Strategic National Energy Plan

2006 - 2020

Annex III of IV

PETROLEUM

Energy Commission, Ghana
July, 2006

Strategic National Energy Plan 2006 – 2020

Annex Three of Four

ENERGY SUPPLY TO THE ECONOMY

Petroleum

Energy Commission
July, 2006

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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 For sectors where data were not available or outdated, consultants were engaged to collect the data to update and as well fill the missing gaps.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.

* 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.

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 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 expects 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 Traditional 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.

Executive Secretary

Danish International Development Agency

Background

Institutional set-up

1. The public institutions involved in the petroleum subsector direct operations are as follow:

Institution	Function
Ministry of Energy	Formulation of policies.
Energy Commission	Energy planning and policy advisory role
Ghana National Petroleum Corporation	Oil and gas exploration, production and regulation
Tema Oil Refinery (TOR)	Importation of crude oil, petroleum products, refining of crude oil and bulk sale of petroleum products.
National Petroleum Authority (NPA)	Market regulations, licensing of oil marketing companies, procurement of oil for the nation.
Bulk Oil Storage and Transportation Company (BOST)	Planning and management of strategic stocks of petroleum products.
Oil Marketing Companies (OMCs)	Distribution and Marketing of petroleum products.

The Petroleum subsector comprises the upstream and the downstream.

Upstream

2. The upstream activities cover mainly petroleum exploration and related operations. The responsibilities are in the hands of GNPC.

3. Although, exploration activities indicate that 75 percent of all wells drilled have encountered hydrocarbons, Ghana does not currently, produce oil in significant commercial quantities. Exploration activities started in 1896 and had resulted in drilling of about 66 wells, but no commercially sustainable deposit of oil and or natural gas has been found [1].

4. The only commercial extraction is at Saltpond in the Central Region yielding between 350 to 1000 barrels of crude oil a day compared to 40,000 – 60,000 barrels a day requirement

[1] Information sources: GNPC, Ministry of Energy, 2003.

of the country[2]. Production from June 2002 when it reopened to end of 2004 totalled 294,430 barrels.

5. Gas flared at the Saltpond fields since 2002 averaged 2 million cubic feet per day. Total gas flared from 2002 to 2004 is about 1000 million cubic feet.

6. Focus on deepwater exploration has been increasing due to wells drilled in the deepwater areas of Ghana between 1999 and 2000, and the deepwater discoveries in the sub-region. Data gathered from these wells confirm the presence of source rocks, petroleum generation and migration in the deepwater areas of Ghana.

Downstream

7. Downstream activities consist of refinery, storage, transportation, distribution and retailing operations.

Refinery

8. The Tema Oil Refinery (TOR) refines all the crude oil imported into the country, except for consignments going to the Takoradi Thermal Power Plant for power production.

9. TOR's maximum production capacity was 28,000 barrels of oil per day in 1990. By 2000, i.e. a decade later, the production capacity had been expanded to 45,000 barrels per day to meet increasing demand.

Storage and strategic Stock

10. Besides storage facilities at TOR, in-country product storage depots are at Accra Plains, Mamiwater (near Akosombo, Eastern Region), Buipe (Northern Region) and at Takoradi (Western Region).

11. Limited storage facilities in-country however means petroleum products are still distant away from larger sections of the populace, particularly, rural consumers and would require a very efficient transportation and distribution network.

12. As a result of the total dependence on imported oil, the country maintains strategic stocks of petroleum products to minimize disruptions in economic activities in the event of external supply problems. Strategic stock storage capacities as at 2000 were 6,420 tonnes for gasoline, 8,470 tonnes for gas oil and 4,580 tonnes for kerosene.

[2] For transport and others (40,000 – 45,000 barrels per day) and electricity generation (up to 15,000 barrels per day).

13. BOST manages the strategic stocks and is expected to initially keep a strategic stock of three weeks of national demand for petroleum products. This would finally be increased to six weeks. Storage capacity is at present not sufficient to cover six weeks of strategic stocks as envisaged by the sector.

