cooking

Start-up cost of LPG usage is high due to relatively high cost of appliances. Subsidy on LPG on the other hand tends to benefit largely urban dwellers.

Policy

293. It is recommended that

- i. *Government supports the promotion of woodstove efficiency programmes.*
- ii. *Government improves access to LPG in the country by supporting measures aim at widening LPG distribution network to increase access for rural dwellers.*
- iii. *Government reduces subsidy on LPG and redirect it to subsidize LPG-related appliances for the poor.*

294. Implementation measures

- a) Energy Commission jointly with Energy Foundation will manage efficiency woodstove promotional programmes.
- b) Intensify support for demand-side management activities of Energy Foundation for the residential sector.
- c) Energy Commission grants licences for more LPG filling plants to be opened in-country.
- d) Increase LPG production at the refinery.
- e) Expand production of domestic LPG cylinders.
- f) Government through the sector ministry, Energy Commission and the National Petroleum Authority encourage and design financial packages to support fabrication of single and double LPG burners.
- g) Use NGOs, community-based organisations and District Assemblies as key facilitators and implementing agencies.

Commercial and Services Sector

Electricity

Policy

295. It is recommended that

- i. Government supports energy efficiency and conservation measures in the service sector.*
- ii. Government supports the promotion of pre-paid meters in government buildings and offices.*
- iii. Government sets an electricity consumption ceiling for ministries, government departments and agencies, military barracks, police and other security services, as part of efficient usage measures.*

296. Implementation measures

- a) Activities of Energy Foundation in this regard are acknowledged but would be intensified.
- b) Promote the use of solar water heaters in hospitals, hotels and restaurants to satisfy part of their hot water needs.
- c) Government makes it mandatory for all ministries, government departments and agencies to use pre-paid meters instead of credit meters.
- d) A committee comprising the PURC, Energy Foundation, the Energy Commission and chaired by the Ministry of Energy works out ceilings for the ministries, government departments and agencies and the barracks. Beyond a ceiling, the defaulting ministry, government department or agency ministry pays from its own coffers.
- e) Extend CFL promotional projects to the campus of the four public universities and the 10 public polytechnics as first phase. Subsequent phases will cover the rest of the tertiary institutions.
- f) Distribution utilities introduce pre-payment meters to the residential halls.
- g) Target Residential halls of the country's tertiary institutions for demonstration and later replicated nationwide.

Cooking

Policy

297. It is recommended that

- i. Government regulates the use of firewood and charcoal for cooking in restaurants, chop bars, canteens located in regional capitals.*
- ii. Government ensures that LPG is fairly accessible throughout the country.*

298. Implementation measures

- a) Energy Commission and Energy Foundation will promote woodfuel efficiency stoves for commercial cooking facilities such as canteens, chop bars, restaurants, pito/beers located outside towns, regional and district capitals.
- b) Energy Foundation implements the programme targeting commercial cooking facilities located in regional capitals.
- c) Use NGOs, CBOs and District Assemblies as key facilitators and implementing agencies targeting district capitals and rural areas.
- d) Energy Commission encourages more LPG filling stations to be opened in the regional and district capitals.
- e) Encourage more OMCs to operate LPG mobile tankers.

Policy

299. **It is recommended that**

- i. *Government promotes biogas-for-heating in institutional kitchens, laboratories, hospitals, boarding schools, barracks, etc.*
- ii. *Government supports the development of biodiesel as a substitute for diesel for running grain mills and other cottage industries in rural areas.*

300. Implementation measures

- a) Examples of such facilities exist in Agogo Hospital, Ashanti Region and the Catholic hospital, Akwatia in the Eastern Region. Biogas generated from the liquid wastes of the hospital is fed back to the kitchen as a cooking fuel.
- b) Energy Foundation may implement similar biogas-for-heating in institutional kitchens nationwide supported by the Energy Commission.
- c) Energy Commission may act as the execution agency.
- d) Identify government institutions, schools, and barracks for demonstrational and promotional projects.
- e) Contract expertise from the Department of Mechanical & Agricultural Engineering, which has been building previous biogas facilities in the past for nationwide promotion.
- f) Draw similar demonstration programme for biodiesel development.
- g) Seek counterpart and funding support from the GEF, the CDM and other the donor agencies

Agriculture and Fisheries Sector

Policy

301. It is recommended that

- i. Government through the PURC devises a separate cost-effective tariff for the agricultural sector to induce electricity consumption and growth.*
- ii. Government ensures that adequate premix gasoline is available to farmers and fishermen.*
- iii. Government encourages commercial agricultural projects to meet at least 10 percent of own energy by providing incentives to develop appropriate alternatives with emphasis on electricity in order to promote decentralised and minigrid countrywide to complement the national electrification programme.*
- iv. Government promotes the utilisation of solar energy for large scale drying of cash crops and cereals.*

302. Implementation measures

- a) Mandate PURC to develop feed-in tariff for decentralized power generation
- b) Mandate PURC to set up a special attractive tariff for the use of electricity for irrigation and poultry production.
- c) Encourage energy efficiency measures in irrigation and other agricultural activities using agricultural inputs as incentives.
- d) Undertake capacity building, information and awareness campaigns.
- e) Put in mechanism to ensure that large agricultural and agro-processing ventures based in remote areas get adequate supplies of energy.
- f) De-monopolise the supply of premix gasoline. Allow competitive bidding from other oil marketing companies.
- g) Demonstrate the use of solar for commercial drying of pepper, maize, paddy rice, etc.

Energy for fish preservation

Between 70 – 80 percent of all fish landing comes from canoe and boat fishing. Only about 10 – 20 percent however is handled by cold storage, the rest is smoked.

Commercial cold-storage is available in grid connected urban centres and some grid-connected rural communities. It is less labour-intensive but becomes unreliable if power supply is intermittent.

Commercial cold storage is also relatively very expensive to construct or install in rural areas. Constructing a 30 cubic-metre cold store could cost around US \$8,300 equivalent. Installing a used (second-hand) freezer-container costs about US \$6,600 for a “20ft container” and US \$8,000 for a “40ft container”, labour and haulage costs excluded. New freezer-containers will of course cost more⁶⁷.

Traditional fish smoking is a must for non-grid rural fishing communities, if healthy preservation is desired.

Commercial or large-scale fish smoking is labour-intensive but labour is seemingly becoming harder and expensive to come by in rural fishing communities.

Chorkor smoker so far happens to be the largest traditional fish smoker but it is still labour intensive. It is however the most efficient traditional fish smoker; consuming between 0.26 – 0.51 kilogramme of fuelwood to smoke one kilogramme of fish⁶⁸.

Large-scale solar drying of most of the preferred fish has so far not been commercially proven. A larger more efficient fish smoker with reduced labour is likely to be welcomed by the indigenous fish-smoking industry.

Policy

303. It is recommended that

Government supports the development of larger and more efficient commercial fish smokers.

304. Implementation measures

- a) Develop large-scale smokers, at least double the size of a typical ‘chorkor smoker’⁶⁹.
- b) Energy Commission provides seed funds to develop such larger commercial fish smokers.
- c) Energy Commission partners with Food Research Institute, Ministry of Agriculture, research institutions and NGOs to undertake field trials of larger fish smokers.

⁶⁷ Nyberg J., and K. Nilsson, (2004) *Options for Rural Electrification in Ghana – A study for Edumafa Settlements in Ghana*, Energy and Environment Systems Degree Project, Division of Engineering Science, Physics and Mathematics, Karlstads universitet, Sweden.

⁶⁸ Fish in question are tuna and sardinella (‘Amane’). Initial and final moisture contents are about 70 percent and 40 percent respectively.

⁶⁹ A tandem traditional commercial fish smoking pot. It is either constructed from mud or metal drum. (For more information, see Energy Sector Technology Catalogue, Ghana, a publication by the Energy Commission and the Royal Danish Ministry of Foreign Affairs, September 2004).

Transport Sector

Road

Policy

305. It is recommended that

- i. *Government supports promotion of fuel efficiency and conservation programmes for the road transport sector.*
- ii. *Government supports evaluation of the potential of alternative fuels to supplement petroleum products.*

306. Implementation measures

Continue to provide incentives to promote the use of mass transport systems (commercial cars and buses).

Fuel efficient devices

There are some fuel-saving devices on the market, some claiming to have between 15-20 percent savings in fuel consumption. Whilst some have proven to be true in the short term in some respect, the use of the devices would require regular monitoring and strict maintenance schedule by the motoring public.

The state of the average vehicle on the Ghanaian road however, is difficult to project. The low salaries of most workers in the country mean that they can hardly support regular procurement of brand new vehicles. So a significant number of the vehicles on the market are used vehicles with refurbished engines. The state and age of the engines suggest they are operating at low efficiencies. Also, many motorists do not follow regular maintenance schedules. These circumstances do not allow the efficacy of these fuel efficiency devices to be realised over their life span.

Policy

307. It is recommended that

Government supports the promotion of fuel-efficient devices.

308. Implementation measures

- a) Regulatory institutions provide support in the form of public education and demonstrations to the motoring public.
- b) Support energy efficiency activities of the Energy Foundation.

The newer a vehicle, the more efficient it is

Technological advancement means that new or young vehicles tend to be more fuel-efficient than older and aged versions.

Policy

309. It is recommended that

- i. *Government supports reduction of import payments on new vehicles*
- ii. Port clearance fee, where import costs increase with the age of the vehicle is encouraged.

310. Implementation measures

- a) Limit importation of vehicles and engines older than 10 years.
- b) Re-look at the way import taxes and duties are imposed on vehicles.

Pollution control

With the withdrawal of leaded gasoline from circulation, adoption of other pollution control measures such as the use of catalytic converters for reduction of nitrogen oxides in engines in the country should be encouraged. Nitrogen oxides are precursors to ground-level ozone and are also acidic pollutants with the potential for acid rain.

Bicycle is a popular means of transport in northern Ghana, where the sun is relatively scorching compared to southern Ghana. Bicycle use is however relatively low in the south.

Elsewhere in the developed world, bicycle is the most popular means of transport on university campuses. This is however not common on the campuses of Ghana's tertiary institutions.

Policy

311. It is recommended that

- i. *Government through the regulatory institutions encourages the use of catalytic converters in vehicles by 2015 and adopt it legally by 2020.*
- ii. *Government supports the introduction of non-motorised vehicles on the campuses of the country's tertiary institutions.*

312. Implementation measures

- a) Encourage the use of bicycles on the campuses of the country's tertiary institutions.
- b) Support the university authorities to erect bicycle stands on the campuses.
- c) Set up credit schemes to allow students to purchase bicycles at affordable rates.

Rail

The sector ministry in the late 1990s sought to re-introduce the idea of bulk transportation of petroleum products inland, mainly by rail transport instead of road transport.

Rail transport in Ghana, even though it relies on diesel, is more fuel-efficient than road transport in medium to long distance freight haulage. Diesel consumption for rail transportation is on the average 15 percent lower than for road transport. Secondly, rail transport has a greater carrying

capacity for both passenger and freight than road transport. Furthermore, the transportation of petroleum products by rail is much safer.

Thus, rehabilitating the rail sector and expanding the national coverage, particularly into remote and rural communities to make it more accessible to the rural poor could invariably reduce the nation's consumption of diesel fuel. The Government plans to modernise, improve and expand the country's railway system and make it safer and more attractive to both passengers and freight is highly commended.

Policy

313. It is recommended that

- i. *Government promotes the modal shift of bulk haulage from road back to rail transport.*
- ii. *Government deregulates the railway subsector to permit private sector investment and participation in rail transport system.*

Maritime

Policy

314. It is recommended that

- i. *Government improves inland water transport from the south to north over the Volta Lake by removing physical obstacles posing risks to safe and smooth navigation.*
- ii. *Government builds a pipeline from Debre to Buie in the north to offset the interruption in fuel supply on the Volta Lake to the north which occurs during certain periods of the year.*

315. Implementation measures

- a) *Government, public and the private sector support the VRA to continue to remove tree stumps in the Volta Lake in order to reduce risks to boat users and to improve movement on the lake.*
- b) *Promote south-north transport over the lake for both commercial and recreational (tourist) purposes.*
- c) *Provide more ferries and build more landing points in major towns along the lake.*
- d) *Remove the Debre shoals that interrupt water transport during certain periods of the year.*

Policy

316. It is recommended that

Government promotes the use of more efficient transportation modes by developing others such as boat transportation to coastal areas.

