

I: Background

In early June through December 2002, the Centre for Policy Analysis (CEPA) together with the Energy Commission undertook a nation-wide representative energy intensity survey to gather baseline information from key firms and organizations engaged in both the Industrial – including mining, manufacturing and construction – and the Services sectors of the Ghanaian economy. The purpose of the survey was not only to provide some insights about energy consumption, the technologies and production process (boilers, plant capacity, etc) in use in these sectors, but more importantly to gather energy-related information from these firms and institutions that could best serve as the opening point for projecting likely energy consumption paths in non-residential production-related sectors of the national economy for the next twenty years, 2001-2020.

Projections of the likely energy demand paths in each sector of the economy is one of the critical elements required to initiate the Energy Commission's planning activities in developing a Strategic National Energy Plan (SNEP) for Ghana. The overarching objective of the SNEP is to contribute to the development of a sound and well-regulated energy market that provides sufficient, viable, efficient, and least-cost energy services to the satisfaction of the population in its economic activities of consumption and production.

The outcomes of CEPA's tasks regarding the SNEP for Ghana are to be documented in two reports:

- a main report spelling out the macroeconomic aspects of the energy sector; forecasting methodology; general economic and structural changes; and sectoral developments regarding energy consumption; and
- a report on the energy intensity survey with baseline data for the national economy.

The research team from CEPA completed analytical work and a draft report of findings from the energy intensity survey within the six-month period, January-June 2003. The teams' task regarding the projections for the main report is ongoing and expected to be finalized by end-September 2003.

This paper summarizes the findings from the energy intensity survey, highlighting also the sampling design and sampling methods used. It also draws attention to a number of shortcomings – quite inevitable in a nationwide representative sample survey as big as this one – with the view to guiding succeeding generations of researchers avoid incurring huge unforeseen costs as a result of improper planning.

Financial support for the survey came from the Danish International Development Assistance (DANIDA) in support of the Strategic National Energy Plan (SNEP) for Ghana, and also from the African Capacity Building Foundation (ACBF, Harare).

II: Survey Methodology

The process of building a baseline database that reflects an accurate picture of actual energy demand patterns of different end-users in production is a very challenging task that can only be undertaken successfully with the help of a good sampling design, i.e., one that is not only representative of the population from which it is drawn, but it is moreover, also cost effective in terms of the size of the sample chosen.

In the Ghanaian context, a credible and full-bodied baseline database upon which to anchor a scientifically representative establishment survey does not currently exist in the truest sense. While stakeholders¹ have compiled a number of individual directories of establishments, these have all too often proven to be narrowly focused, several years outdated and irrelevant, and rarely contain any credible data on output and capital employed by enterprises.

II.1: Sampling Design

In line with the energy demand study, CEPA had devoted some time and energy at supplementing directories of the energy generating and distributing firms in Ghana with requisite statistical information put together in not-so-outdated statistical frames by other stakeholders. This task has been made all the more intricate, however, on account of

¹ These include the Ghana National Chamber of Commerce, Association of Ghanaian Industries, Ghana Chamber of Mines, Ghana Statistical Service, Social Security and National Insurance Trust, Electricity Company of Ghana, Volta River Authority and oil marketing companies (OMCs).

inaccessibility to the register of the electricity distributing agency responsible for the northern segment – the Northern Electricity Department (NED) of the VRA. Consequently, the sampling frame as constructed does not cover the Brong Ahafo, Northern, Upper West and Upper East regions.

The statistical sampling frame from which the sample is drawn was constructed from clientele registers of the hydroelectric power generating authority, the VRA, and the power distribution company responsible for the southern segment, the ECG. The constructed sampling frame thus consists of:

- high-voltage electricity-consuming firms directly supplied electrical power by the VRA; and
- the entire non-residential customers of the ECG.

High-voltage electricity-consuming firms supplied directly by the VRA include:

- the privately owned American aluminum smelter – the Volta Aluminium Company (VALCO);
- mining companies principally engaged in surface and subterranean gold mining exploration and production – Ashanti Goldfields Company (AGC), Goldfields Ghana Limited, Billiton Bogosu Gold Limited, Prestea Gold Resources Limited, Obenemase Gold Mining Company Limited (Konongo), and S.G.M.C. (Prestea and Dunkwa); and
- light manufacturing firms – Akosombo Textiles Company Limited and Aluworks Limited.

A summary of the quantum of electricity consumption by these and other industrial firms in the constructed sampling frame used for the survey is presented in Table II.1 below. Overall electricity consumption of these high-voltage electricity-consuming firms amounted to 3,168.6 gigawatts hour in 2000 – an increase of 19.3 percent over the 2,656.4 gigawatts hour consumed in 1999. These levels of electricity consumption represented 42.6 percent and 41.0 percent shares of the total sales to the domestic economy in 2000 and 1999 respectively (see details in Table II.1).