14. Cost of maintaining the strategic stocks was accounted for as a levy in the 2003 petroleum price build-up but not anymore as of 2006. BOST other operational activities are financed through a BOST Margin in the existing petroleum price build-up.

15. Crude oil strategic stock is non-existent in the country.

Transportation

16. Unloading crude oil from the ocean tankers docking at the Tema seaport to Tema Oil Refinery is through pipelines; it is pumped from the seaport straight to the refinery.

17. Taking cognisance of growing shipment in merchandise cargo at the Tema seaport, a Single Buoy Mooring (SBM) System to service the oil tankers has been constructed at the seaport to address any potential problem of congestion by vessels at the harbour.

18. Primary transportation of petroleum products from the oil refinery for storage in depots is by four main modes:
    i. Pipeline transport from Tema to Mami Water depot and Akosombo transit depot;
    ii. ocean transfer using small marine vessels from Tema to Takoradi;
    iii. fuel barges on the Volta lake from Akosombo to Buipe by VLTC vessels; and
    iv. Bulk Road Vehicles (BRVs) operated by the OMCs and private owners.

19. Transportation of fuel on the Volta Lake from Akosombo (south) to Buipe (northern Ghana) is however hampered by reduced water levels in the months of December up to the following June which expose rock hazards and limit access to ferry landing ramps. Rock shoals situated about 35 km downstream of Buipe Port render waterway inaccessible by VLTC vessels when the lake level falls below 75 metres (about 245 ft). Thus the exposed shoals interrupt fuel supply to the north, routed along the lake.

20. To improve and ensure uninterrupted distribution of petroleum products up-north particularly during periods that vessels on the lake are obstructed by the shoals, storage facilities are to be expanded and a 275-kilometre petroleum products pipeline from Buipe to Bolgatanga has been constructed.

21. In order to cut down the cost of primary distribution, the Bulk Road Vehicles (BRVs) have been limited to haulage of petroleum products to depots. Furthermore, the Government intends to rehabilitate the railway line from Tema to Kumasi to facilitate the use of Rail Tank Wagons, which is expected to be cheaper than the BRVs to transport petroleum products to Kumasi.

Distribution and retailing

22. Secondary distribution of petroleum products is done by the oil marketing companies (OMCs) and private operators using mainly Bulk Road Vehicles. They obtain their supplies from TOR's bulk storage depots.

23. The cost of the secondary distribution is accounted for in the price build-up of petroleum products as the distributor's margin.

24. ATK for the aviation transport is conveyed by road from TOR to the Accra international airport depot using specially designated tankers, owing to the strict aviation standard requirements. The aviation subsector regulator plans constructing an 6-8 inch pipeline from Tema to the Accra airport; a distance of about 25 km to replace or complement the road transportation. Lack of funding is holding back the project.

Pricing Policy

25. Until 2001, the Government used to regulate the prices of petroleum products. The policy of price regulation by the Government has had some negative effects on the operations of the Tema Oil Refinery (TOR). The Government failure to adjust prices in 2000 when world market price of oil shot above US$30 per barrel from an average price below US$20 per barrel led to debt accumulation by TOR. In 2001 therefore, an automatic price adjustment formula was put in place to enhance transparency in the pricing of petroleum products. The three main objectives given for the pricing formula were to:

    i Gear prices to levels based on the principle of full cost recovery of all investments made to procure, transport and market the fuel;
    ii use the price to generate revenue for the Government; and
    iii ensure that the ex-pump prices are the same throughout the country.

26. The Pricing Policy comprises levies, taxes and margins. Parliamentary approval is required for the levies and the taxes.

27. The downstream subsector is being de-regulated at present, but is still some degree of price regulation particularly on kerosene and LPG through cross-subsidization. At present, The NPA sets the margins and the OMCs announce their preferred rates within a maximum indicative pump prices to the public market.