317. Implementation measures

- a) For instance, introducing ferry transport between Tema port to James Town of Accra for speedy connection to central Accra could be a novel pilot project. Other potential pilot projects could be Tema port or Accra James Town to Bortiano to link motorists from Tema or Accra central to Accra-Winneba Road bypassing vehicular downtown traffic. Or, Tema/Accra James Town port to Winneba port to allow bulk haulage road vehicles to bypass traffic jams in the city centre of Accra to join the Accra – Takoradi Road through Winneba, etc.
- b) It will however require building belting ports in the selected coastal towns.

Industrial Sector

Policy

318. **It is recommended that**

- i. *Government through the regulatory bodies ensures that energy supply to the industrial sector is adequate, reliable and of acceptable quality to the industries.*
- ii. *Government through the regulatory bodies ensure that energy audits are made mandatory for all formal industries.*
- iii. *Energy efficiency and conservation measures in industries will continue to be supported.*
- iv. *Government supports attractive feed-in tariffs to encourage industries capable of generating own or part of their energy especially from renewable sources such as biomass and wastes to do so.*

319. Implementation measures

- a) Energy Commission and the PURC ensure the utilities strictly comply with code of performance.
- b) Develop incentives for energy efficiency, e.g. the introduction of “time-use” electricity tariffs for industries.
- c) Develop protocol for energy auditing for the industries.
- d) Energy Commission and the Energy Foundation will jointly promote energy efficiency and conservation awareness programmes in industries.
- e) Set up revolving fund to provide training for Energy Managers for industries.
- f) PURC develops feed-in tariffs to encourage industries capable of generating own or part of their energy especially from renewable sources such as biomass or wastes to do so.

Policy

320. **It is recommended that**

Government supports environmental management practices and cleaner production methods in industries.

321. **Implementation measures**

Energy Commission, Energy Foundation and the Environmental Protection Agency coordinate on energy and environmental issues in industries.

Policy

322. **It is recommended that**

The Government ensures that primary industries are provided high quality but cost-effective energy services to induce high industrial growth for wealth creation in the country.

323. **Implementation measures**

- a) PURC and the utilities work out an electricity price range for sustainable operation of primary metal industries in the country.
- b) Offer price incentives only for underground gold mining and aluminium smelting. Utilities and the PURC provide price incentives to surface miners on condition that they will use it for deep mining only where the latter exists.
- c) For industrial power tariff:
 - i. An option is to dedicate all hydropower for industrial customers, whilst the thermal and other sources of power go to commercial and residential customers.
 - ii. Another option is to fix the proportion of energy mix for all the consumer classes (sectors). 'x' hydro + 'y' thermal is kept same for Residential, Commercial and Industrial customers. Where 'x+y=1'.

Energy Efficiency and Conservation

Policy

324. **It is recommended that**

- i. *Government continues to encourage the use of efficient end-use appliances such as compact fluorescent lamps as well as good energy savings practices in the home, at work places and industries.*
- ii. *Energy Commission makes available the necessary regulations for the safety of household energy appliances.*

- iii. *Government supports promotion of solar water heating and drying for demand-side management.*

325. Implementation measures

- a) Adopt energy demand management in middle and high-income households.
- b) Government supports Energy Commission to extend the Energy Efficiency labelling to cover other home and commercial appliances notably; refrigerators, freezers, electric fans and television sets.
- c) Government continues to support Energy Foundation in its energy efficiency and conservation measures in institutional buildings, ministries, government departments and agencies, barracks, etc.
- d) Set up a special purpose fund; an Energy Efficiency Revolving Fund. The objective is to offer low interest credit facility for energy efficiency improvements (retrofits), targeting industries and service entities such as hotels and restaurants.
- e) Sustain the Public Education and Information Programme campaign activities of Energy Foundation.
- f) Encourage training of industrial energy managers for local industries and for countries within the sub-region, particularly, under the ECOWAS protocol.

Policy

326. **It is recommended that**

- i. *Government enacts an Energy Efficiency and Conservation Act to make it mandatory for industries in the formal sector, all grades of hotels and commercial guesthouses to adopt energy management practices and building codes and carry out routine energy audits in their facilities.*
- ii. *Government makes it mandatory for all equipment bought for government facilities and public educational institutions to meet minimum energy efficiency standards/specifications, set by the Ghana Standard Board.*
- iii. *Government supports instituting Energy Management practices in government buildings and facilities including public educational institutions and vehicular fleets.*

327. Implementation measures

- a) The Ghana Standards Board, in collaboration with the Energy Commission and all other appropriate agencies develop and establish minimum energy efficiency standards and labels for energy consuming appliances imported or manufactured for use in Ghana. These include lighting, air conditioners, refrigerators and deep freezers, industrial electric motors.

- b) Encourage private sector Energy Service Companies (ESCOs) to invest in upgrading energy consuming facilities and share in the cost savings accruing from lower energy bills. This would help enhance the adoption of energy efficiency practices and technologies by the entire public.
- c) Government helps by providing tax incentives to financiers of energy efficiency projects and dealers in energy efficiency devices and appliances.
- d) PURC introduces tie-in tariffs to help promote Combined Heat and Power Production (co-generation).
- e) Energy Commission helps to intensify capacity building of Energy Service professionals both at the formal and informal levels to produce the required expertise needed for building an energy efficient economy.
- f) Energy Foundation and the Energy Commission intensify public education on Energy Efficiency strategies and practices. Include the existing formal and informal educational structures of the education sector ministry and the local government.
- g) Government supports Energy Foundation and the Energy Commission to set up a network of local energy advisory units in the district assemblies to advise consumers on energy efficient technologies and practices.

POLICY RECOMMENDATIONS - SUPPLY SECTOR

Electricity Subsector

Security of supply

Objective: To produce adequate, high quality, reliable and efficient power supply to meet economic and social development needs of Ghana and for export.

Strategic Target:

Secure and increase future energy security by diversifying sources of supply, including increasing access to renewable energy technologies so as to achieve 10 percent penetration in terms of installed capacity by 2020⁷⁰.

Policy

328. It is recommended that

- i. Government facilitates the timely completion of the West African Gas Pipeline project*
- ii. Government ensures the speedy resolution of fuel to the ‘Osagyefo’ Power Barge.*
- iii. Government speeds up the development of the Bui hydropower project.*
- iv. Government supports the development of alternative energy sources including renewable energy for power generation.*
- v. Government explores various options including decentralised and mini-grid systems for reducing the cost of supplying utility power to the rural communities.*

329. Implementation measures

- a) Create incentives to attract private sector investment including, wherever relevant and appropriate, access to loans on concessionary terms, financial instruments, government, guarantees and or grants for infrastructure investment.**
- b) Promote the entry of multiple players into the generation market by encouraging private and public investors to take advantage of the opening up of the generation market.**
- c) Timely implement the power sector reform strategy already outlined for the sub-sector.**

⁷⁰ Computation for renewable energy share shall not include existing hydropower stations of Akosombo and Kpong generation stations.

- d) Government scouts for overseas development assistance for the development of the Bui dam since that looks more favourable than private capital. Bui besides the energy it provides, has the potential to balance the entire transmission network from south to the north and in the process reduce transmission losses. It will also create thousands of jobs during construction and operation.
- e) PURC resolve feed-in tariff for embedded generation to allow existing biomass co-generation plants to be integrated into the grid system.
- f) Energy Commission issues licence for the operation of renewable energy large power plants in the country.
- g) Ministry of Energy and the Energy Commission jointly undertake pre-feasibility study of coal and nuclear power plants to prepare the initial ground work for the possibility of including “clean coal” and nuclear power in the grid power supply mix in the foreseeable future.

Access to Electricity

Objective: National goal is to achieve 100% universal electrification by 2020. The present level of access to electricity for households is estimated to be over 50%. Connection however has largely been by grid.

Strategic Target:

To achieve 30% penetration of rural electrification via renewable energy technologies by 2020.

Policy

330. It is recommended that

- i. *The universal access to electrification via the National Electrification Scheme be by both grid extension and decentralised minigrid and microgrid energy systems including renewable energy.*
- ii. *Government sustains its commitment to achieving the National Electrification Scheme objective of 100% universal electrification by 2020.*
- iii. *Government ensures that sufficient funding is available for the National Electrification Scheme.*
- iii. *Government establishes a Rural Electrification Board with a Rural Electrification Fund to manage and coordinate the rural electrification component of the National Electrification Scheme.*
- v. *Government supports local agencies to solicit funding from the international donor facilities such as the Global Environment Facility and the Clean Development Mechanism.*

- vi. *Government encourages instituting energy planning and management committee at the community level in rural areas as structures to support rural electrification.*
- vii. *Government supports the issue of favourable feed-in tariffs for electricity from embedded generation, particularly renewable energy, to promote distributed generation systems in the country.*

331. Implementation measures

- a) Consider the possibility of encouraging District Assemblies to provide electricity services to their off-grid communities via mini-grids and micro-grids through alternative distributed generation sources such as biomass but other than traditional (petroleum) diesel.
- b) Integrate the supply of electricity to rural areas with other social infrastructure e.g. water, road network etc.
- c) Ensure that the Self Help Electrification Programme (SHEP) and the National Electrification Programme (NEP) are part of an integrated rural development programme of the District Assemblies.
- d) Rural electrification is seen to be providing energy services for social enterprises but also to support economic (wealth creation) activities. Therefore establish a Rural Electrification Board, a Rural Electrification Fund and a transparent mechanism for funds disbursement to bring down costs of equipment and materials through the provision of grants and loans for rural electrification schemes.
- e) Government legislates **0.1-0.2 cents per kWh** of existing hydro generation for rural electrification to augment existing levy on the tariff for rural electrification to support the proposed Rural Electrification Fund. Or,
- f) Government could alternatively **adjust the existing hydropower tariff** to that of the thermal plant running on natural gas and use the incremental difference to fund the Rural Electrification. Natural gas thermal generation tariff could be the benchmark for baseload electricity sales.
- g) Also, efforts should be doubled to tap the numerous 'green credits' available worldwide such as the Clean Development Mechanism (CDM) into the country for rural electrification via decentralised renewable energy systems.

The Power Transmission System

Objective: To facilitate bulk transportation of power to where it is needed and as the main artery for facilitating the long-term vision of 100 percent universal electrification of the country.

Transmission losses sum up least when the country's electricity generation is mainly from the Akosombo and Kpong hydropower stations since they are located in the east. Transmission losses however, go up when generation is largely thermal since the power has to be wheeled from the thermal station at Aboadze in the west to the east where demand is greater. The losses are greater than expected due to over-loading of coastal lines, which are close to their transfer limits. It thus makes economic sense to site future power stations at locations along the east coast where for obvious reasons most of the industries are located, specifically within Accra – Tema coastal segment. The high demand within Tema-Accra coastal stretch also makes the coast the most favourable location for future thermal power plants

Future industries are also likely to be attracted to the east for the power supply reason as well. However, over concentration of power plants and industries in the east could give rise to serious balancing problems in the national transmission system and in addition threaten the coastal environment unless stricter environmental policies are enforced. Thus, to enhance the dynamic stability of the transmission network and also to keep losses to the optimum minimum, there will be the need for deliberate industrial policy to develop the western segment of the coast and consequently encourage future industries to go there. Reinforcement of the coastal line will also be required.

It is recommended that the government expedite the establishment of the Electricity transmission Utility. Without the transmission ownership separated from VRA system ownership and an Independent System Operator appointed quickly, it would be very difficult to envisage immediate and active private sector participation in power generation.

Policy

332. It is recommended that

- i. *Government encourages future industries to be sited in the west coast of the country.*
- ii. *Government improves the basic industrial infrastructure within the Sekondi – Takoradi - Cape Coast coastal segment to make it equally attractive for industrialisation as in the east.*
- iii. *Government looks for suitable locations for future power plants inland and mark them out as national reserves.*
- iv. *Government conducts feasibility study on extension of the WAGP from the coast to a suitable location near Kumasi*
- v. *Government facilitates the upgrading and expansion of the transmission and the distribution networks.*
- vi. *Energy Commission in consultation with the Independent System Operator and the Transmission Utility develops:*
 - *The Grid Code for transparent access, information and despatch; and*
 - *Rules for the operation of the transmission system.*

333. Implementation measure

- a) Government help set up the Independent System Operator and the Transmission Utility as soon as possible.
- b) Assets of the transmission network of VRA – including the Volta Load Despatch Centre at Tema and Engineering and the System Planning Division at Akuse transferred to the Electricity Transmission Utility.
- c) Government financially assists the Transmission Utility to expand transmission network.
- d) Energy Commission develops standards of performance, codes of practice and regulations of electric transmission.