Table II.1: Sampling Frame - Electricity Consumption of Firms in Production

	Electricity Consumption (kWh)			Number of Firms in Register		
	1999	2000	2001	1999	2000	2001
High-Voltage Customers of VRA	2,656,379,000	3,168,590,000	568,765,000	12	12	12
Volta Aluminium Company	1,928,331,000	2,504,762,000		1	1	1
Akosombo Textiles Limited	18,690,000	20,432,000		1	1	1
Aluworks Limited	13,149,000	12,976,000		1	1	1
Mining Companies	696,209,000	630,420,000	568,765,000	9	9	9
SLT Customers List	1,076,538,709	1,393,039,906	1,119,277,608	557	557	557
Agriculture	853,879	1,328,980	841,366	9	9	9
Mining and Quarrying	293,118,863	289,670,756	307,003,519	27	27	27
Manufacturing	434,868,773	732,413,854	441,793,823	299	299	299
Electricity & Water	154,681,154	163,606,161	163,757,404	3	3	3
Construction	2,146,341	1,899,088	1,724,177	10	10	10
Commerce (incl Hotels)	28,764,053	29,757,397	29,143,557	69	69	69
Transport & Communication	30,656,746	32,968,983	31,784,171	12	12	12
Finance, Insurance, Real Estate	21,893,270	23,809,695	24,417,941	17	17	17
Community & Social Services	105,988,589	113,142,508	113,887,214	96	96	96
Other Extra Territorial Bodies	3,567,041	4,442,484	4,924,436	15	15	15
Non-SLT Customers	91,278,220	108,825,629	110,256,358	278,272	357,030	473,337
Industrial Sector	10,163,237	11,789,295	-	2,417	3,338	-
Alcoholic Beverages	367,929	472,573		77	118	
Food Processing	2,857,058	3,988,978		1,264	1,675	
Textiles	135,914	115,794		5	6	
Manufacturing	3,048,073	3,325,227		434	675	
Printing & Publishing	872,992	467,954		164	171	
Sawmills & Wood Products	492,128	553,608		106	167	
Fabricated Metal Products	653,562	787,792		293	433	
Chemical Industries	468,853	463,620		5	6	
ECG Premises	1,266,253	1,612,219		68	85	
Construction	475	1,530		1	2	
Services Sector	81,114,983	97,036,334	110,256,358	275,855	353,692	473,337

Source: Volta River Authority and Electricity Company of Ghana

In the case of the non-residential customers of the ECG, the original list consisted of six hundred and twenty (620) Special Load Tariff (SLT) customers and close to three hundred and sixty thousand (357,030) Non-SLT customers – the latter was made up of 3,338 industrial firms and the remainder of 353,692 were classified under services-related activities. Generally, the Non-SLT customers list covered commercial consumers with very small electricity consumption levels – i.e., 75 percent of firms on this list had consumption levels not exceeding 2,000 kilowatts hour per annum.

II.2: The Sample

In choosing the sample for the survey, a complete census was conducted to cover all the high-voltage electricity-consuming firms supplied directly by the VRA as well the firms on the SLT customer list of the ECG.

In the case of Non-SLT customers, a multi-stage stratified sampling approach was employed to ensure that the selected firms were truly representative of the underlying population. The multi-stage sampling method took account of region of location, type of economic activity engaged in by the firm, and the quantum of power consumption².

Six hundred and fifteen (615) industrial firms were selected from the Non-SLT customer list of the ECG to be covered in the survey. Together with the 12 high-voltage power-consuming firms and the 557 firms on the SLT customer list of the ECG, a total of one thousand one hundred and eighty four firms were to be covered in the survey.

II.3: Questionnaire Design

The survey collected establishment level data using a multi-purpose questionnaire designed by research teams from CEPA, the Energy Commission, the ECG and other stakeholders. Establishment level data included energy supply and usage, with particular reference to the quantum and/or cedi values of electricity and fuel types – motor gasoline (petrol), diesel, residual fuel oil, kerosene, charcoal, firewood and premix – consumed over the three reference years of the survey (1999-2001). Purposes for which these energy types are used were also highlighted in the questionnaire.

III: Field Operations

Field operations involving the training of interviewers, testing the questionnaire in a pilot survey and on-sight interviews to collect the requisite information was undertaken by *Messrs Business Interactive Consulting* – a locally based Ghanaian marketing research

² Firms utilizing less than 2000 kilowatts hour of power were excluded from the sample. These represented about 75 percent of firms in the Non-SLT list of ECG non-residential customers.

company that had been recommended to CEPA by the World Bank Group following the company's impressive nationwide field studies of Ghanaian water users experiences.³

A total of six hundred and seventy firms completed questionnaires administered for the survey. Of this total only three – Ashanti Goldfields Company Limited, Volta Aluminium Company Limited and the Diamonds Mine at Akwatia – belong to the high-voltage electricity-intensive sub-population of ten firms. The remainder of six hundred and sixty seven (667) firms belongs to either one or the other of the other two sub-populations – the SLT list of ECG customers (260 firms) and the Non-SLT sub-population of non-residential ECG customers (407 firms).

IV: Findings from the Survey

IV.1: Consumption of Fuel Types

Results from the survey indicate quite emphatically that diesel fuel is the most widely utilized of the fuel types across economic activities in all three sub-populations (high-voltage power-consuming firms supplied directly by the VRA, the SLT and Non-SLT customers of the ECG) that form the domain of study. The Industrial sector had the highest share in the total consumption of diesel fuel in all three-reference years of the survey, followed by the Services sector; the Agricultural sector's share was negligible.

The most commonly reported purposes for which diesel fuel is utilized in Industry vary from sub-sector to sub-sector. In general, its usefulness is in operating excavators, fork lifts and dump trucks and equipment of machinery for drilling, crushing, hoisting, loading and transfer to haulage trucks, as in the mining and construction sub-sectors. The picture is no different in the case of gasoline (petrol) whose use in the Services sector, particularly in the Transport and Haulage sub-sector, is superseding.