Petroleum fuels supplied since 2000

28. Crude oil import was about 1.1 million tonnes in 2000, but rose to 1.8 million tonnes in 2004 after a dip in 2002 (table 1).

Table 1. Product Slate at Tema Oil Refinery

		2000	2001	2002	2003	2004
Crude oil imports	Tonnes	**1,131,834**	**1,262,872**	**1,179,364**	**1,406,205**	**1,813,464**
Crude oil intake at TOR[3]		**1,094,860**	**1,137,278**	**1,269,568**	**1,485,106**	**1,757,936**
Refinery production	**Tonnes**	**1,028,409**	**1,069,876**	**1,156,414**	**1,351,757**	**1,604,031**
Percentage shares of products	*LPG*	*0.9*	*0.6*	*2.1*	*3.9*	*4.0*
	Gasoline	*23.2*	*26.8*	*29.9*	*3 2.1*	*34.7*
	ATK	*10.5*	*6.0*	*7.1*	*6.3*	*6.7*
	Diesel	*34.8*	*33.0*	*38.6*	*37.5*	*35.4*
	RFO	*25.5*	*24.4*	*16.9*	*12.1*	*12.4*

Source: Tema Oil Refinery, 2005.

29. Diesel, gasoline and RFO constituted the largest share of fuels produced at the refinery. The large percentage shares of the fuel oil in 2000 and 2001 were due to the fact that the refinery was a simple crude distillation plant (CDU) and thus could not process the Residual fuel oil (RFO) into value-added products. The scenario changed from 2002 when Residual Fuel Catalytic Cracker (RFCC) was commissioned. The diesel, gasoline and the LPG yields improved whilst the RFO yield dropped.

30. Net refined product import to supplement demand dropped from over 800,000 tonnes in 2000 to about 580,000 by 2004, mainly due to improvement in product yield as a result of the operation of the RFCC (table 2).

Table 2. Petroleum Product Import and export: 2000-2004

		2000	2001	2002	2003	2004
Oil product imports	Tonnes	**816,344**	**800,938**	**749,692**	**569,049**	**579,476**
Percentage shares of products	*LPG*	*4.3*	*4.4*	*4.3*	*2.9*	*1.9*
	Premium gasoline	*47.4*	*48.6*	*49.5*	*40.8*	*44.1*
	Kerosene (DPK)	*3.7*	*2.7*	*6.5*	*6.1*	*0*
	Diesel	*44.5*	*44.2*	*39.8*	*50.2*	*54.0*
	RFO	*0*	*0*	*0*	*0*	*0*
Oil product exports	Tonnes	**294,646**	**344,499**	**287,287**	**217,352**	**368,065**
Percentage shares	*LPG*	*2.1*	*0.3*	*1.6*	*5.1*	*1.6*
	Diesel	*0.2*	*0.3*	*0.7*	*5.5*	*11.5*
	RFO	*64.7*	*62.6*	*52.8*	*41.1*	*45.9*
	Heavy gasoline	*32.9*	*36.8*	*45.0*	*47.4*	*39.8*
	Premium gasoline	*0*	*0*	*0*	*0.5*	*1.2*

Source: Tema Oil Refinery, 2005.

[3] TOR is Tema Oil Refinery.

31. Although, Ghana does not produce oil, it exports some petroleum products largely Residual Fuel Oil (RFO) and heavy gasoline (naphtha) which have little use in Ghana. Whilst the export share of RFO decreased over the years, the heavy gasoline share increased due to the inability of the refinery to process it efficiently into lighter products of higher market value on the Ghanaian market.