Distribution and Tariff

Under the Power Sector Reform, ECG is proposed to absorb or merged with NED to form single national distribution company. Total system losses had ranged from 24 – 26 percent for both ECG and NED. NED operational area is largely rural, sparsely populated and poorly resourced, whilst ECG's is largely urban, relatively densely populated and highly resourced. Average salary of NED professional staff is higher than that of ECG. It may therefore not be healthy to merge the two entities without addressing salary disparity issue and the bottlenecks within ECG that are militating against its optimal performance.

Policy

334. **It is recommended that**

- i. *Government ensures that ECG is put on a sound management footing before it is made to absorb NED into a new ECG.*
- ii. *ECG explores innovative ways to reduce their high system losses including ways of improving collection from customers with credit meters.*
- iii. *Government promulgates the standards of performance, codes of practice and regulations for electricity distribution.*
- iv. PURC resolves quickly the issue of favourable feed-in tariffs for electricity from embedded generation, particularly renewable energy, to allow distributed generation systems to be hooked to the distribution grid network.

335. Implementation measures

Introduce private participation into the management of new ECG to improve technical, financial and commercial operations.

Cost of Unserved Energy

Presently, economic costs of power outages to the various economic sectors of the country are not officially known. Knowing the high cost of unserved energy endured

by the economic sectors will encourage the nation to invest in measures to reduce power outages to the barest minimum.

Policy

336. It is recommended that

Energy Commission, PURC in consultation with the utilities compute cost of unserved energy at all the load centres in the country.

Tracking and reducing bill defaults

Even though, introducing more pre-paid meters can significantly reduce the default and delay in payments, a system whereby individual customer is made the target of identification instead of the meter for the bill payment is likely to reduce drastically cases of customers absconding with unpaid bills. For instance, prospective customer is issued with identification number based on his/her Social Security number and a bank account. For those without Social Security numbers and bank accounts, their birthday or baptismal certificates are used, so that the individual is billed based on any of the above being used as personal identification number (PIN). In this case, if such a customers defaults say in Accra and moves to Tamale in the Northern Region, the debt will still be following that individual since past records will pop up whenever the individual applies or tries to apply for a new meter (or connection) in any new residency the individual finds him or herself.

For the distribution companies to effect this arrangement, there should be in place a centralised computer system where information on all individual customers are stored.

Policy

337. It is recommended that

- i. *Government supports nationwide computerisation of all bills into one billing network.*
- ii. *Government supports the distribution companies to adopt a more efficient system to track bill defaulters.*

Petroleum Subsector

Upstream

Objective: *To accelerate the rate of petroleum exploration with the aim of achieving an adequate local hydrocarbon production to meet economic and social development needs of Ghana and for export.*

Ghana is yet to find any significant commercially proven reserve. In her almost a century old drilling history, the country had drilled less than 100 wells.

Taking cognisance that Ghana is in West Africa sitting on the same geological tectonic crust of the earth, which once joined the regions of Western Africa and the eastern coast of South America together. It is the same tectonic plate that is yielding oil in significant commercial quantities for Venezuela and Brazil in Southern America; Nigeria, Equatorial Guinea, la Cote d'Ivoire, Cameroon, Gabon and Angola in western part of Africa.

Perhaps, the rate of oil exploration has not been aggressive enough to hit any large-scale discoveries. Considering the OPEC proposed new price basket, it is imperative that the government accelerates scouting for investors to develop the Tano oil and gas fields. There is also the need to intensify deepwater hydrocarbon exploration and exploitation in the country.

Under the prevailing regulatory regime, GNPC is supposed to regulate the operations of the activities of the investors whilst it is expected to participate in the production activities at the same time. There could be conflict of interest and compromises since GNPC cannot be a player and at the same time a referee to the upstream business. It may be prudent to move the upstream regulation from the jurisdiction of GNPC to a third party being it the sector ministry or an independent agency like the National Petroleum Authority. The petroleum exploration and production law should rather maximise GNPC's capacity to enter into joint venture partnership or have production sharing agreements with all companies interested in doing upstream business in Ghana. This will also help increase the local content of upstream investments and indirectly upgrade the know-how of GNPC.

Policy

338. It is recommended that

- i. *The Government ensures more competitive Regulatory Regime for the conduct of upstream petroleum operations in Ghana in the face of favourable conditions in Nigeria, la Cote d'Ivoire, Equatorial Guinea and Gabon.*
- ii. *The Government divests the upstream regulatory activities from GNPC's jurisdiction and place it in a separate body.*

339. Implementation measures

Review of regulatory regime commenced in 2001/2002 with technical support from the Commonwealth Secretariat. There have been stakeholder consultations involving the Ministries of Energy, Finance, CEPS, Internal Revenue Services, Attorney General, EPA and the Navy.

There is the need to

- a) Speed up review of the Regulatory Regime.

- b) Expedite action on approvals.
- c) Encourage regional and international co-operation in exploration, development of infrastructure, trade, database and capacity building.
- d) Amend NPA Act to take up regulatory functions of the GNPC. Or the sector ministry temporary takes charge of the regulatory functions of the upstream.
- e) Improve promotional communication plan. Current level of promotion hydrocarbon potential relatively low.
- f) Continue transcribing existing data on to modern media and formats compatible with international standards.
- g) Accelerate facilitation of acquisition of geological and geophysical data for assessing the petroleum potential of the country.

Policy

340. It is recommended that

- i. *Government continues to support and enhance the capacity building of GNPC to enable it meet challenges in the upstream petroleum sector.*
- ii. *GNPC is adequately resourced to effectively play its role as a national hydrocarbon development entity of Ghana.*

341. Implementation measures

Even though, GNPC has built capacity over the years, the upstream petroleum industry is knowledge-based and very dynamic. There is the need to continue enhancing its capacity. Also, if GNPC is to focus on exploration, which is a capital intensive activity, there is the need to improve its existing financial base. Measures include:

- a) Ensuring an efficient administrative system by establishing one-stop shop procedure for negotiating exploration permits.
- b) Recapitalising GNPC including increasing the exploration levy in the petroleum pricing formula. Levy should be easily and directly accessible when generated.

Royalty Rates and Geological locations

Deepwater

Exploration in deepwater (depths beyond 200 metres) is obviously more expensive compared to shallow waters and onshore and the situation worsens for Ghana where deepwater depths extend beyond 3000 metres. Investment becomes more risky in the country since no oil has been discovered yet.

Shallow water

Most of the hydrocarbon discoveries in the country have been found in shallow waters but were economically marginal in size. However, with the rising trend in crude oil prices, and advances in technologies, previous exploration discoveries which were considered uneconomic at the time may be becoming economic to produce.

Onshore and Voltaian Basin

The Voltaian Basin covers about 40% of Ghana's landmass. This basin has the least hydrocarbon exploration. This is attributed to inadequate seismic data as well as little study conducted on the general geology so far.

An average royalty rate of 10 percent for all exploration activity whether onshore, off-shore, in shallow or deep waters have been applied in the past and has been taken from gross production of the companies irrespective of the commercial viability of the field.

It has been observed however that the existing royalty rate provided under the Model Petroleum Agreement (MPA)⁷¹ is too high to attract serious investment in the context that Ghana is yet to discover significant commercial hydrocarbon fields.

Policy

342. It is recommended that

- i. *Government keeps the level of royalty hitherto charged to investors at levels far below those charged in oil producing countries in the West African sub-region.*
- ii. *Government supports the introduction of different royalty rates to capture the risk profile of the geology and depth of the locations.*

343. Implementation measures

- a) Introduce 1-2% royalty rate for deep sea exploration but re-negotiate when commercial discovery is made.
- b) Introduce 2-3% royalty rate for Voltaian Basin exploration but renegotiate when commercial discovery is made.
- c) Introduce 3-4% royalty rate for shallow water exploration but renegotiate when commercial discovery is made.
- d) Include favourable fiscal terms for contractors to re-appraise old discoveries which were earlier classified uneconomic in the revision of the existing petroleum law.
- e) Reduce and fix the petroleum income tax rate from 50% to 35% or lower to make Ghana more competitive in the sub-region.

⁷¹ MPA, Article 10.2 dated 17th August, 2000 applies 12.5% royalty rate.

- e) Incorporate tax exemptions in the Internal Revenue Act, the Value Added Tax (VAT) Act and the National Health Insurance Levy (NHIL) Act. Existing arrangement does not facilitate efficient issuance of exemptions to approved investors.

Extension of the Exploration period for Deep Water and the Voltaian Basin.

Exploration in the country's deepwater and the Voltaian Basin will require extensive seismic programme due to the limited data for these areas. This is necessary for detailed evaluation. Companies also require adequate time to mobilized specialized equipment and resources particularly required for deepwater exploration, a relatively expensive and high risk exercise more so in these times where equipment demand exceeds supply. However, since no discovery has been made in the country's deepwater and the Voltaian Basin, there is no recognised exploration trend to allow exploration periods to be established.

Thus the seven years exploration period provided under the Model Petroleum Agreement (MPA)⁷² might be too short to attract favourable investments. On the other hand, too long a period too could be abused by ill-resourced companies with the tendencies to hold on to a block but without undertaking any serious exploration.

Policy

344. It is recommended that

- i. *Government extends the exploration period to at least, a duration longer than what is available in all countries in the West African sub-region which are without commercial hydrocarbon production fields.*
- ii. *Government will extend the exploration period to at least twice what is available in countries in the sub-region with commercial hydrocarbon production fields.*
- iii. *Government will only extend the exploration period to investors who show concrete proof of significant exploration activities in their leased blocks after the first seven years.*

Decommissioning and Environmental Impact Assessment

The provisions governing the decommissioning exercise in the existing Petroleum law⁷³ requires a company to

'restore the affected areas and remove all causes of damage or danger to the environment in accordance with the Regulations. Such restoration responsibility shall include the removal of all property brought into the affected area but which no longer required for further petroleum operations, the plugging or closing off of all abandoned wells in such a manner as may be provided by the Regulations.'

⁷² Section 12 (1) of the petroleum exploration and production law and Article 3.1 of the Model Petroleum Agreement

⁷³ Petroleum Exploration and Production Law, Section 28.

It is therefore important to address how an investor will finance its decommissioning obligation, since it may not have the financial resources to undertake these obligations at the end of its contract. The existing Petroleum law does not provide or state how the decommissioning is to be funded.

Full scale Environmental Impact Assessment is also necessary to unearth the full cycle impact of an investor's exploration activities from commencement to completion.

Policy

345. It is recommended that

- i. *Government establishes a Decommissioning account into which a company will be required to contribute a pre-determined proportion of its revenues accruing from its operations.*
- ii. *Environmental Impact Assessment is made mandatory for all petroleum exploration, appraisal and development activities.*

346. Implementation measures

- a) Set up a joint trusteeship of the company and the Government to manage the Account.
- b) Government and the company work out the principles governing the establishment of the Account.
- c) Synchronise environmental provisions under the Petroleum law with the Environmental Protection Agency Act 1994.

Downstream

Strategic Objectives:

- *Ghana achieves 10% penetration of liquid fuels by renewable and alternative fuel complementation by 2015 expanding to 20% by 2020.*
- *Ghana to be self-sufficient in petroleum products by 2015 with the ultimate aim of becoming a net exporter of products by 2020 within appropriate health, safety and environmental standards.*
- *Replace manganese⁷⁴ additive with ethanol as performance enhancer in gasoline by 2015.*
- *Reduce sulphur content in gas oil (automobile diesel) from the prevailing 2000 ppm to*
 - i. *1000 ppm by 2015*
 - ii. *500 ppm by 2020*

⁷⁴ MMT in gasoline

Export oriented refineries

With the limited refining capacity worldwide for the short-to-medium term, it is prudent that the right and attractive investment climate is created to encourage investment in new refineries in the country.

Policy

347. It is recommended that

- i. *Government ensures that the petroleum subsector meets national and international quality standards of petroleum products; and*
- ii. Government creates attractive investment climate to encourage construction of new refineries to serve the export market.

348. Implementation measures

- a) National Petroleum Authority in conjunction with the National Standards Board and other regulatory agencies enforce standards for petroleum products.
- b) The Ministry of Energy in conjunction with the Ghana Freezone Board, Environmental Protection Agency and the National Petroleum Authority (NPA) create adequate incentives to attract investment in refinery capacity to target the export market.
- c) The Ministry of Energy and the NPA relook at the NPA Act 691, 2005 to ensure that any bottlenecks to refinery investment by the private sector are eliminated or reduced to the minimum.