Residual fuel oil (RFO), according to the survey findings, is widely used in production processes of the Manufacturing sub-sector of Industry. It is principally used for

³ Funding of the water study was by the UK-based Adam Smith Institute – the Department of International Development (DFID). The Public Utilities Regulation Commission (PURC) had sponsored the study in 2001.

generating heat in equipment of machinery such as boilers and compressors mostly in the food processing, alcoholic beverages, textiles, iron and steel, and the non-ferrous metal industries. The consumption shares of VALCO have also been substantial.

Woodfuels (charcoal and firewood) consumption, as reported in the survey, is not extensive across sectors of economic activity. The bulk is used in boilers of sawmills and in ovens in brick and tile and ceramic factories. Educational institutions and hospitals account for a smaller proportion of firewood consumption for cooking and food preparation purposes. Charcoal consumption, on the other hand, is mostly common in small-scale restaurants and eating places, but educational institutions also account for a relatively smaller proportion.

Kerosene is also limited in use across economic sectors other than in health and educational institutions. A fair amount of this fuel type is used in the non-ferrous metal industries and the manufacture of professional and scientific products – basically used in boilers, ovens, and furnaces, and also as a polishing detergent.

Perhaps, an altogether startling finding from the survey is the extensive use of liquefied petroleum gas (LPG) in almost all economic activities within the modern sector. Results of the survey show that LPG is a heavily patronized energy fuel whose consumption is widespread across sectors of production and spans all three domains of study. High-voltage electricity-consuming firms reportedly accounted for well over 30 percent of LPG consumption in 1999 and 2000; consumption by the SLT category of firms was 47 percent of the total in both years. In the subsequent year, however, the share of the high-voltage electricity-consuming firms increased to 42 percent while that of the SLT category of firms slumped to 28 percent of the total.

In the Manufacturing sub-sector of Industry, the food processing and the printing and publishing sub-divisions were key LPG-consuming activities. VALCO and the Services sector closely trailed the Manufacturing sub-sector, while the contribution of the Agricultural sector was negligible.

In terms of uses, the findings revealed that among key consumers within the Services sector – health and educational institutions – the principal uses of liquefied petroleum gas are in ovens and stoves for cooking and food preparations. Within the Mining and Quarrying sub-sector of Industry, the results further indicate that considerable amounts of LPG find its use in furnace treatment plants, particularly in gold and diamond production, for molding and cutting processes. Larger quantities still were used in furnaces and dryers as part of the production processes involving the smelting of aluminum and in metallurgical industries.

IV.2: Electricity Consumption

Electricity consumption, while widespread across economically productive activities of all types varied from sector to sector in terms of what it is used for. Its uses in Industrial activities vary from being a potent energy source for smelting aluminum and basic metals to being used to operate conveyor belts in gold mines and granite stone quarries and in alcoholic beverage industries as well. Within manufacturing, majority of saw-milling plants and wood products manufacturers have found electricity a most reliable energy source in their respective production processes – basically for operating electrical motors and equipment. Manufacturers of cement, ceramic, and household aluminum products have equally found this energy type very valuable. Even in the Agricultural sector, where electricity usage is very marginal compared to its use in Industry and the Services sector, some use is found for it in hatcheries and for lighting chicken coops.

Findings from the survey indicate that the high-voltage power-consuming firms (namely, VALCO, the mines, Akosombo Textiles and Aluworks), and the Ghana Water Company Limited are the principal electricity-consuming firms in the country today. In the case of VALCO, electricity is the overriding energy type used in production. The company's share of electricity consumption in the total reported in the survey increased from 62.7 percent in 1999 to 70.7 percent in 2001. In the case of the gold and diamond mines, while the consumption shares in the total are the next highest, they have been declining (from

20.4 percent in 1999 to 14.2 percent in 2001) – possibly reflecting the intermittent power outages in 2000 and 2001 and the persistent calls for increased power tariffs.

Substantial amounts of electricity are also used within the manufacturing sub-sector of Industry (excluding VALCO). Indications from the survey are that the food processing, the wood products and cement manufacturing, as also the chemical manufacturing and iron and steel manufacturing industries are all principal electricity-consuming activities within the sub-sector.

Sawmills and wood products manufacturing companies, food processing, chemicals and cement manufacturing firms, individually consume more than 10 percent of electricity in the manufacturing sub-sector. Textiles manufactures, the paper products, and alcoholic beverage industries consume less than 10 percent of power in this sub-sector of Industry.

V: National Baseline Estimates of Energy Demand

The survey findings, in combination with information pieced together from petroleum fuel sales to bulk purchase customers of the oil marketing companies (OMCs) and supplemented with a small number of personal interviews of practitioners involved with energy issues — Tema Oil Refinery (TOR), Ghana National Petroleum Corporation, the Energy Commission, among others — formed the basis for estimating baseline national energy consumption in the non-residential segment of the energy-consuming economy. Standard conversion factors were also used in transforming liters of petroleum fuels, kilograms of Woodfuels and LPG, and gigawatts hour of electricity into energy equivalents — tonnes of oil equivalent (TOE) in this case.

The national estimates of energy utilization in the non-residential energy-consuming economy (including the Transport and Haulage sub-sector) reveal that total energy consumption amounted to 2,081.2 thousand TOE in 1999, rising by almost 11.3 percent to reach 2,315.8 thousand TOE in 2000 and further to 2,387.8 thousand TOE in 2001 – some 306.6 thousand TOE more than was registered in 1999. The bulk of the energy consumed in all the three reference years of the survey is in the form of petroleum

products; electricity utilization represents an average of 8.0 percent of the total energy consumption per annum (see Table V.1).