32. Total petroleum fuels supplied for the country's usage were as follows:

Petroleum products	**2000**	**2001**	**2002**	**2003**	**2004**
			Tonnes		
LPG	39,478	42,667	51,119	58,076	67,576
Unified Gasoline[4]	49	0	18	91	0
Heavy Gasoline (naphtha)	885	1,062	1,669	1,440	1,902
Gasoline premium	526,027	521,270	567,493	524,917	584,366
Gasoline premix	30,856	27,383	27,366	29,737	28,665
Kerosene	65,003	69,244	75,346	70,458	72,711
ATK	96,344	76,578	90,371	89,233	107,233
Diesel	735,666	720,999	777,076	815,074	897,134
Residual fuel Oil	57,297	52,079	51,320	47,548	47,653
Total	**1,551,000**	**1,511,282**	**1,641,778**	**1,636,574**	**1,807,240**

Investments

33. The major public investments in the petroleum subsector since 2000 amounted to about US $315 million. It is made up of the following[5];
    - The RFCC which cost about US $185 million;
    - The Buipe-Bolgatanga product pipeline costing US$ 40 million
    - The Single Buoy Mooring (SBM) project at the Tema port costing about US$ 30 million.
    - Expansion of the national strategic storage involving construction of more storage tanks, costing about US$ 60 million[6].

34. The SBM project is a Build-Operate-Transfer project undertaken by the private sector. It will later be transferred to the government or public sector, when the investor has recouped its investment.

[4] Unified gasoline is a treated heavy gasoline (naphtha). It is fed into the petroleum reformer unit to combine with light gasoline (naphtha) to produce premium gasoline.

[5] Sources of cost information were from Tema Oil Refinery and BOST

[6] Project is on going.

Projections up to 2020

35. Demand for diesel, gasoline kerosene and LPG however, have already exceeded the Business-as-usual economic growth scenario. Diesel and gasoline demand growth rates of 10 – 13 percent per annum and 6 – 9 percent per annum respectively are closer to the projections for the GPRS high economic growth rates. LPG growth (over 15 percent per annum) and kerosene growth (over 9 percent per annum) have also exceeded the high economic growth scenario. The projection of future demand has therefore been based on the high economic growth scenario of the GPRS

36. Therefore, the petroleum products required to service the economy are projected as follows[7] :

	2008	2012	2015	2020
GPRS High economic growth scenario in thousand tonnes				
LPG (*no constraints*)	200–225	231–259	324-352	418-445
LPG (*with constraints*)	100-110	115-130	162-176	210-223
Kerosene & jet fuel	218–225	255-265	305-330	356-420
Gasoline premium	705–719	814-830	970-1,000	1,120-1,300
Gasoline premix	105–107	111–113	117-130	124-150
Diesel	1,100–1,300	1,500-1,600	1,800-2,000	2,300-2,500
RFO (*without NG*)	197–198	214–217	236-237	255–260
RFO (*with NG*)	66-70	71-75	78-90	95-115

37. For the moderately high economic growth scenario, the petroleum supply projections are as follows:

	2008	2012	2015	2020
Moderately High economic growth scenario in thousand tonnes				
LPG (*no constraints*)	121–134	162–176	223-237	298-300
LPG (*with constraints*)	91-100	121-132	167-178	223-275
Kerosene & jet fuel	215–219	237-242	283-300	330-350
Gasoline premium	704– 711	822-825	964-970	1,115-1,200
Gasoline premix	68–70	73–75	76-80	81-85
Diesel	1,030–1,128	1,420-1,470	1,720-1,800	2,030-2,100
RFO (*without NG*)	124–125	34 – 136	146-147	156–159
RFO (*with NG*)	41-42	44-45	48-50	52-53

38. Residential demand for LPG will be the key driver for LPG. If existing distribution channels are not improved, then supply is going to be retarded leading to an increased reliance on charcoal as cooking fuel.

[7] Fuel oil (without NG): Demand for fuel oil if potential industries do not switch to natural gas. Fuel oil (with NG): Demand for fuel oil if most industrial heating switches to natural gas. It is assumed that significant switches are likely at the coast. It has assumed that most in-country based large-scale industries will still depend on fuel oil except the natural gas network is extended inland.
LPG (no constraints): if little or no supply constraints exist. LPG (with constraints): if existing supply constraints largely remain.