Deregulation and end-use fuel efficiency

It is expected that the National Petroleum Authority will continue the process of economic deregulation of the petroleum subsector to encourage maximum private sector participation. It is commendable that announcement of petroleum price adjustments are now done by the oil marketing companies taking cognisance that prices of the products fall within the allowable price band provided by the National Petroleum Authority (NPA). However, it is also essential that it targets reducing the fuel intensity in relation to GDP growth from prevailing 3-4:1 to 2-1:1 in the short to medium term, by promoting energy efficiency and conservation measures. There is the need to reduce overall losses in the supply-retail chain⁷⁵.

Policy

349. It is recommended that

Government supports energy efficiency activities to ensure reduction in the petroleum product intensity in the economy

⁷⁵ The Energy Commission chaired a National Oil Losses Control Committee, which looked into how best to rectify the overall losses in the petroleum product supply to the retail chain. The Energy Commission submitted a comprehensive report of the findings and the recommendations to the Ministry of Energy.

350. Implementation measures

- a) Energy Foundation continues to create public awareness in efficient use of energy.
- b) NPA performs effective monitoring and enforcement of regulations.

Management of Tema Oil Refinery

Refinery expansion even though capital intensive is usually a sustaining profitable business if managed business-like devoid of politics and besides, operating above 90% capacity utilisation on the average. It therefore offers the Government, currently the sole owner, the opportunity to divest itself from the operations of the Tema Oil Refinery by inviting private capital to participate in the direct management of the refinery. The private partner should be obliged to invest in the expansion of the refinery taking cognisance of a profitable product-slate configuration that will also take the country's fuel supply security in the consideration.

Policy

351. **It is recommended that**

- i. *Government opens up Tema Oil Refinery for privatisation.*
- ii. *TOR continues to pursue activities to improve technical and economic performance.*
- iii. *Government supports measures to ensure that the economic prices of petroleum products are based on full cost recovery.*
- iv. *NPA encourages the expansion of product slate in all refineries.*

352. Implementation measures

- a) Government invites strategic investors to participate in the operations of Tema Oil Refinery.
- b) Pursue gradual off-loading of shares to move Government from major to minority shareholder status and eventually to total withdrawal from TOR operations. Government offloads its share onto Ghanaian market through the Ghana Stock Exchange allowing Ghanaian and local companies and individuals the first option to buy the shares.
- c) Run the Tema Oil Refinery above 90% capacity utilisation on the average.
- d) Rehabilitate and upgrade the premium former unit of Tema Oil Refinery to correspond to the prevailing capacity of the crude distillation unit (CDU) to improve product yield.
- e) Upgrade utility system of Tema Oil Refinery to meet at least the total energy and steam requirements of the CDU, RFCC and the premium former unit to reduce processing losses and consequently, improve refinery efficiency.

- f) Reduce internal consumption and losses of Tema Oil Refinery from the prevailing average of 6% to 4-5%⁷⁶ or better.
- g) Reduce loading rack losses at Tema Oil Refinery by improving loading process.
- h) Increase the loading points for road-tankers by expanding the loading-racks at the Tema Oil Refinery and decentralising loading of tankers nationwide.
- i) Expand both crude oil and refined product storage capacities of Tema Oil Refinery.
- j) NPA in conjunction with other regulatory institutions establish and enforce performance benchmarks for refinery operations in the country.
- k) Introduce relative incentives for investments in more value-added technologies like hydro-cracking and coking.

Policy

353. It is recommended that

Government continues to create an enabling environment and incentives for the oil marketing companies to service remote areas of the country.

354. Implementation measures

- a) Create an enabling environment to attract private investments.
- b) Ensure adequate margins for all downstream industry operators.
- c) *Ensure efficient operation of the Unified Petroleum Price Fund (UPPF).*

Clean Air Quality

Policy

355. It is recommended that

- i. Government supports the regulatory agencies to ensure that refineries operating in Ghana as well as finished products imported into the country meet targeted and established environmental standards.*
- ii. Government supports NPA to make it mandatory for oil refineries operating in Ghana introduce liquid biofuel blends in their production slate.*

356. Implementation measures

National Petroleum Authority, EPA in conjunction with the National Standards Board ensure that oil refineries operating in Ghana take progressive steps to

- Introduce manganese-free gasoline on the local market by 2015.

⁷⁶ Standard for efficient refineries found in some developing countries.

- Decreasing sulphur content in their gas oil to meeting AFRI-4 (0.05% sulphur) by 2020.
- Introduce biodiesel and gasohol blends in their production slate.

Petroleum product retail

LPG

In 2000, only about 6% households had access to LPG for cooking compared to 30% and about 56% for charcoal and wood respectively. Estimates for current LPG penetration are not significant from the figure in 2000. Increasing refinery capacity and revamping of TOR will increase the production of LPG at TOR. Limited storage capacity however will continue to constrain local consumption as well as export. The consequence is flaring of this value-added product. To arrest the situation, TOR is constructing a 3,000m³ capacity LPG storage spheres. Fatal accidents and burns regarding LPG handling are however, apparently on the increase both at the retailing stations and in the home during usage. With the increasing demand for both residential and commercial cooking, there are fears of corresponding increment in potential fatal accidents.

Policy

357. It is recommended that

- National Petroleum Authority re-introduces the national LPG promotion programme periodically to raise awareness of the dangers of careless handling of LPG accessories and usage.*
- National Petroleum Authority encourages the OMCs to set up more LPG distribution centres to increase access and consumption.*
- Government supports the local LPG cylinder manufacturers to expand their production capacities to meet the corresponding demand.*

358. Implementation measures

- National Petroleum Authority (NPA) speeds up the development of regulations for the operation of LPG filling stations.
- Government, NPA and Industry assist technical institutions in training in LPG handling and technology.
- Encourage OMCs and the private sector to set up LPG training facilities for would-be LPG service operators.
- NPA and OMC certify trained LPG operators.
- NPA strengthens collaboration with Ghana Standards Board, CEPS on the importation of new domestic cylinders.

Gasoline Premix

Gasoline premix is basically gasoline with low octane number and targeted at agricultural activities⁷⁷. It is used as fuel for cocoa spraying machines and outboard fishing motors. It therefore has less taxes compared with regular (premium) gasoline consequently, making it less expensive than the latter. For this reason it has become attractive to fraudsters to either adulterate it with regular (premium) gasoline or divert it for use as vehicular transport fuel. This illegal practice leads to occasional shortages of the premix fuel and either not reaching the intended targets or, reaching them but at exorbitant prices. There may be the need to introduce a dye in it and as well label all vehicular tankers carrying the gasoline premix for distribution to fishing and farming communities to help reduce the fraudulent activities.

Policy

359. It is recommended that

- a. *Government and NPA make it mandatory for OMCs to have dedicated tankers for premix gasoline.*
- b. *Government and NPA enact a legislation to compel all gasoline-premix carrying tankers to be labelled PREMIX GASOLINE.*
- c. *Government and NPA make it mandatory for TOR to introduce colour dye in premix gasoline.*

Kerosene

Kerosene is regarded as the petroleum fuel for the poor and rural communities. The obvious price policy intervention therefore would be to *subsidise* its retail price⁷⁸. On the other hand, introducing price *subsidies* on kerosene gives opportunity for fraudsters to adulterate diesel with kerosene and creates higher demand for kerosene and the kerosene hardly reaches the intended target. The higher kerosene demand means more kerosene would to be imported and cross-subsidising with the major products of gasoline and diesel. Increasing cross-subsidization also means the most taxed products, gasoline and diesel are over-taxed and become more expensive than expected.

Instead of cross-subsidizing or reducing taxes on kerosene, the petroleum tax revenues could be used to target vulnerable segments of the society by improving delivery of health, education and other social services in rural areas.

Since, kerosene is used mainly for lighting in rural and non-electrified communities, one major way to reduce or slow down nationwide consumption of the fuel is by accelerating the penetration of rural electrification either by grid or decentralised power systems in the country. Increasing penetration of electricity for better and alternative lighting in rural communities would on the other hand reduce kerosene consumption in rural households and make available

⁷⁷ Premium gasoline has octane number above 90. Premix gasoline has octane number lower than 90; it is usually between 80-85

⁷⁸ The Government of Ghana and the NPA create the impression that kerosene is subsidized, but this subsidy appears to be largely in the form of reduced taxes. The ex-refinery price of kerosene is usually above the cost-recovery or the ex-pump price.

more kerosene, which could be diverted to produce jet kerosene, a more valuable fuel. Provided that the price is competitive, adequate aviation kerosene will facilitate smooth aviation traffic by attracting airlines to refuel in the country, which would mean additional revenues to the Civil Aviation Authority and the nation as a whole. Aviation fuel is of importance to the economy such that TOR intends to build a 30,000 m³ storage capacity for ATK. In addition, the civil aviation authority has plans to build a pipeline from TOR ATK storage system to the international airport in Accra to facilitate quick and direct fuel transportation.

Policy

360. It is recommended that

- i. *Government supports programmes that will displace kerosene for lighting with better alternative energy sources like solar, wind and micro hydro plants.*
- ii. *NPA ensures that kerosene and diesel maximum indicative pump prices are matched equally to discourage adulteration.*
- iii. *Government and NPA instead of cross-subsidizing kerosene uses part of the petroleum tax revenues to target vulnerable segments of the society by improving delivery of health, education and other social services in the poor and rural areas.*

Diesel (Gas oil)

Diesel, the main fuel for mass passenger and freight transport is also the major petroleum fuel for rural based commercial activities like grain milling and motorised farm machinery.

Lower diesel price in Ghana however, could encourage some level of smuggling of the product to neighbouring countries where it is more expensive. OMCs believed that matching petroleum product prices with neighbouring countries would reduce the incidence of smuggling⁷⁹.

For rural based commercial services like grain milling and mechanised farming, the diesel demand is expected to drop with increased penetration of grid electricity for operating grain mills in rural communities.

Policy

361. It is recommended that

- i. *NPA sets indicative price for diesel to match those available in neighbouring countries.*
- ii. *Government and NPA use part of the tax revenues from diesel sales to support productive uses of electricity (wealth creation) in newly grid-connected rural communities requiring fuel-switching from diesel to mains-electricity.*

⁷⁹ NDPC/UNDP (2004), Distributional Impact and Effects of Ghana's Petroleum Pricing Policy, Poverty and Social Impact Assessment, prepared by Armah and Associates on contract.

Promotion of Natural Gas Industry

The introduction of natural gas is an important strategy to improve the energy efficiency and competitiveness of the industrial and transport sectors.

Policy

362. It is recommended that

- i. *Government supports the establishment of natural gas distribution system.*
- ii. *The local distribution companies (LDC) ensure the security of their distribution pipelines.*
- iii. *Government provides support for the security of designated natural gas transmission pipelines.*
- iv. Government supports acceleration of development of indigenous natural gas fields.

363. Implementation measures

- a) The Government seeks private sector partnership and multilateral funding for the development of the natural gas distribution infrastructure.
- b) Initiate capacity building programme for the Energy Commission to develop the code of practice for the natural gas industry. The Energy Commission shall develop:
 - The necessary instruments for legislation.
 - Effective monitoring procedures for the gas industry
 - Standards for the natural gas equipment.
 - Regulations to ensure effective open access to pipelines and other facilities.
- c) The PURC by its mandate (PURC Act 1997, Act 538) shall develop the tariff regime for:
 - the pipeline operations; and
 - the secondary gas market.
- d) Initiate capacity building programme for PURC to develop efficient tariff system for natural gas use in the country.
- e) The Energy Commission in conjunction with the National Petroleum Authority and the Energy Foundation shall:
 - Develop incentives for fuel-shift from RFO and industrial diesel to natural gas in boilers.

- Promote natural gas as heat source for mineral processing and as feedstock for some chemicals, where applicable.
 - Promote the use of natural gas for cogeneration of power and heat or steam.
- f) Promote efficient use and application of natural gas in industry, commerce and eventually transport.

Alternative transport fuels

Strategic Objective:

Secure and increase future energy security by diversifying sources of supply through fuel substitution and complementation of alternative fuels so as to achieve 10 percent penetration in supply mix by 2015 and 20 percent by 2020.

Policy

364. It is recommended that

Government diversifies its sources of supply of transport fuels by looking at alternative fuels such as compressed natural gas and liquid biofuels.

365. Implementation measures

- a) The Ministry of Energy in conjunction with the Ministry of Agriculture will evolve land use policy to identify lands for biofuel cultivation.
- b) The Energy Commission in conjunction with the National Petroleum Authority and the Energy Foundation introduce:
 - biodiesel and gasohol blends to complement diesel and gasoline use nationwide by end of 2008.
 - natural gas as transport fuel substitute for diesel in coastal cities. Pilot programmes could start in Accra, Tema and Takoradi by end of 2008 due to their relative proximity to the natural gas regional pipeline from Nigeria.