Table V.1: Economy-wide Energy Consumption Indicators, 1999-2001

	1999	2000	2001
Consumption of Energy Fuels			
Gasoline (liters)	626,264,684	726,572,392	728,444,680
Diesel Fuel (liters)	828,315,498	888,486,495	956,767,617
Residual Fuel Oil (liters)	56,543,665	55,859,098	58,402,527
Heavy Distillate (liters)	50,344,317	56,696,612	46,736,676
Kerosene (liters)	239,348	737,839	833,808
Aviation Gasoline (liters)	28,786,450	35,648,509	40,150,941
Premix Fuel (liters)	49,133,086	43,647,103	41,066,164
Liquefied Petroleum Gas (kg)	6,670,087	6,029,816	6,208,588
Charcoal (kilograms)	9,676	10,704	12,523
Firewood (kg)	597,552	449,802	469,601
Electricity (kWh)	3,832,089,523	4,518,172,874	4,625,700,564
Tons of Oil Equivalent (TOE)			
All Fuel Types	1,920,795	2,126,669	2,194,132
Electricity	160,413	189,133	193,634
Miscellaneous Items			
Tonnes of Oil Equivalent			
Agricultural Sector	85,789	82,430	70,091
Industrial Sector	514,535	509,589	519,121
o/w VALCO	105,889	130,409	134,606
Services Sector	1,480,884	1,723,783	1,798,554
o/w Transport & Haulage	1,364,591	1,614,919	1,688,947

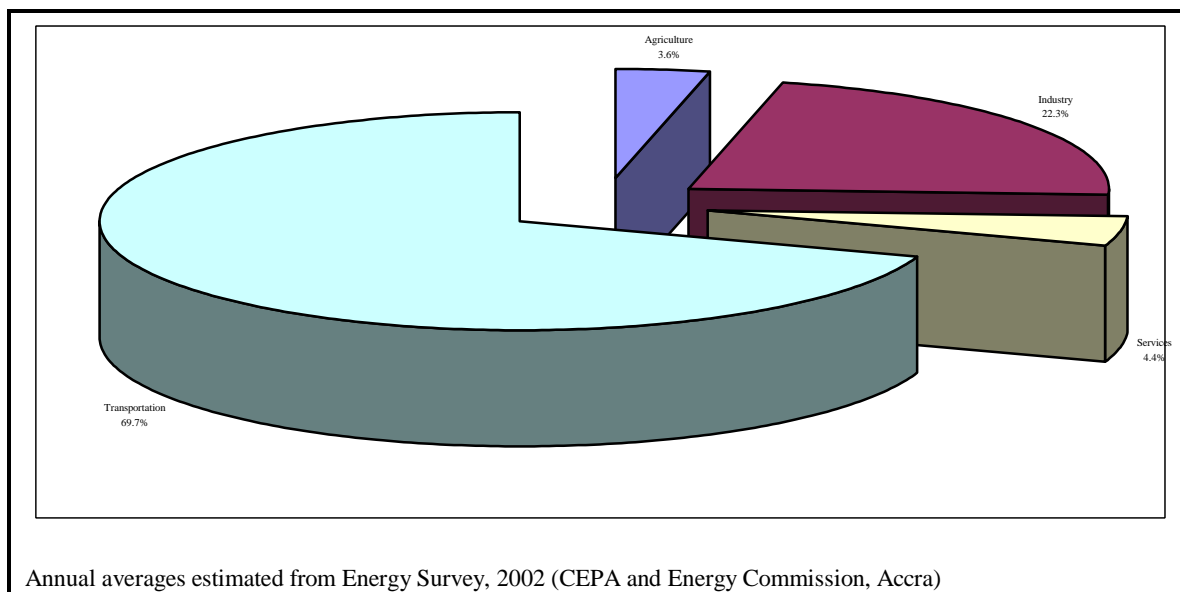
Based on Energy Survey, 2002 (CEPA and Energy Commission, Accra)

Relative to the rest of the economy, the Transport and Haulage sector emerged the largest energy-consuming sector, accounting for 68.7 percent of total energy demand in the non-residential energy-consuming economy. In the three reference years of the survey, energy consumption of the sector amounted to an average of 1,556 thousand TOE per annum. Petroleum products – motor gasoline, diesel, and jet (aviation) fuel – are the dominant fuel types used in the Transport and Haulage sector, accounting for an average of 99.9 percent of total energy use in the sector.

The Industrial sector (including the mines and VALCO) trails the Transport and Haulage sub-sector in energy consumption terms; total energy utilization in the sector amounted to

an average of 514 thousand TOE per annum, representing an average of 22.8 percent of total energy consumption over the three reference years of the survey. Meanwhile, energy consumption in the Services sector (excluding Transport and Haulage) fell from 101.3 thousand TOE in 1999 to 96.5 thousand TOE in 2000 but recovered somewhat to reach 99.3 thousand TOE in 2001.

Figure V.1: Sectoral Shares of Energy Consumption (TOE)



Energy utilization in the Agricultural sector has tended to be small, with an average share of 3.5 percent per annum of the economy-wide total compared to those of Industry and the Services sectors. Energy consumption for this sector, which includes activities in poultry and livestock, marine fishing, and mechanized farming, reflects the use of final fuels consumed at the end-use. Diesel fuel is by far the most extensively utilized in the sector to operate small motors, tractors and trailers. Diesel fuel, heavy distillates, and premix also serve as heating fuels in the marine fishing sub-division and also to drive out-board motors of small boats and fishing vessels. The sector, however, is the smallest electricity-consuming sector, accounting, on average for 0.03 percent of total electricity consumption per annum. Electricity use in the sector is particularly extensive in hatcheries and for warming chicken coops. Post-harvest drying and winnowing, and threshing of cereals is typically solar-energy reliant.