Challenges in the Petroleum Sub-Sector

39. The Petroleum sub-sector envisages developing export capacity and as well providing refinery services to needy countries particularly, within the West African sub-region. Ghana hopes to take advantage of the limited refining capabilities in Nigeria and other countries within the sub-region by expanding its total refining capacity.

40. Annual diesel, gasoline and kerosene demand growth have been about two to three times the annual real GDP growth, whilst that of LPG has quadrupled. The implications are that gasoline and diesel demand have exceeded the country's refinery capacity, increasing the risk of supply interruptions.

41. Injection of capital is needed to expand the country's total refinery capacity. The difficulties in attracting private capital into the petroleum sub-sector and the immediate past financial experiences with the Tema Oil Refinery (TOR) have compelled the Government to deregulate the downstream market. As part of the deregulation, the Government established the National Petroleum Authority by act of parliament (Act 691, 2005) to oversee the necessary market deregulation for orderly operations.

Global crude oil supply outlook

42. Global crude oil production was about 80 million barrels per day in 2004 but consumption has exceeded 81 million barrels per day by end of 2004 and it is expected to reach 83 million barrels a day by end of 2006. Most forecasts indicates that production vis-à-vis consumption will continue to be tight until 2012 when production will outstrip consumption significantly due new capacities being added[8].

43. Non-OPEC countries produce around 60 percent of the world's crude oil, but have only about 23 percent of proven reserves. Their current output is at 100 percent production capacity and their proven reserves is said to be declining.

44. OPEC countries by comparison, produce a little less than 40 percent of the world's crude oil supplies, but have close to 80 percent of the world's proven reserves. They are however running at 96 percent production capacity on the average. OPEC's production was around 30 million barrels a day by mid 2004, almost about its full production capacity of about 32 million barrels a day, whilst world price was over US $45 per barrel.

45. OPEC countries however know that by keeping supplies tight, the price will inevitably rise, given the prevailing strong demand in Asia; China and India in particular.

46. Thus, even though, their ability to increase production, at least in the short term, is limited, long-term supplies is going to be dependable on OPEC reserves and production. Even though,

[8] BP Global Reports and Publications, 2006.

OPEC proposed to increase its price band from US $22 – 28 per barrel before 1999 to US $38 – $40 per barrel, average light crude oil price had been beyond $40 per barrel since 2000 against the backdrop of World Bank's long-term projection of $20 per barrel made in year 2000. Indications are that the supply situation is not going to improve significantly to bring the world crude oil price down to its pre-1999 levels, in the short to medium term.

47. The key issues facing the petroleum sub-sector may be summarised as follows:

i. **Attracting foreign investment for intensified offshore exploration.**
ii. **Ensuring reliable and stable supply of crude oil and petroleum products in the midst of short-to-medium term high cost of crude oil supply.**
iii. **Ensuring availability of foreign exchange for the procurement and importation of crude oil and petroleum products.**
iv. **Improving operational efficiencies of the petroleum subsector.**
v. **Sustaining adequate availability of petroleum products countrywide.**
vi. **Managing and sustaining the strategic stock capacity of the country to buffer supply shortfalls.**
vii. **Positioning Ghana as a petroleum product exporting country.**
viii. **Improving supply security by diversifying the supply base by integrating liquid biofuels into the petroleum mix.**

Options for meeting the nation's petroleum requirements

48. The alternative approaches 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

49. 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.

Catalytic Reformer

50. 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).

51. 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

52. 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 PURC[9].

53. 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

54. 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

55. 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:

	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	1.76million
RFO	124,100	140,300	161,000	182,300
Total import cost[10]	*US$303 million*	*US$611 million*	*US$900million*	*US$1,187 million*

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

[9] Public Utility Services Commission, a sister regulatory institution of the Energy Commission responsible for electricity and water tariff regulation.

[10] Assumed crude oil price at US$70 per barrel for 2008; US$65 per barrel for 2012; US$55 per barrel for 202.

Expand of refinery capacity

57. 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.

58. 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.

59. 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.

60. 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.

61. 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

62. 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.

    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

63. 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.

64. 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.