Strategic Stocks

Strategic Objective:

Ghana achieves a strategic stock capacity of at least;

For refined products:

- 8 weeks of national demand by 2015;
- 12 weeks of national demand by 2020.

- and for crude oil:

- 8 weeks of national demand by 2015;
- 12 weeks of national demand by 2020.

Refined products storage

Fuel supply security and erratic fuel prices have advised countries to set up strategic stocks both for crude oil and refined products. Most developed countries, for instance, the OECD⁸⁰ members have agreed on a minimum of six months of strategic stocks.

Ghana decided on a similar measure in the 1990s and now maintains three weeks of strategic stocks of refined products on the average. Among the long term strategy is to expand the stock to include crude oil.

BOST keeps gasoline up to three months on the average in storage to avoid gum formation in the fuel. This is because most gasoline when bought from open market is cracked gasoline and for that matter has relatively short lifespan compared to straight-run products. This also means such cracked products must be used within three months of their storage.

It is therefore imperative that BOST put priority on stocking straight-run gasoline, which is apparently more suitable for storage beyond three months. Periods when the stocks are about to expire but the nation has sufficient products in circulation, BOST should be allowed to explore the sub-regional foreign market to enable the products to be sold on the spot market which tends to attract good prices.

For instance, increasing global crude oil prices make it difficult for TOR to operate its crude distillation unit (CDU) to the fullest. Insufficient light crude to feed the CDU means inadequate atmospheric residual (AR) feedstock for the RFCC to run at full capacity, compelling TOR to import make-up quantities from third parties. To offset this constructed a 40,000 m³ (251,572 barrels) capacity atmospheric residual (AR) tank so as to facilitate full capacity running of the RFCC⁸¹.

Policy

366. It is recommended that

- i. *BOST expands the strategic stock capacity to a minimum of four weeks by 2008; six weeks by 2012; eight weeks by 2015; and increasing to 12 weeks of national demand by 2020.*
- ii. *BOST construct more bulk storage depots in all the regions in order to bring products closer to end-users.*
- iii. *Government and NPA encourage TOR to supply BOST with straight-run products in order to increase the lifetime of products in strategic storage.*
- iv. *BOST will be encouraged to explore sub-regional spot market to off-load excess stocks to earn foreign exchange revenue.*

⁸⁰ OECD is Organisation for Economic Cooperation and Development.

⁸¹ The RFCC has a design capacity of 14,000 BPSD but it can be operated at 108% capacity to produce 15,120 BPSD. There are plans to upgrade it to produce 18,000 BPSD. *challenge, TOR*

367. Implementation measures

- a) *Build additional storage capacities in the country.*
- b) *Locate these depots for effective distribution throughout the country.*
- c) *Government reinstates the cost of maintaining the strategic stocks in the petroleum product price build-up.*
- d) *TOR supplies BOST with straight-run gasoline and products when available.*

Potential Additional Oil Storage at Aboadze

The Takoradi Thermal Power Station (TTPS) at Aboadze is expected to switch from crude oil and distillate oil to natural gas by ending of 2006 or early 2007. The power station has four 30,000 cubic metre tanks capable of storing almost 100,000 tonnes (or 755,000 barrels) of crude oil, about 19 day crude requirement of the country. With natural gas replacing crude and distillate oils as the default input fuel after 2006, this additional storage could serve as the country's first crude oil strategic storage besides those found on the premises of Tema Oil Refinery. *There is however a technical challenge that has to overcome first. The piping and pumping systems currently in use at the TTPS do not allow the re-exportation of crude held in its tanks.*

Policy

368. **It is recommended that**

Government supports the expansion of the strategic stock capacity of the country by leasing the crude oil storage tanks at Aboadze to the existing national storage being handled by BOST.

369. Implementation measures

- a) Takoradi Thermal Power Station (TTPS) leases part of its oil storage tanks to BOST when it starts firing on natural gas.
- b) BOST and TTPS relook at the possible re-engineering of the piping and the pumping systems at Aboadze when natural gas starts reaching the latter

Underground Crude oil storage

Most developed countries' strategic storage includes crude oil storage in underground caverns. The US Energy Policy and Conservation Act in the 1980s provided for the storage of up to one billion barrels of crude oil in underground caverns but it was only able to reach 700-million-barrel capacity in 2005. China, the world's third largest oil importer after the United States and Japan was completing its first strategic oil reserve in 2005.

The 33 million barrel facility will hold about one-third of China's planned emergency reserves. The country aims to increase the storage capacity to about 133 million barrels a day equivalent to her 20 days of consumption by 2010.

Ghana has disused underground gold mines in Obuasi, Tarkwa and Prestea, some of which could be used for similar strategic crude oil storage. The way forward is to investigate the holding

capacities and their suitability for such strategic storage. Ghana may not need to develop the abandoned empty mines by herself but explore the opportunities for leasing to interested countries that may like to develop offshore underground storage as part of their national inventories.

Policy

370. It is recommended that

Government investigates the possibility of utilising disused underground mines for strategic crude oil storage.

371. Implementation measures

Capacity building in the storage of strategic crude oil in disused underground mines.

Offshore floating storage

There is an innovative enterprise where offshore storage systems are set up largely to service spot market demands. Private enterprises take advantage of prevailing market prices to make purchases, store and resell at favourable market rates. Whilst the business looks lucrative for private investment, it has environmental consequences regarding pollution of the water body during the process of recharging and discharging. Special cleansing taxes may be necessary to regulate such enterprises.

It is however an opportunity for BOST to also invest in offshore strategic storage to protect the country's demand in times of high oil prices. Furthermore, it is an opportunity for BOST to enter into investment partnership with the private sector to explore the spot market business opportunities.

Policy

372. It is recommended that

- i. Government supports regulations for offshore storage operations in the in the country.*
- ii. BOST is encouraged to enter into public-private partnership business arrangements with private investors to explore spot market opportunities.*

373. Implementation measures

- a) Government assists BOST, National Petroleum Authority, Environmental Protection Agency and the Navy to develop the capacity and the regulations for the operation of offshore floating storage system.
- b) Government support BOST to expand its operations to cover offshore trading to earn some revenues, whilst retaining its core business of strategic stocking of oil for the country.

Woodfuel and Renewable Energy Subsector

Woodfuels

Immediate Objective: To ensure sustainable production, marketing and consumption of woodfuels.

Promotion of sustainable production

Policy

374. **It is recommended that**

Government supports promotion and development of sustainable management of the country's natural forests and woodlands for sustainable supply of wood including woodfuels.

375. **Implementation measures**

- a) Survey, map, register and gazette all sustainably managed woodfuel areas outside the forest reserves.
- b) Government through public and private agencies encourage and assist local community groups or individual entrepreneurs to establish woodlots or plantations to ensure sustainable supply of wood.
- c) Introduce woodfuel production contracts, which allow the utilization of timber off-cuts from the forest reserves for the production of woodfuels.
- d) Define rights and responsibilities of fringing landowning communities in forest reserve management and in the harvesting and sale of the woodfuels.
- e) Establish standards and registration requirements for woodfuel producers and registration of all commercial woodfuel producers to be given trading rights.
- f) Investigate ways to address the issues of bushfires and salvaging wood in connection with large construction works such as roads and hydro dams, especially, with the impending construction of the Bui hydroelectric project.
- g) Revise the current woodfuel taxation system to ensure that taxation of wood from sustainably managed areas is less than from unsustainably managed ones and that a substantial part of the tax revenues is used for reforestation and support of sustainable management of woodlands.
- h) The Energy Commission, the Forestry Commission, the District Assemblies and the traditional authorities would decide the revision and agreement on collection and redistribution of taxes.
- i) Standardize the woodfuel trading. Trade in charcoal should be done in bags with official seals.

- j) Review the system of allowing exploitation of forest resources for production of commercial woodfuels. The number of permits issued should reflect the ‘sustainable production’ levels in that area.

Establishment of a National Woodfuel Office

Policy

376. **It is recommended that**

Government establishes an institutional framework to enhance and coordinate woodfuel related activities as an integral part of national energy development strategy.

377. **Implementation measures**

- a) Involve all institutional agencies associated in the woodfuel industry in the planning, implementation and monitoring of activities in the subsector.
- b) Energy Commission sets up a National Woodfuel Office with working linkages with the Forestry Commission, the Local Government institutions and other identifiable stakeholders.

Regulation of the woodfuel industry

Policy

378. **It is recommended that**

Government regulates the woodfuel transportation, marketing and export system to encourage more sustainable practices.

379. **Implementation measures**

- a) Energy Commission should liaise with the District Assemblies to license the following categories of woodfuel traders: Commercial and Bulk Producers, Commercial and Bulk Transporters, Wholesalers and Bulk retailers.
- b) All commercial woodfuel transporters should be in possession of an information sheet specifying the origin of the load, the destination of the load with due signature of the District Assembly Revenue Collectors and the Woodfuel Transporters Association at the destination point.
- c) Energy Commission will collaborate with the relevant institutions to ensure safety measures are applied on bulk transportation of charcoal.
- d) Energy Commission will strengthen its licensing framework for exporters of woodfuels. As part of the licensing requirement all exporters will be obliged to submit shipping documents indicating the quantity, source and origin of the woodfuel and destination to the Energy Commission for endorsement. Exports will only be allowed from waste wood and wood from planted energy forests.

Energy efficient production and use of woodfuels

Charcoal production in the country is still largely based on the rudimentary earth mound technology which is low yielding consuming between 4 – 6 tonnes of wood per every tonne of charcoal produced. Market forces regulate the trade and uncontrolled demand could pose a high environmental risk to the resource base. The production of charcoal in this manner releases a lot of methane gas and other greenhouse gases.

Woodfuel utilisation in the home was responsible for about 68 percent of carbon monoxide (CO), over 50 percent of methane (CH₄) and about 68 percent of nitrous oxide (N₂O) emissions of the country, all global warming gases.

In late 80's two major programmes were instituted to address the issue of inefficient end-use devices used for cooking. These were the:

- i. Promotion of LPG as a means of achieving energy conservation through fuel shifting to more efficient LPG stoves; and
- ii. Nationwide promotion of the Ahibenso improved charcoal cooking stove, which was meant to replace the traditional "coalpot" .

The Ahibenso Improved stove was introduced on the market in 1989. This improved coal pot saves between 35-40% of charcoal over and above the traditional coalpot. Furthermore an expenditure survey conducted among households indicated that it saved between 15-20% of the amount of money normally spent on charcoal. The woodfuel efficiency programme however fizzled out by the mid 1990s after the Ministry's funding ended.

Policy

380. It is recommended that

Government supports development and introduction of improved technologies and higher levels of efficiency in the production and consumption of woodfuels.

381. Implementation measures

- a) Register all traditional and commercial charcoal producers and train them in improved carbonisation process.
- b) Undertake continuous Energy Efficiency and Conservation Awareness campaign targeting all levels of consumers.
- c) Monitor the health impact of woodfuel production and use especially, on women and children and feed the information to stove designers and for policy formulation.

Manpower development

Woodfuel being the most important energy source for the country cannot be left in the hands of inefficient charcoal producers, if the country wishes to see a sustainable production and consumption in the foreseeable future.

The industry will only see modernisation when regulations and professionalism is introduced. Tertiary institutions should be assisted to run courses and programmes in Woodfuel Technology.

Policy

382. It is recommended that

Government supports training in Woodfuel Technology in tertiary and other learning institutions.

383. Implementation measures

- a) Energy Commission should sensitise and assist the tertiary institutions to establish a curriculum for Woodfuel Technology.
- b) Include woodfuel technology in existing Agriculture Extension Officer courses.
- c) Government support agencies in-charge of technical and vocational training in the country to develop courses in modern woodfuel technologies.

Renewable energy

Objective: To increase the use of renewable energy sources to 10 percent of the national energy mix by 2020.

Regulatory framework for grid-connected renewable energy power generation

Perhaps the single most important policy intervention that will accelerate the development and use of renewable energy for electricity generation is the establishment of a tariff regime that is friendly to Renewable Energy and is backed by a regulatory framework that allows such generation plants to be connected to the national grid.

Since all wind farms and most RE projects are embedded generation, the feed-in tariffs could be established within the context of the embedded generation costs as in the PURC Electricity Rating Setting Guidelines⁸².