VI: Energy Intensities

Energy intensity measures, particularly those relating energy input to product output, have all too often been important components of the debate about the direction of future energy policy in sectors of the Ghanaian economy. Accurately measuring this requires that the demand for energy and output in these sectors are known in advance.

Table VI.1: Energy Intensities by Economic Activity, 1999-2001

	Tonnes of Oil Equivalent (TOE)			TOE per c million Real GDP		
	1999	2000	2001	1999	2000	2001
ALL ECONOMIC ACTIVITIES	2,081,208	2,315,802	2,387,766	0.42	0.45	0.45
AGRICULTURAL SECTOR	85,789	82,430	70,091	0.05	0.04	0.04
Commercial Farming	602	453	591	0.004	0.003	0.003
Poultry & Livestock	201	206	231	0.0002	0.0002	0.0002
Irrigation	246	235	247	0.0015	0.0013	0.0013
Marine Fishing	84,799	81,562	69,041	0.35	0.34	0.29
INDUSTRIAL SECTOR	514,535	509,589	519,121	0.41	0.39	0.39
Mining and Quarrying	194,584	174,992	168,417	0.69	0.61	0.58
Manufacturing	240,702	271,300	283,713	0.002	0.002	0.002
Electricity & Water	436	466	458	0.003	0.004	0.003
Construction	71,614	55,255	58,625	0.186	0.136	0.136
SERVICES SECTOR	1,480,884	1,723,783	1,798,554	1.02	1.13	1.12
Wholesale/Retail Trade	125,935	145,481	159,298	0.37	0.41	0.43
Transport & Haulage	1,364,591	1,614,919	1,688,947	5.91	6.59	6.55
Finance Insurance, Real Estate	80,527	91,974	94,095	0.38	0.42	0.41
Government Services	29,589	28,712	29,932	0.06	0.05	0.05
Community, Social & Personal Services	175,496	183,385	184,369	1.93	1.88	1.82
Private Non-Profit Services	49,762	69,337	83,203	1.10	1.48	1.70

Based on Energy Survey, 2002 (CEPA and Energy Commission, Accra)

Sector-specific energy intensities in each of the major sectors of the economy are measured by the ratio of energy use (in tonnes of oil equivalent, TOE) per the real GDP component – a proxy for the real cedi values of products produced – in each of the sectors and sub-sectors of the economy. This measure facilitates comparability of energy intensity coefficients both across and within broad economic sectors of the economy.

Energy intensity coefficients, while varied between sectors, turned out to be relatively stable within specified sectors across all the three reference years of the survey (see Table VI.1).

Agriculture has the lowest energy intensities – fixed around 0.05 TOE per ₵ million real GDP in 1999, but falling to 0.04 TOE per ₵ million GDP in both 2000 and 2001; the Industrial sector – made up of the Mining and Quarrying, Manufacturing, Electricity Generation and Water Treatment and Supplies, and Construction sub-sectors – has the second highest energy intensity coefficient after the Services sector and with the energy intensity coefficient fixed at about 0.4 TOE per GDP (₵ million) in all the three reference years of the survey. In the Services sector, the estimated energy intensity coefficient is slightly above unity. This is largely on account of the very high energy intensities in the Transport and Haulage, the community and Social Services, and the Private Non-Profit Services sub-sectors (see Table VI.1).

While the Mining and Quarrying, the Construction and the manufacturing sub-sectors of Industry appear to be the ones with relatively higher energy intensity coefficients within Industry, there are also indications that these coefficients have been fairly stable within sub-divisions of these sub-sectors – at least when measured in terms of tonnes of oil equivalent (TOE) per units of output produced (Table VI.2).

Energy intensity in gold mining, for example, has been relatively stable around 0.08 TOE per fine ounce in 1999, gradually declining to 0.06 TOE per fine ounce in 2001. A similar picture emerges in the case of diamond mining; this time, however, the energy intensity coefficient increased from 0.005 TOE per carat in 1999 to 0.008 TOE per carat in 2001.

As with gold mining, energy intensity in the basic iron and steel industry has also been on a smoothly declining path, as the coefficient dropped marginally from 0.046 TOE per metric tonne in 1999 to 0.042 TOE per metric tonne in 2000 before tumbling to 0.032 TOE per metric tonne in 2001. Quite clearly, a continuously declining energy coefficient, as measured, implies that lesser amounts of energy was utilized in the production of a

metric tonne of iron and steel products in both 2000 and 2001. This could be due to a more efficient use of energy.