65. 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.

66. 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

67. 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.

68. 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.

69. 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.

70. Even though, it is a matter of cost, the flexibility of an isomerisation unit[11] 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.

71. 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.

72. 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.

73. 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.

[11] Isomeriser 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.

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

74. Suggested refinery configuration for 2008, 2015 and 2020 are as follows[12]:

Fuel refining slate flexibility

75. 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.

76. 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 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 grows[13].

77. 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.

78. 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

[12] BPD – Barrels per stream day

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

to invest in vacuum distillation units (VDU) and cokers, a situation which is also helping to raise refining margins.

79. 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 2015[14]. Therefore, refineries capable of processing heavy and sour crude oils will enjoy high margins.

80. 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 distillation[15] 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.

81. 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.

Strategic Response at TOR[16]

82. 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

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

[15] 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.

[16] 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 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. [0]

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 RFCC[17].

83. 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.

84. 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

85. 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 2020[18].

A supply mix of petroleum and liquid biofuels approach

86. The main objectives are:
    - To produce alcohol for commercial blending of gasohol to complement gasoline use in vehicles.
    - To produce plant oil (most likely jathropha 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.

Clean Air Quality

87. Ghana is a party to the African Clean Air Agenda[19] which sets out conditions for realising better air quality to protect the heath 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

[17] 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% stabilized LCO is achieved.
[18] Source: Tema Oil Refinery Corporate Plan 2006 – 2009.

[19] Clean Air Agenda set out by the African Refiners Association

effects on infants and therefore has the potential to attract protests from environmentalists.

88. Ethanol in gasoline eliminates the need for the poisonous and controversial enhancers such as MMT and MTBE[20]. Both MMT and MTBE are being faced out in the developed world where they are being replaced with ethanol.

89. 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 advance 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-5[21] .

90. 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 AFR1-5 (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.

91. 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.

92. 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 supplements its diesel requirements, a lesson that Ghana Railways Company could adopt.

93. 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.

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

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

94. 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.

95. 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. .

96. 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.

97. 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.

98. Furthermore, the residues after large-scale commercial starch production such as in the Government's PSI[22] 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

99. 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

[22] 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.

100. 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 Natural Gas complementation in the petroleum supply mix

101. 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

102. 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 $4.26 – 5.84 per mmBTU[23] yielding between US$ 100 – 114 per tonne on the low-side and US $ 140 – 150 per tonne on the high-side.

103. 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.

104. VALCO[24] 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.

[23] Million British Thermal Unit

[24] VALCO is an aluminium smelting facility

105. 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 20mmcfd 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 (mmcfd) for Tema and up to 10 mmcfd 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.

Natural gas as vehicular fuel

106. 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.

107. It is estimated that carbon monoxide emissions are reduced by 97%, NOx 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.

108. 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.

109. 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.

110. 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 included[25]. 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.

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

111. 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 2020[26].

Favourable Petroleum Exploration & Production Law

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

113. 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.

114. 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.

115. 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 regime[27] would enable Ghana to attract investments from companies with the requisite financial and technological capabilities.

The Export Market in West Africa

116. 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.

117. Nigeria for instance, has four refineries[28] 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

[26] 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.
The following elements make up the fiscal regime; Royalty, GNPC Initial interest, Petroleum income tax, GNPC Additional interest, Additional Oil Entitlements (AOE).

[27] The following elements make up the fiscal regime; Royalty, GNPC Initial interest, Petroleum income

[28] As of 2004

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.

118. Targeting the Nigerian market for product export could be a bit tricky since it is not obvious.

119. Equatorial Guinea, which has approached Ghana for refining services[29], consumes only about 2,000 BPD of products. This seemingly, is not enough to attract significant capital investment.

120. On the other hand, total consumption in non-refinery countries[30] 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.

121. Political instability in la Cote d'Ivoire is likely to retard the smooth functioning of its refinery.

122. Sierra Leone has just emerged from civil war, meaning it will take some time for their markets to peak.

123. Ghana could quickly use its comparatively 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.

124. 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.