Policy

384. It is recommended that

⁸² The Embedded Generation Cost is defined as the avoided cost of procuring electricity supply directly from the Market

- i. *The Government through the Energy Commission develops the necessary Renewable Energy Technology regulatory framework.*
- ii. *The Government through the Energy Commission develops Technical Regulations, including standards and codes of generation and interconnection to the grid especially on network voltage range, voltage fluctuations, harmonics, thermal ratings, etc. to facilitate the development of grid-connected Renewable Energy Technologies.*
- iii. *The Government through the PURC sets favourable feed-in tariffs for electric power from Renewables in particular and embedded generation in general.*

385. Implementation measures

- a) Government supports capacity building programmes for the regulatory and the utility agencies.
- b) Increase collaboration between the regulatory bodies and sister institutes in advanced countries to improve technical know-how.

Overcoming the high initial cost barrier

The initial high costs of Renewable Energy Technologies have been a major barrier to their widespread deployment. The key problem that any innovation market delivery model has to deal with is the high upfront cost of Renewable Energy Technologies and in the case of the solar photovoltaic systems the additional cost of replacing the balance of system components such as batteries, controllers and the direct current (d.c) lamps.

Policy

386. **It is recommended that**

- i. *Government investigates innovative capital subsidy arrangements to assist rural communities acquire Renewable Energy Technologies.*
- ii. *Government rationalises the fiscal regime regarding import duty and VAT on renewable energy technology equipment in order to help lower the upfront RE-equipment costs.*
- iii. *The current tax exemption regime for Renewable Energy Technologies would be expanded beyond wind power and solar energy equipment to include import duty and VAT exemption for other renewable energy utilisation equipment, appliances and system components.*
- iv. *Government supports the promotion of local manufacturing of renewable energy devices and equipment in the medium-to-long term.*

387. Implementation measures

- a) The Ministry of Energy tasks the Energy Commission to investigate innovative financial schemes including capital subsidy arrangements and micro-financing. The Ghana Investment Promotion Council (GIPC) Investment Code, for example, should make provision for tax exemptions for Renewable Energy manufacturing. In addition, wind powered and solar energy generating sets, plants, machinery, equipment or parts for the establishment of manufacturing facility are exempt from import duty, VAT and excise duties.
- b) Government encourages Ghanaian industrialists to partner with popular brand manufacturers to set up branches of production and assembly lines in the country.

Ensuring good quality equipment and installations

A system of certification and standardisation needs to be developed in order to ensure high quality installation and performance:

Policy

388. **It is recommended that**

Energy Commission establishes and enforces certification and licensing of dealers in Renewable Energy Technologies based on predetermined requirements.

389. Implementation measures

- a) The requirements for receiving a license should include: Evidence of competence of technical staff; Track record; Evidence of certification from principals; Evidence of capacity to provide after sale service; Evidence of financial capacity to offer services.
- b) Licensing will be made a precondition for local dealers applying for public grant, subsidies and contracts.

Role of Government and the Private Sector

The rural electrification has largely been by grid and driven by donor support. It would be extremely difficult to achieve 100 percent national electrification without the inclusion of distributed systems.

The Government alone may not be able to implement projects covering both the public and private sectors due to limited funding sources.

Policy

390. **It is recommended that**

- i. *Government focuses on provision of decentralised renewable energy power systems for public communal facilities and needs.*

- ii. *Government supports the private sector to provide decentralised renewable energy systems for individual and commercial needs.*

391. Implementation measures

- a) The Government focuses on provision of decentralised power for public social amenities such as health centres, schools and potable water. Support the training of manpower and research. Create the necessary market environment such as tax rebates, equipment certification.
- b) Private enterprises focus on provision of systems for homes, commercial and industrial entities. Government support could include arranging concessionary credits for the local dealers.
- c) There will be public –private sector partnership in large-scale centralised power projects through shared costs.

CROSS CUTTING ISSUES

Research and Development

Policy

392. **It is recommended that**

- i. *Government supports the revival of the National Energy symposia and the biannual energy colleges where issues and innovations in the energy sector are shared and discussed.*
- ii. *Government supports Ghanaian professionals in regional and international cooperation on Research and Development on energy and related topics.*

393. **Implementation measures**

- a) Energy Commission and the Ministry of Energy should support the revival of the National Energy Symposia and the energy colleges, etc⁸³.
- b) Energy Commission and the Ministry of Energy to facilitate and sustain collaboration in research, exchange of data, information and documentation, capacity building and the training of energy specialists.

Capacity Building and Development

Policy

394. **It is recommended that**

- i. *Government maximizes the level of participation of its local resources in the conduct of its energy sector activities and investments along the entire energy value chain.*
- ii. *Government sets up a Local Content Committee to direct efforts to maximize local content and participation in energy investments*
- iii. *Government provides funding to support capacity building, education and information dissemination activities of the sector.*
- iv. *Outstanding performances, innovations and conduct by individuals and organisations be identified, monitored and appropriately rewarded by the sector ministry to encourage maximisation of work output in the sector.*
- v. *Education and training for women in all energy aspects both on the demand and supply side be facilitated.*

⁸³ Energy Research Group supported by the erstwhile National Energy Board and the Ministry of Energy used to organise the National Energy Symposia and the energy colleges since their inception in 1980s to end of 2000. These energy conference had not been held since 2001.

- v. *Adequate incentives including appreciable remuneration to attract and retain qualified professionals in the energy sector be explored and sustained.*

395. Implementation measures

- a) For the local content and participation policy to succeed, the sector Ministry in conjunction with the Ministry of Finance should provide the pivotal role in Government.
- b) Set up a Local Content Committee to be responsible for updating the local content and participation policy. It could be located in the energy sector Ministry or, the Finance Ministry to cover the general economy as a whole.
- c) Develop subsidiary policies and strategies to ensure the transfer of technology and know-how to improve local skills and enterprises.
- d) Government ensures that the Local Content Committee has the necessary resources to properly deliver on its mandate.
- e) Training covers formal education and informal education.
- f) Identify and select areas for focus of local capacity building development.
- g) Set targets for local capacity building.
- h) Preference should be given to multinationals that are prepared to partner with local companies during contract negotiation and agreements.
- i) Ensure delivery of maximum local value-added by removing barriers for local participation.
- j) Where there is no local capacity, the multinationals should be encouraged to share expertise by helping to train and build alliances with local institutions.
- k) Also, encourage job training through attachments in sister countries.

Gender and Energy Use

Policy

396. **It is recommended that**

- i. *Government supports awareness and advocacy on gender issues in the energy sector.*
- ii. *Government ensures that women are involved at all levels of the decision making process in the energy sector.*

- iii. *Government promotes efficient, safe and healthy use of domestic energy sources.*

397. Implementation measures

- a) Regularly survey the sector to find out gender shares.
- b) Encourage women to participate in energy programmes, conferences and workshops.
- c) Specially developed energy conservation programmes should target illiterate women.
- d) Promote awareness campaign to address efficiency, health and safety aspects of energy cooking appliances such as LPG and wood fuel stoves by women.
- e) Collaborate with local administration to build and demonstrate well-ventilated kitchens for women who use firewood stoves in both rural and poor urban communities.

APPENDICES

Appendix 1: RECOMMENDED PETROLEUM PLAN

YEAR	ACTIVITY	OBJECTIVE	COST (USD MILLION)
2006-8	(1) Rehabilitate and Revamp the Catalytic Reformer Unit (CRU) of TOR	Brings CRU capacity from 5,000 to 8,000 – 10,000BPD	30 – 35
	(2) Rehabilitate and expand the Utility Unit of TOR	Generate at least 200-210 tonnes of steam to run the CDU, CRU, and the RFCC concurrently	45 – 50
	(3) Rehabilitate and expand products storage tanks Expand strategic storage stock	Increase crude oil and product storage capacity of the refinery	25 – 30
	(4) Complete the Single Buoy Mooring system	Facilitate faster discharge of oil at the Tema seaport	30-35
	(5) Complete the Buipe-Bolgatanga product pipeline	Facilitate transport of oil products from Buipe port to Upper East via pipeline	40 – 42
	(6) Plan to construct ATK pipeline from Tema to Accra international airport	Facilitate direct transport of ATK from Tema to the filling point at the airport.	4 – 5
	(7) Seed money to kick-start the National Biodiesel and Alcohol programmes	Promotion of blending fuels, gasohol and biodiesel starts in Ghana	10
	(8) Construct natural gas transmission and distribution pipeline networks at Tema and Takoradi	To promote industrial use of natural gas with the advent of the WAGP.	10
	(9) Initiate plans to construct a new refinery (<i>takes 2 – 4 years to build a refinery</i>)	<ul style="list-style-type: none"> A new plant of capacity of at least 70,000 BPD is needed to meet supply requirements up to 2020. 100,000 BPD will be required if export market is guaranteed. 	
	(10a) Construct a new refinery of at least <ul style="list-style-type: none"> 30,000 BPD (CDU), 6,000 BPD reformer or isomerisation unit and/or 10,000 BPD cracker unit and should be ready by 2008.	Increases national refinery capacity to at least 75,000 BPD	60 – 90

YEAR	ACTIVITY	OBJECTIVE	COST (USD MILLION)
2006 – 2008 (contd)	(10b) Expand new refinery to 45,000 BPD (CDU) with corresponding increases in secondary conversion unit if export market is guaranteed.	Increases national refinery capacity to least 90,000 BPD	30 – 45
	(10c) Install pilot natural gas filling stations for vehicles in Tema and Takoradi	Demonstrate CNG use in vehicles	3
2009 - 2012	(11a) Expand the new refinery capacity to at least <ul style="list-style-type: none"> 45,000 BPD (CDU) 8,000 BPD reformer or isomerisation unit 14,000 BPD cracker Skip (10a) if (9b) was the case and proceed to (10b).	Increases national refinery capacity to least 90,000 BPD.	30 – 45
	(11b) Expand new refinery to 65,000 BPD (CDU) with corresponding increases in secondary conversion unit if export market is guaranteed.	Increases national refinery capacity to least 110,000 BPD	40 – 60
	(12) Install pilot natural gas filling stations for vehicles in Accra.	Demonstrate CNG use in vehicles	5
2013 - 2020	(12a) Expand the new refinery capacity to at least, <ul style="list-style-type: none"> 70,000 BPD (CDU) 12,000 BPD reformer or isomerisation unit 22000 BPD cracker May instal a 5,000 BPD lube baseoil plant Skip (12a) if (10b) was the case and proceed to (12b).	Increases national refinery capacity to least 115,000 BPD. Meet demand of Tema Lube Oil from local refinery.	50 – 75
	(12b) Expand new refinery to 100,000 BPD (CDU) with corresponding increases in secondary conversion unit if export market is guaranteed.	Increases national refinery capacity to least 145,000 BPD	70 – 100
	(13) Expand natural gas use for commercial operation of vehicles in major coastal cities in Ghana	Expand CNG use to Cape Coast, Winneba junction, Mankessim, and Saltpond junction.	4
	(14) Expand strategic stock	Strategic stock doubled	35

Appendix 2: ROAD MAP FOR INTRODUCING BIOFUELS INTO THE PETROLEUM SUBSECTOR

Year	Activities	Results	Responsibility
2006 - 2007	Set up national committees for Gasohol and Biodiesel	Assembly of key stakeholders	Action to be chaired by the Energy Commission
	Encourage plantations of jatropha (for biodiesel production) and sugarcane, cassava (for alcohol production)	Export produce if local use is not ready	Private sector, the Ministry ⁸⁴ and Energy Commission initiatives.
	Commission a commercial biodiesel distillation plant	Refined biodiesel is available for use	Private sector initiative
	Develop regulations for gasohol and biodiesel use as transport fuel.	Standard biodiesel and gasohol made available	Action undertaken by Energy Commission and NPA
2008	Re-activate the Komenda and the Asutuare Sugar factories if possible.	Commercial production of alcohol restarts	Joint government-private sector initiative
	Install gasohol and biodiesel blending plants in Tema and Takoradi	Blending centres for the southern sector exist	Joint action by the Ministry of Energy Commission, NPA and the OMCs.
	Introduction of B5 and E10 in the country's oil market	Commercial use of gasohol and biodiesel in the transport sector starts.	Joint action by the Energy Commission, NPA, BOST and the OMCs.
2009 - 2012	Install gasohol and biodiesel blending plants in Kumasi.	Blending centres for the northern sector	Joint action by the Energy Commission, NPA, BOST and the OMCs
	Introduce B10 and E20 with voluntary participation by OMCs		Joint action by the Energy Commission, NPA, BOST and the OMCs
	Install biodiesel blending plants in Tamale and Bolgatanga		Joint action by the Ministry, Energy Commission, NPA, BOST and the OMCs.
2013 - 2020	Install gasohol blending plants in Komenda and Asutuare	Blending centres for the remaining regional cities	An example of Public-private partnership (PPP) activities.
	Introduce gasohols up to E85.	Commercial use of gasohol and biodiesel is sustained.	
	Make B5, B10 and E10 mandatory for dispensation at all service stations. Up to E85 voluntary through out the country.		