Table VI.2: Energy Intensities in Selected Mining and Manufacturing Industries

	1999	2000	2001
Mining			
Gold Mining			
Energy Consumption (TOE)	182,937	163,717	137,706
Output (ounces)	2,417,976	2,339,595	2,208,732
Energy Intensity (TOE/ounce)	0.08	0.07	0.06
Diamond Mining			
Energy Consumption (TOE)	1,076	1,121	1,367
Output (carats)	204,832	191,460	179,522
Energy Intensity (TOE/carat)	0.005	0.006	0.008
Manufacturing			
Iron and Steel			
Energy Consumption (TOE)	2,209	3,090	3,219
Output (metric tonnes)	48,000	72,868	100,000
Energy Intensity (TOE/tonne)	0.05	0.04	0.03
Aluminium Smelter (Valco)			
Energy Consumption (TOE)	105,869	130,385	127,820
Output (metric tonnes)	110,460	208,997	153,678
Energy Intensity (TOE/tonne)	0.96	0.62	0.83
Cement Production			
Energy Consumption (TOE)	2,830	3,282	3,364
Output (metric tonnes)	740,861	668,896	701,142
Energy Intensity (TOE/tonne)	0.004	0.005	0.005

Based on results from Energy Survey, 2002 (CEPA and Energy Commission, Accra)

Energy intensity in the country's cement production industry, meanwhile, has remained remarkably stable at 0.005 TOE per metric tonne in both 2000 and 2001, having risen from 0.004 TOE per metric tonne in 1999.

There are other equally interesting and quite remarkable developments in the Manufacturing sub-sector emerging from the survey results. Gross output levels of sub-divisions of the Manufacturing sub-sector — the dominant sub-sector of Industry in terms of shares of GDP — have remained stagnant to declining in the three reference years of the survey. But even as production levels had been stagnating, energy use in the sub-sector had been on a rising path (see Table VI.3).

Table VI.3: Energy Intensities in Manufacturing Sub-sector of Industry

	1999	2000	2001
Electricity (kWh)	2,398,318,487	2,981,463,080	3,097,869,258
Gasoline (liters)	5,597,931	6,626,810	6,953,949
Diesel Fuel (liters)	68,000,852	72,070,255	76,088,621
Residual Fuel Oil (liters)	56,543,665	55,859,098	58,402,527
Heavy Distillates (liters)	1,842,721	2,823,057	2,928,432
Kerosene (liters)	213,437	658,539	799,938
LPG (kilograms)	3,805,126	3,609,107	3,751,042
Firewood (kilograms)	525,338	386,188	402,696
Tonnes of Oil Equivalent	240,702	271,300	283,713
All Fuel Types	140,307	146,495	154,035
Electricity	100,395	124,805	129,678
Gross Output (¢ billion)	454	472	489
Energy Intensities			
Electricity (kWh/GDP - ¢ million)	5,283	6,317	6,335
Gasoline (liters/GDP - ¢ million)	12	14	14
Diesel Fuel (liters/GDP - ¢ million)	150	153	156
RFO (liters/GDP - ¢ million)	125	118	119
Heavy Distillates (liters/GDP - ¢ million)	4	6	6
Kerosene (liters/GDP - ¢ million)	0	1	2
LPG (kg/GDP - ¢ million)	8	8	8
Firewood (kg/GDP - ¢ million)	1.16	0.82	0.82
TOE/GDP - ¢ million	0.53	0.57	0.58
Memorandum Items			
GDP Growth Rate (%)	4.8%	3.8%	3.7%
Contribution to Real GDP (%)	9.2%	9.2%	9.1%

Based on Baseline data from Energy Survey, 2002 (CEPA and Energy Commission, Accra)

Energy use in the Manufacturing sub-sector of Industry increased by 12.7 percent from 240.9 thousand TOE in 1999 to 271.3 thousand TOE in 2000; in the subsequent year, about 283.3 thousand TOE of energy, representing a 4.4 percent jump on levels registered in 2000, was utilized in the sub-sector. As it turned out, VALCO, the aluminum smelter, continued to be the lead energy-consuming firm in the sub-sector; its share of electricity consumption rose from 80.3 percent of the sub-sector's total in 1999 to 84.0 percent in both 2000 and 2001.

Import-substituting firms within the manufacturing sub-sector of Industry (excluding VALCO) comprise a broad range of firms in fourteen sub-divisions, each of which has varying electricity/energy consumption propensities, and are characterized, as indicated

in an earlier section of the report, by different sophistication levels of technology and capacity utilization rates. At the upper end of this spectrum are Sawmills and Wood Products and Other Non-Ferrous Metals Basic Products (excluding VALCO), which, by our estimations, have energy intensity coefficients in excess of unity – energy intensity being measured by the ratio of energy use in tonnes of oil equivalent (TOE) to real GDP (¢ million) as in Table VI.4 below.

Table VI.4: Energy Intensive Activities in Sub-Divisions of Manufacturing

	Energy Consumption (TOE)			Energy Intensity (TOE/¢ million)		
	1999	2000	2001	1999	2000	2001
High Energy-Intensive Industries						
VALCO	105,889	130,409	134,606	2.34	2.87	2.85
Cutlery & Other Non-Ferrous Metals	3,998	4,674	4,876	1.73	2.02	2.02
Sawmills and Wood Products	46,208	48,928	51,032	1.36	1.43	1.43
Middle-to-Low Energy Intensive Industries						
Cement & Other Non-Metallic Minerals	8,595	9,129	8,679	0.55	0.65	0.61
Pulp & Paper, Printing and Publishing	4,674	4,987	5,131	0.51	0.54	0.54
Very Low Energy-Intensive Industries						
Food Processing	20,166	18,502	19,279	0.29	0.26	0.26
Alcoholic Beverages	17,234	17,153	17,753	0.45	0.45	0.45
Tobacco Products manufactures	1,665	2,067	2,117	0.05	0.06	0.06
Textiles and leather Tanneries	13,868	16,794	17,516	0.21	0.26	0.26
Iron and Steel	2,209	3,090	4,240	0.05	0.04	0.04
Household Aluminium & Other N-F Metals	6,804	5,328	7,033	0.15	0.12	0.12
Chemical Products (except Petroleum)	6,472	7,081	7,335	0.21	0.23	0.23
Petroleum Refinery & Petro-Chemicals	821	771	923	0.012	0.009	0.010
Electrical and Transport Equipment	2,288	2,511	2,594	0.11	0.12	0.12