Estimated cost of future supply

125. Minimum investment in the petroleum subsector is estimated to cost US$548 – 665 million. Minimum cost range could escalate to about US$1,000 million depending upon the sophistication of the intended refineries to be built. The breakdown is as follows:

[29] Ministry of Energy, 2003.
[30] Benin, Burkina Faso, The Gambia, Guinea Bissau, Equatorial Guinea, Liberia, Niger, Mali, Mauritania, Togo

SUBSECTOR	ACTIVITY	2006-2008[31]	2009-2012	2013-2020
		US $ Million		
Petroleum	Revamping/ rehabilitation of storage, secondary and utility units of TOR	70 - 75		
	ATK pipeline (Tema to Accra airport)	4 - 6		
	Natural gas transmission and distribution pipelines		10	
	strategic stocks storage tanks ,	5 - 10	35	
	New Refinery (s) (100,000 BPD)	60	70 – 105	60
	New Refinery (100,000 BPD[32])	90 - 135		120-175
	Seed money to kick-start the National Biodiesel and Alcohol Programmes	*500*	2	
	CNG Demonstration	10	5	
		3		4
	Total	**242 –299**	**122 – 157**	**184-239**
		652 - 664		
	Grand Total			**548 – 665 (*958-1,060*)**

126. Implementation plan and road map for the SNEP recommended option and biofuel complementation are in Appendices 1 and 2.

Policy Recommendations

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.

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

[32] Cost of the refinery when built at a go.

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

1. 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.

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

2. 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 corporation of Ghana.

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)[33]is too high to attract serious investment in the context that Ghana is yet to discover significant commercial hydrocarbon fields.

Policy

3. 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.

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.
f) 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

[33] MPA, Article 10.2 dated 17th August, 2000 applies 12.5% royalty rate.

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)[34] 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

4. 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 the Environmental Impact Assessment

The provisions governing the decommissioning exercise in the existing Petroleum law[35] 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.*'

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.

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

[35] Petroleum Exploration and Production Law, Section 28.

Policy

5. 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.

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 manganese[36] 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

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.

[36] MMT in gasoline

Policy

6. 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.

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 create adequate incentives to attract investment in refinery capacity to target the export market.
c) The Ministry of Energy and the Board of the National Petroleum Authority (NPA) relook at the NPA Act 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 chain[37].

Policy

7. It is recommended that

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

Implementation measures

a) Energy Foundation continues to create public awareness in efficient use of energy.

[37] 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.

b) National Petroleum Authority 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

8. It is recommended that

i. Government opens up Tema Oil Refinery for privatisation.

ii. TOR pursues 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. Government through the NPA encourages the expansion of product slate in all refineries.

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%[38] 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.

[38] Standard for efficient refineries found in some developing countries

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

9. 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.

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

10. 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.

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.
- 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 3,000m^3 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

11. It is recommended that

i. 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.

ii. National Petroleum Authority encourages the OMCs to set up more LPG distribution centres to increase access and consumption.

iii. Government supports the local LPG cylinder manufacturers to expand their production capacities to meet the corresponding demand.

Implementation measures

a) National Petroleum Authority (NPA) speeds up the development of regulations for the operation of LPG filling stations.
b) Government, NPA and Industry assist technical institutions in training in LPG handling and technology.
c) Encourage OMCs and the private sector to set up LPG training facilities for would-be LPG service operators.
d) NPA and OMC certify trained LPG operators.
e) 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 activities[39]. 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. They 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.

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

Policy

12. It is recommended that

i. Government and NPA make it mandatory for OMCs to have dedicated tankers for premix gasoline.

ii. Government and NPA enact a legislation to compel all gasoline-premix carrying tankers to be labelled PREMIX GASOLINE.

iii. 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 price[40]. 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 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 m^3 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

13. 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.

[40] Impression is created on the local market 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.