⁸⁴ The Ministry here refers to the Ministry of Energy

Appendix 3A **ELECTRICITY CAPACITY PLAN - OPTION 1:**

Thermal (largely Natural Gas) with 10% Renewables by installed capacity

POWER PLANTS	2006	2007	2008	2009	2010	2011	2012
a. Akosombo Hydro	1,020	1,020	1,020	1,020	1,020	1,020	1,020
b. Kpong Hydro	160	160	160	160	160	160	160
c. Tapco_oil	330	0	0	0	0	0	0
c. Tapco_gas	0	330	330	330	330	330	330
d. Tico_oil	220	0	0	0	0	0	0
d. Tico_gas	0	220	330	330	330	330	330
e. Tema 30MW diesel	0	Expected to be decommissioned					
f. Wind turbines			50	100	160	160	200
g. Effasu Power gas Barge	125	125	125	125	125	125	125
h. Tema 330 MW gas thermal			110	220	330		330
h. 2 nd Tema 330MW gas thermal						110	220
I. Embedded Generation – gas turbine							
j. 2nd 660MW CCGT at Takoradi							
k. Biomass, solar, minihydro, etc		1	5	6	6	7	7
l. Municipal solid wastes							
m. Landfill power						1	1
Total	1,885	1,856	2,130	2,291	2,461	2,572	2,723
VRA expected Import	200	200	0	0	0	0	0

Legend

Green: No installation

Yellow: standby or yet to be connected to the grid

OPTION 1: Thermal (largely Natural Gas) with 10% Renewables (contd)

	2013	2014	2015	2016	2017	2018	2019	2020
POWER PLANTS	Installed Capacity in Megawatts (MW)							
a. Akosombo Hydro	1,020	1,020	1,020	1,020	1,020	1,020	1,020	1,020
b. Kpong Hydro	160	160	160	160	160	160	160	160
c. Tapco_oil	0	0	0	0	0	0	0	0
c. Tapco_gas	330	330	330	330	330	330	330	330
d. Tico_oil	0	0	0	0	0	0	0	0
d. Tico_gas	330	330	330	330	330	330	330	330
e. Wind turbines	200	200	200	200	200	200	200	200
f. Effasu Power gas Barge	125	125	125	125	125	125	125	125
g. Tema 330 MW gas thermal	330	330	330	330	330	330	330	330
g. 2 nd Tema 330MW gas thermal	330	330	330	330	330	330	330	330
h. Embedded Generation – gas turbine						120	120	120
i. 2nd 660MW CCGT at Takoradi	0	110	330	440	660	660	660	660
j. Biomass, solar, minihydro, etc	7	10	10	10	15	15	20	25
kl. Municipal solid wastes	20	40	80	100	120	120	140	140
m. Landfill power	2	4	4	5	8	11	11	15
Total	2,854	2,989	3,249	3,380	3,628	3,751	3,776	3,785
VRA Import	0	0	0	0	0	0	0	0

Legend

Green: No installation

Appendix 3B **ELECTRICITY CAPACITY PLAN – OPTION 2:**

Thermal (largely Natural Gas) + Bui Hydro + 10% Renewables by installed capacity

	2006	2007	2008	2009	2010	2011	2012
POWER PLANTS							
a. Akosombo Hydro	1,020	1,020	1,020	1,020	1,020	1,020	1,020
b. Kpong Hydro	160	160	160	160	160	160	160
c. Tapco_oil	330	0	0	0	0	0	0
c. Tapco_gas	0	330	330	330	330	330	330
d. Tico_oil	220	0	0	0	0	0	0
d. Tico_gas	0	330	330	330	330	330	330
e. Tema 30MW diesel	0	Expected to be decommissioned					0
f. Wind turbines			50	100	160	160	200
g. Effasu Power gas Barge	125	125	125	125	125	125	125
h. Tema 330 MW gas thermal			110	220	330	330	330
h. 2 nd Tema 330MW gas thermal						0	0
i. Embedded Generation – gas turbine							
j. Bui Hydro (200 MW for first two years)						200	200
k. 2nd 660MW CCGT at Takoradi							
l. Biomass, solar, minihydro, etc		1	5	6	6	7	7
m. Municipal solid wastes							
n. Landfill power							1
Total	1,855	1,966	2,130	2,291	2,461	2,662	2,703
VRA Expected Import	200	200	0	0	0	0	0

Legend

Green: No installation

Yellow: standby or yet to be connected to the grid

OPTION 2: Thermal (largely Natural Gas) + Bui Hydro + 10% Renewables (contd)

	2013	2014	2015	2016	2017	2018	2019	2020
POWER PLANTS	Installed Capacity in Megawatts (MW)							
a. Akosombo Hydro	1,020	1,020	1,020	1,020	1,020	1,020	1,020	1,020
b. Kpong Hydro	160	160	160	160	160	160	160	160
c. Tapco_oil	0	0	0	0	0	0	0	0
c. Tapco_gas	330	330	330	330	330	330	330	330
d. Tico_oil	0	0	0	0	0	0	0	0
d. Tico_gas	330	330	330	330	330	330	330	330
f. Wind turbines	200	200	200	200	200	200	200	200
g. Effasu Power gas Barge	125	125	125	125	125	125	125	125
h. Tema 330 MW gas thermal	330	330	330	330	330	330	330	330
h. 2 nd Tema 330MW gas thermal	110	220	330	330	330	330	330	330
i. Embedded Generation – gas turbine			120	120	120	120	120	120
j. Bui Hydro at 300-400MW	300	300	300	300	300	300	300	200
k. 2nd 660MW CCGT at Takoradi						110	220	330
l. Biomass, solar, minihydro, etc	7	10	10	10	15	15	20	25
m. Municipal solid wastes	20	40	80	100	120	120	140	140
n. Landfill power	2	4	4	5	8	11	11	15
Total	2,934	3,069	3,339	3,360	3,388	3,501	3,636	3,755
VRA Import	0	0	0	0	0	0	0	0

Legend

Green: No installation

Appendix 3C *ELECTRICITY CAPACITY PLAN – OPTION 3:*

Thermal (largely Natural Gas) + Bui Hydro + Nuclear + 10% Renewables by installed capacity

	2006	2007	2008	2009	2010	2011	2012
POWER PLANTS							
a. Akosombo Hydro	1,020	1,020	1,020	1,020	1,020	1,020	1,020
b. Kpong Hydro	160	160	160	160	160	160	160
c. Tapco_oil CCGT	330	0	0	0	0	0	0
c. Tapco_gas CCGT	0	330	330	330	330	330	330
d. Tico_oil SCGT	220	0	0	0	0	0	0
d. Tico_gas SCGT / CCGT	0	220	330	330	330	330	330
e. Tema 30MW diesel	0	Expected to be decommissioned				0	0
f. Wind turbines			50	100	160	160	200
g. Effasu Power gas Barge	125	125	125	125	125	125	125
h. Tema 330 MW gas thermal			110	220	330	330	330
h. 2 nd Tema 330MW gas thermal							
i. Embedded Generation – gas turbine							
j Bui Hydro (200 MW for first two years)						200	200
k. Nuclear light water reactor - IRIS 335							
l. Biomass, solar, minihydro, etc		1	5	6	6	7	7
m. Municipal solid wastes							
n. Landfill power							1
Total	1,905	2,026	2,180	2,291	2,461	2,662	2,703
VRA expected Import	200	200	0	0	0	0	0

Legend

Green: No installation

Yellow: standby or yet to be connected to the grid

OPTION 3: Thermal (largely Natural Gas) + Bui Hydro + Nuclear + 10% Renewables
(contd)

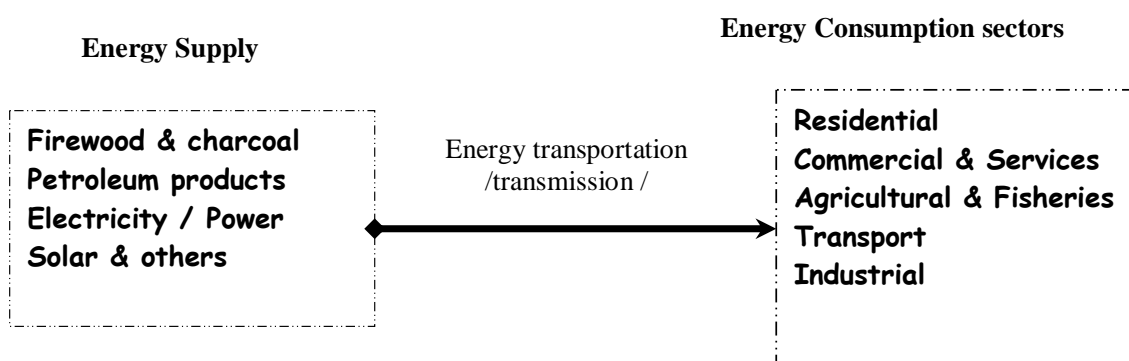
	2013	2014	2015	2016	2017	2018	2019	2020
POWER PLANTS	Installed Capacity in Megawatts (MW)							
a. Akosombo Hydro	1,020	1,020	1,020	1,020	1,020	1,020	1,020	1,020
b. Kpong Hydro	160	160	160	160	160	160	160	160
c. Tapco_oil	0	0	0	0	0	0	0	0
c. Tapco_gas	330	330	330	330	330	330	330	330
d. Tico_oil	0	0	0	0	0	0	0	0
d. Tico_gas	330	330	330	330	330	330	330	330
f. Wind turbines	200	200	200	200	200	200	200	200
g. Effasu Power gas Barge	125	125	125	125	125	125	125	125
h. Tema 330 MW gas thermal	330	330	330	330	330	330	330	330
h. 2nd Tema 330MW gas thermal	110	220	330	330	330	330	330	330
i. Embedded Generation - gas turbine			120	120	120	120	120	120
j. Bui Hydro at 300-400MW	300	300	300	300	300	300	300	300
k. Nuclear light water reactor - IRIS 335						335	335	335
l. Biomass, solar, minihydro, etc	7	10	10	10	15	15	20	25
m. Municipal solid wastes	20	40	80	100	120	120	140	140
n. Landfill power	2	4	4	5	8	11	11	15
Total	2,934	3,069	3,339	3,360	3,388	3,726	3,751	3,760
<i>VRA expected Import</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>

Legend

Green: No installation

Appendix 4. ENERGY SUPPLY–CONSUMPTION CHAIN

Biomass in the form of firewood and charcoal, Petroleum products in the form of gasoline, diesel etc, and Electricity make up the Energy Supply. The integrated energy supply feeds the economy comprising Residential, Commercial & Services, Agricultural & Fisheries, Transport and Industries. The Energy Supply Sector of Ghana thus comprises Biomass, Petroleum and Power (Electricity), whilst the Energy Demand sectors of the Economy are the Residential, Commercial & Services, Agricultural & Fisheries, Transport and Industries (as illustrated below).