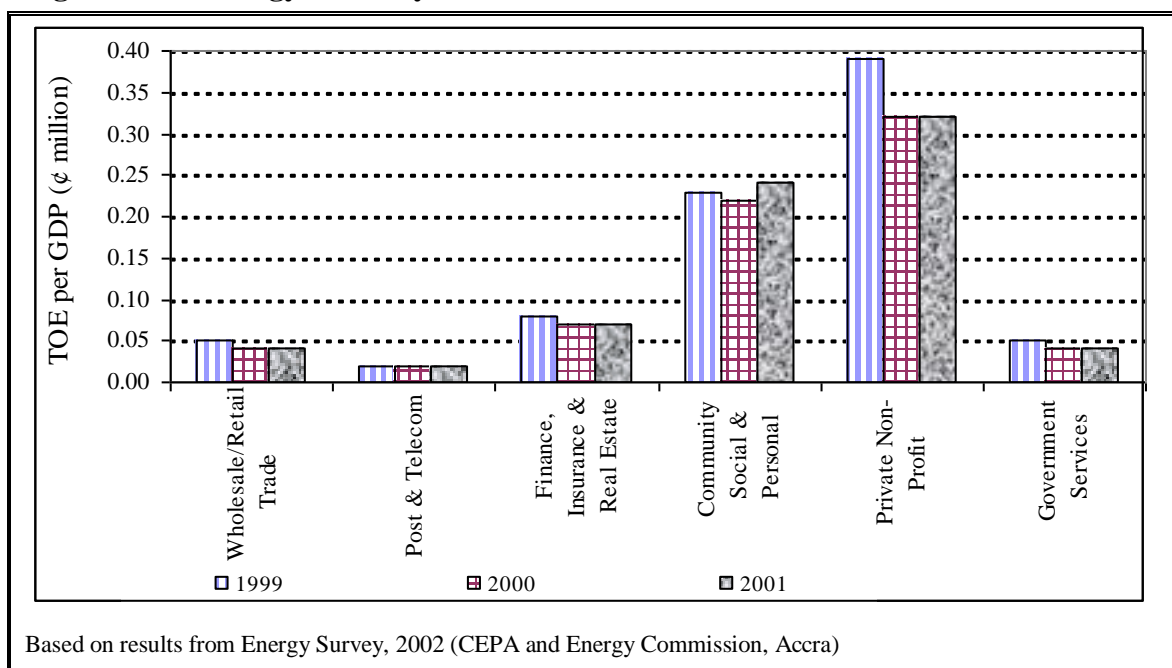
Based on baseline estimates of the Energy Survey, 2002 (CEPA and Energy Commission)

There are also middle-to-low import-substituting manufacturing industries – cement and other non-metallic mineral products; and pulp and paper products, printing and publishing – with energy intensity coefficients of between 0.5 and 1.0, and also occupying the middle grounds of the spectrum.

At the bottom end are a diverse collection of industries – food processing; alcoholic beverage industries; tobacco products manufacturing; textiles, wearing apparel and leather tanneries; chemical products (excluding petroleum); petroleum refinery; and the manufacture of metal-based durables (including transportation machinery and electronic and electrical equipment, and other professional and scientific instruments) – with energy intensity coefficients of below 0.5 TOE per GDP (¢ million).

The high energy-intensive firms, as defined, consumed large amounts of energy – an average of 58,921 TOE per annum, representing 82 percent of total consumption per annum in the Manufacturing sub-sector (including VALCO).

Figure VI.1: Energy Intensity Coefficients in Sub-sectors of the Services Sector



In the case of the middle-to-low energy intensive firms, the energy coefficients, while more than 0.5 TOE per GDP (¢ million), nevertheless, vary between sub-divisions, and in some cases on a year-to-year basis as well. But even as they are also higher than those in the very low-intensity group, it by no means implies that the latter category of firms utilize energy more efficiently. What it means, in principle, is that there may be different characteristics and different uses to which energy is put in all of these activity-specific

sub-divisions of Manufacturing. Moreover, utilization rates of installed capacity, ease of accessibility to energy supplies, the state-of-the art technology in use, etc. may vary within and across sub-divisions of Manufacturing. These different characteristics require that each of the sub-divisions be treated separately in its own right.

Finally, estimated energy intensity coefficients for sub-sectors of Services (excluding Transport and Haulage) range between 0.02 TOE per GDP (¢ million) in the Posts and Telecommunications sub-sector to 0.3 TOE per GDP (¢ million) in the Private Non-Profit Services sub-sector — making the latter sub-sector the lead energy intensive in the sector, while establishing the former — the Posts and Telecommunications Services sub-sector — the least energy-intensive (see Figure VI.1).