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.*

iv. *Government and NPA make it mandatory for TOR to introduce a colour dye in either kerosene or diesel to expose adulterated products at the pump.*

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 smuggling[41].

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

14. 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.*

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

15. 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.

[41] 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.*

iv. Government supports accelerated development of indigenous natural gas fields.

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 (renewable) fuels so as to achieve 10 percent penetration in supply mix by 2015 and 20 percent by 2020.

Policy

16. 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.

Implementation measures

a) The Ministry of Energy in conjunction with the Ministry of Agriculture will evolve land use policy to identify suitable lands for biofuel cultivation.
b) The Energy Commission in conjunction with the National Petroleum Authority and the Energy Foundation to promote natural gas as transport fuel substitute for diesel in coastal cities. Pilot programmes could start in Accra, Tema and Takoradi by 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 OECD[42] 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

[42] OECD is Organisation for Economic Cooperation and Development.

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 challenge, TOR has constructed a 40,000 m_3 (251,572 barrels) capacity atmospheric residual (AR) tank so as to facilitate full capacity running of the RFCC[43].

Policy

17. 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.

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.

[43] 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.

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

18. 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.

Implementation measure

Takoradi Thermal Power Station (TTPS) leases part of its oil storage tanks to BOST when it starts firing on natural gas.

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

19. It is recommended that

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

Implementation measure

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

20. 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.

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.

APPENDICES

Appendix 1: Recommended Petroleum Subsector 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 – 6
	(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 *(takes 2 – 4 years to build a refinery*)	• 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 • 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 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 • 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, • 70,000 BPD (CDU) • . 12,000 BPD reformer or isomerisation unit • 22000 BPD cracker • May install 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: Recommended Road Map For Introducing Biofuels

In 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[44] 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 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.		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	Blending centres for the northern sector	Joint action by the Ministry, Energy Commission, NPA, BOST and the OMCs. An example of Public-private partnership (PPP) activities.
2013 - 2020	Install gasohol blending plants in Komenda and Asutuare Introduce gasohols up to E85.	Blending centres for the remaining regional cities	
	Make B5, B10 and E10 mandatory for dispensation at all service stations. Up to E85 voluntary through out the country.	Commercial use of gasohol and biodiesel is sustained.	

[44] The Ministry here refers to the Ministry of Energy

Appendix 3: List of Participants

LIST OF INSTITUTIONS REPRESENTED AT THE STAKEHOLDER MEETINGS[45]			
	SNEP AREA PARTICIPATED		
	Electricity	**Petroleum**	**Renewables**
Ministries and Governmental Committees			
1. Ministry of Energy	•	•	•
2. Ministry of Finance & Economic Planning	0	•	•
3. Ministry of Environment and Science	•	•	•
4. Parliamentary Select Cmmttee. 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 of the Energy Commission	•	•	•
2. Public Utility Regulatory Commission (PURC)	•	0	0
3. National Petroleum Authority	Not invited	•	•
4. Environmental Protection Agency	•	•	•
5. Bank of Ghana	0	•	•
6. National Development Planning Commission	•	•	0
7. Ghana Atomic Energy Commission	•	Not invited	Not invited
8. Ghana National Petroleum Corporation	0	•	0
9. Bulk Oil Storage & Transport Company	0	•	0
10. Ghana Statistical Services	0	•	0
11. Electricity Company of Ghana	•	0	0
12. Volta River Authority	•	0	0
13. Tema Oil Refinery	•	•	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	•	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
•	***Attended***		
0	***Absent***		

[45] 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 &	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	•	•	•
7. Ghana Broadcasting Corporation Radio	•	•	•
8. JOY FM	•	•	•
9. CITI FM	•	•	•
10. TOP Radio	•	•	•

• ***Attended***
0 ***Absent***

Note Names of experts attending in their individual capacities are not included here but available at the Energy Commission

Bibliography

EnergySecctor 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 AppliancesAn 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 Attah 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 Laboratory[46], 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.retscreen.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 (*website not available yet*)…….

[46] Now called UNEP Risoe