ENERGY SUPPLY SECTOR	ENERGY DEMAND SECTORS OF THE ECONOMY	
	Economic Sectors	Sub-sector classification
Biomass in the form of Firewood and charcoal	Residential	Urban, Rural
	Commercial and Services	Tourism, Health, Defence, Education, ICT, Offices, Stores, Informal (vendor cooking, etc), Others
Petroleum in the form of gasoline, diesel, kerosene, LPG, residual fuel oil, etc.	Agricultural and Fisheries	Irrigation, Land Preparation and Harvest, Spraying and Logging, Post Harvest Processing, Livestock, Fisheries.
	Transport	Road, Rail, Maritime, Air
Power/ Electricity from hydropower, oil and natural gas.	Industries	Manufacturing, Mining, Utilities, Construction, VALCO

Appendix 5. LIST OF PARTICIPANTS

LIST OF INSTITUTIONS REPRESENTED AT THE STAKEHOLDER MEETINGS ⁸⁵			
	SNEP AREA PARTICIPATED		
	Electricity	Petroleum	Renewables
Ministries and Governmental Committees			
1. Ministry of Energy (MoE)	•	•	•
2. Ministry of Finance & Economic Planning	0	•	•
3. Ministry of Environment and Science	•	•	•
4. Parliamentary Select Committee for Mines & Energy	•	0	0
5. Power Sector Reform Committee	•	0	0
6. Bui Hydro Development Committee	•	0	Not invited
Public Sector Bodies, Enterprises & Commissions			
1. Board members of the Energy Commission	•	•	•
2. Public Utility Regulatory Commission (PURC)	•	0	0
3. National Petroleum Authority (NPA)	Not invited	•	•
4. Environmental Protection Agency (EPA)	•	•	•
5. Bank of Ghana	0	•	•
6. Nat. Development Planning Commission (NDPC)	•	•	0
7. Ghana Atomic Energy Commission (GAEC)	•	Not invited	Not invited
8. Ghana National Petroleum Corporation (GNPC)	0	•	0
9. Bulk Oil Storage & Transport Company (BOST)	0	•	0
10. Ghana Statistical Services (GSS)	0	•	0
11. Electricity Company of Ghana (ECG)	•	0	0
12. Volta River Authority (VRA)	•	0	0
13. Tema Oil Refinery (TOR)	•	•	0
Private sector (non-oil) energy companies			
1. NEK Ghana Ltd	0	Not invited	•
2. AESSEL Development Group Ltd	Not invited	Not invited	•
3. GHAESCO	Not invited	Not invited	•
4. Wilkins Engineering Ltd.	0	Not invited	•
5. Deng Solar Ltd.	0	Not invited	•
6. 'Pluck the Day' Solar Company	Not invited	Not invited	•
7. A1 Quality Engineering	0	•	Not invited
8. AngloGold Ashanti Ltd	•	0	Not invited
9. Volta Aluminium Company (VALCO)	•	0	Not invited
Oil Marketing Companies (OMCs)			
1. OMC Coordinator	0	•	0
2. Ghana Oil Company (GOIL)	Not invited	•	Not invited
3. Vanco Ghana Ltd.	Not invited	•	Not invited
4. Tema Lube Oil	Not invited	•	Not invited
5. Nasona Oil Company, Ltd	Not invited	•	Not invited
•	<i>Attended</i>		
0	<i>Absent</i>		

⁸⁵ Name of individuals are available at the Energy Commission.

LIST OF INSTITUTIONS REPRESENTED		Electricity	Petroleum	Renewables
NGOs/ Consultancy/Unions/Advocacy groups				
1.	Ghana Private Road Transport Union (GPRTU)	Not invited	•	Not invited
2.	Ghana Chamber of Mines	•	•	Not invited
3.	Association of Ghana Industries	•	0	0
4.	Energy Foundation	•	•	•
5.	KITE	Not invited	•	•
6.	Energy Research Group - Ghana	•	•	•
7.	Ghana Solar Energy Society	•	0	•
8.	Sustainable Environment Group	Not invited	0	•
9.	Jeavco	Not invited	0	•
10.	AESSEL Development Group Ltd.	Not invited	•	•
11.	Ghana Institution of Engineers	•	0	0
Educational & Research Institutions				
1.	Resource Center for Energy Economics & Regulation /ISSER	0	•	•
2.	Institute of Industrial Research of CSIR	•	0	•
3.	Dept of Physics, University of Ghana	0	•	•
4.	Dept of Physics, University of Cape Coast	•	0	0
5.	College of Engineering, KNUST	•	0	0
The Press				
Television				
1.	GTV - Ghana Broadcasting Corporation	•	•	Not invited
2.	TV3	•	•	Not invited
Print Media				
3.	Daily Graphic	•	•	•
4.	Ghanaian Times	•	•	•
5.	Business & Financial Times	•	•	•
6.	Daily Guide	•	•	•
Radio and FM stations				
7.	Ghana Broadcasting Corporation Radio	•	•	•
8.	JOY FM	•	•	•
9.	CITI FM	•	•	•
10.	TOP Radio	•	•	•
•		<i>Attended</i>		
0		<i>Absent</i>		
Note	Names of experts attending in their individual capacities are not included here but available at the Energy Commission			

Appendix 6. MAJOR COMMITTEES DURING THE SNEP PROCESS ⁸⁶

<ol style="list-style-type: none"> 1. 2. 3. 4. 5. 	<p><u>Steering Committee</u></p> <p>Ministry of Finance</p> <p>Ministry of Energy</p> <p>Energy Commission</p> <p>Royal Danish Embassy (<i>sponsor of SNEP as of 2003</i>)</p> <p>RAMBOLL Consultancy (<i>Secretary</i>)</p>
<ol style="list-style-type: none"> 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 	<p><u>Technical Committee</u></p> <p>Ministry of Energy</p> <p>Ministry of Land and Forestry</p> <p>Ministry of Trade and Industry</p> <p>Ministry of Food and Agriculture</p> <p>Ministry of Roads and Transport</p> <p>National Development Planning Commission</p> <p>Public Utilities Regulatory Authority</p> <p>Minerals Commission</p> <p>Environmental Protection Agency</p> <p>Ghana Statistical Services</p> <p>Energy Foundation</p> <p>Volta River Authority</p> <p>Electricity Company of Ghana</p> <p>Ghana National Petroleum Corporation</p> <p>Tema Oil Refinery</p> <p>Ghana Chamber of Mines</p> <p>Association of Ghana Industries</p> <p>Dept. of Geography & Resource Devt., University of Ghana</p> <p>Institute of Statistical, Social & Economic Research (ISSER)</p> <p>Energy Research Group</p> <p>Private Enterprise Foundation</p>

⁸⁶ As of April 2003, when Danish Support ended and the contract with Ramboll was not renewed. Names of persons representing the institutions are available at the Energy Commission.

BIBLIOGRAPHY

Energy Sector Technology Catalogue (*Energy Commission publication, 2004*).

A catalogue of both qualitative and quantitative descriptions of present and projected future energy technologies and appliances for Ghana's economy. The Catalogue is one of the key outputs of the SNEP and is to provide a reliable and acceptable technology database for planning exercises as well as a credible reference for the energy market in Ghana.

Least Cost Assessment of Power Generation Technologies and Demand-Side Appliances: An Integrated Resource Planning approach (*Energy Commission publication, 2004*)

Assessment of power generation technologies and demand-side appliances using the Integrated Resource Planning (IRP) methodology. IRP is a planning tool that looks at the entire energy supply-demand chain on one scale. It allows both the supply-side technologies and Demand-Side Management programmes to be combined and ranked on one scale in the order of least cost option. Balancing the demand side with the supply side options provides an overview of the cheapest way to satisfy the need for energy services.

Indigenous Resource Catalogue (*Contract carried out by the Dept. of Mechanical Engineering, Kwame Nkrumah University of Science and Technology for the SNEP, 2003*)

This resource catalogue contains qualitative descriptions and quantitative estimates of the known energy resources of Ghana that could be exploited up to the year 2020. It is a database on reserves and production as well as technical, environmental and socio-economic features of each resource that could serve as a reference for policy planning.

Energy Balance and Environmental Impact Assessment Report (*Contract carried out by the Dept. of Economics, University of Ghana for the SNEP, 2002*)

An analysis of baseline data on primary energy production, import, conservation and usage. The results were used to prepare the energy balance of the base year and the disaggregation of the economic sectors for inputting into LEAP, the computer-modelling tool used for the projections. Also included in the report is an EIA of the Akosombo hydroelectric project.

Estimation of Woodfuel Demand in the Household Sector of Ghana (*Contract executed by the BRRI of CSIR, for the SNEP, 2003*)

A compilation and analysis of woodfuel consumption data for the household sector. The report provided the household sector input for the LEAP. The Building and Road Research Institute (BRRI) carried out the exercise for SNEP.

Economic Analysis of the Energy Sector (*Contract undertaken by Prof. Bartholomew Armah, a visiting researcher of the Institute of Economic Affairs, Ghana, 2003*)

This report provides the economic context for the formulation of the SNEP. The first part of the report describes the economic structure of Ghana and is followed by an analysis of the contribution of energy to the Ghanaian economy. The report also discusses the implications of the nation's development policies, namely the Ghana Poverty Reduction Strategy (GPRS) and

the Coordinated Programme of Economic and Social Development (CPESD) on the country's long-term energy demand.

Policy Framework for Ghana's Energy Sector (*Ministry of Energy, 2001*)

A policy framework document outlining the vision of the Ministry of Energy and its main objectives for the energy sector.

ENERGY & GHANA'S SOCIO-ECONOMIC DEVELOPMENT: Issues, Strategies and Programmes in the Energy Sector under the Economic Recovery Programme (*National Energy Board/Ministry of Fuel and Power, 1989, revised July, 1990*) A policy document outlining the vision of the National Energy Board and the Ministry of Fuel and Power.

An Energy Roadmap for Ghana: from Crisis to the fuel for 'Economic Freedom (*USAID, August, 1998*) A report by a United States Government Interagency Team in response to a request from His Excellency the Vice President John Atta Mills, On behalf of the Government of Ghana. The team was in the country in 1998 during the power crisis that year.

2000 Population & Housing Census, March 2002

Special reports on Ghana's 2000 population census by the Ghana Statistical Services.

VRA Generation and Transmission System Master Plan

(*Final Report -three volumes, July 2001*)

A document prepared by the Acres International for the Volta River Authority (VRA), the power generation utility of Ghana. It provides power generation projections and capacity expansion largely based on thermal options from 2000 – 2020. Transmission expansion plans for VRA are also discussed. VRA owns and operate the national transmission network in addition, even though the latter is to be hived off into an independent transmission utility company under Ghana's Power Sector Reform.

The State of the Ghanaian Economy, 2000, 2001, 2002, 2003, 2004, 2005

A yearly publication by the Institute of Statistical, Social and Economic Research (ISSER) of the University of Ghana. Each year's edition is a commentary and or analysis of the performance of the economy during the previous year.

Sustainable Energy Scenarios for Ghana's Long -Term Development Plan (Vision 2020) (*Essandoh-Yeddu, Joseph and Johansson, Daniel, Chalmers University of Technology / Gothenburg University, Sweden, Department of Physical Resource Theory, 2001*)

A Master of Science thesis that looks at sustainable energy pathways for Ghana's long term development.

The Economist Pocket World in Figures (Edition 2001, 2002, 2003, 2005)

An annual pocket editions published by The Profile Books Ltd of UK in association with The Economist. The annual booklet provides rankings on more than 200 topics and detailed statistical profiles of the world's major economies.

Tools and Methods for Integrated Resource Planning

(UNEP Collaborating Centre on Energy and Environment, RISØ National Laboratory⁸⁷, Denmark, 1997)

A teaching material on energy efficiency, end-use analysis, demand-side management and integrated resource planning (IRP).

LEAP

LEAP (Long range Energy Alternative Planning) is an integrated software developed by the Stockholm Environment Institute for energy and environment planning. It is an accounting modelling tool that can be used for energy projections as well as creating energy balances of production and usage for a given economy or region. It has a Microsoft DOS version (LEAP95) and a WINDOWS version (LEAP2000). For more information visit <http://forums.seib.org/leap>.

RETscreen ® International (*Natural Resources Canada*)

RETSCREEN is a trademark for RETScreen International and is a renewable energy awareness, decision-support and capacity building tool developed by the CANMET Energy Diversification Research Laboratory (CEDRL) of Natural Resource – Canada with major support from UNEP and the World Bank. The core of the tool consists of a standardised and integrated renewable energy project analysis software that can be used world-wide to evaluate the energy production, life-cycle costs and greenhouse gas emission reductions for various types of renewable energy technologies. Renewable energy technology (RET) projects are not routinely considered by planners and decision-makers at the critically important initial planning stage. The RETScreen® Renewable Energy Project Analysis Software has been developed to help address this barrier. For more information visit www.etscreen.net/ang.

MESSAGE (*IAEA, Austria*)

MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact) is a model designed for the optimisation of energy system. The model was originally developed at International Institute for Applied Systems Analysis (IIASA) but the latest version of the model has been acquired by the International Atomic Energy Agency (IAEA). For more information contact the IAEA, P.O. Box 100, Wagramer Strasse 5, A-1400 Vienna, Austria. Email Official.Mail@iaea.org.

Links to Energy Sector Regulatory Bodies in Ghana

Public Utilities Services Commission, www.purc.com.gh

Energy Commission, www.energycom.gov.gh.

National Petroleum Authority www.npa.gov.gh.

⁸⁷ Now called UNEP Risoe

SEPARATE DOCUMENTS TO THIS MAIN TEXT

Annex I of IV: SNEP Energy Demand Sectors of the Economy

Annex II of IV: SNEP Electricity

Annex III of IV SNEP Petroleum

Annex IV of IV: SNEP Woodfuels & Renewables