As indicated in Figure VI.1, the Community, Social and Personal Services sub-sector trails the Private Non-Profit Services sub-sector — the most highly energy-intensive sub-sector of Services (excluding Transport and Haulage), even though the energy coefficients are not in excess of 0.4 TOE per GDP (¢ million). It is closely followed by the Finance, Insurance, Real Estates & Business Services sub-sector whose energy intensity coefficients declined somewhat from 0.08 TOE per GDP (¢ million) in 1999 to stabilize at 0.07 TOE per GDP (¢ million) in both 2000 and 2001. It also turned out that energy intensity coefficients in the Wholesale, Retail Trade, Restaurants and Hotels sub-sector are similar to those registered for the Government Services sub-sector.

VII: Limitations and Conclusions

This study highlights the key findings of an energy intensity survey jointly carried out by CEPA and the Energy Commission in 2002. While the findings from the survey portray a somewhat interesting picture of energy consumption in sectors of the economy, the survey itself has not been without problems. Experience has proven time and gain that it is natural in nationwide establishment surveys of the magnitude undertaken in the present study to be confronted with the problems of non-response and non-sampling errors. However, we had not envisaged the gravity of the non-response problem that confronted us on the field. The involvement of key stakeholders in the Energy Sector was most

disappointing, unenthusiastic, and aloof. Only a few of these institutions had shown some interest in the survey by completing the administered questionnaires.

But there were other problems as well — lack of cooperation from many organizations; low awareness level of the exercise, hence respondents demanding official letters directly from the Energy Commission; and poor record-keeping on the part of a majority of firms, resulting in delays in retrieving administered questionnaires, among others.

There were also difficulties in determining the physical locations of firms: the list of firms provided by the ECG had been listed by names without any indications of their physical locations. This had made identification on the field both time-consuming and irksome. It had also exacted extra costs on the field operations that had not been budgeted for. Future research studies would do well to circumvent these problems by building a more credible and comprehensive sampling frame that lists the names, addresses, and physical locations of all the commercial and industrial customers of the energy-distributing firms in the country. A more important requirement of such a sampling frame, however, will be current data on the quantum and/or cedi values of supplies to each of these commercial and industrial customers.

In a certain sense, our baseline estimates of energy use, particularly in the Transport and Haulage sub-sector of Services is second best. The estimates in this particular sub-sector are based on somewhat incomplete information obtained from the Vehicles and Licensing Department of the Motor Traffic Unit of the Ghana Police Service. The latter statistical information reflects registered vehicles and not the actual numbers of passenger and private vehicles and fleet of haulage trucks operating in the system at any particular time. Aside of this, systemic biases in our estimates on account of non-sampling errors cannot be ruled out completely. All of this, therefore, calls for caution in the use of the estimates.

We nonetheless must extend our profound gratitude to the so many institutions, especially in the private sector, which dutifully completed questionnaires and provided information on their consumption of the energy fuels for the three reference years of the

survey. We thank them for their support and goodwill in seeing us through this rather irksome national assignment. We take solace in the fact that even these firms are beginning to see the need for a truly representative database intended to move the country away from the rather chaotic environment in the energy sector — problems of adjusting prices to reflect current market trends, the issue of the TOR debt, etc.— and, hopefully, serve as a more credible starting point for forecasting energy requirements in sub-sectors and sectors of the national economy to meet policy and planning needs of the relevant stakeholders.

Appendix Table A.1: Gasoline and Diesel Fuel Consumption by Economic Activity

	Gasoline Consumption (liters)			Diesel Fuel Consumption (liters)		
	1999	2000	2001	1999	2000	2001
ALL ECONOMIC ACTIVITIES	625,844,302	726,145,763	728,024,663	704,624,296	787,316,023	858,596,837
AGRICULTURAL SECTOR	-	-	-	2,233,768	2,181,472	2,051,055
Commercial Farming	-	-	-	579,075	435,670	568,624
Poultry & Livestock	-	-	-	175,375	183,250	208,800
Irrigation	-	-	-	228,410	207,000	225,150
Marine Fishing	-	-	-	1,250,908	1,355,552	1,048,481
INDUSTRIAL SECTOR	6,497,021	7,391,508	7,759,341	136,958,266	125,485,216	132,834,512
Mining and Quarrying	420,382	426,629	420,017	124,261,002	101,757,672	98,885,565
Gold Mining	287,737	368,744	348,119	114,029,023	91,804,346	86,669,358
Diamond Mining	-	-	-	569,800	587,200	714,785
Bauxite	-	-	-	517,399	670,661	952,338
Manganese	-	-	-	2,789,520	2,988,161	3,593,333
Stone Quarrying	125,715	54,105	64,769	6,182,255	5,527,954	6,617,496
Salt Mining	6,930	3,780	7,129	173,005	179,350	338,255
Manufacturing	5,597,931	6,626,810	6,953,949	68,000,852	72,070,255	76,088,621
Food & Alcoholic Beverages	1,124,559	918,317	951,836	11,048,849	10,907,931	11,315,585
Food Processing	467,501	324,505	338,134	4,600,814	4,264,795	4,443,916
Alcoholic Beverages	590,010	512,574	530,514	6,038,469	6,281,556	6,501,410
Tobacco Products Manu	67,048	81,238	83,188	409,566	361,580	370,258
Textiles, Wearing Apparel & Leather Tanneries	272,542	254,765	265,720	1,819,685	2,170,379	2,263,705
Wood & Wood Products	939,791	1,049,984	1,095,133	39,370,939	41,775,912	43,572,276
Paper & Paper Products, Printing & Publishing	846,954	964,275	992,239	2,177,164	2,288,313	2,354,674
Chemical Products Other than Petroleum	804,906	1,195,654	1,238,698	1,714,838	2,313,204	2,396,479
Chemical & Pharmaceutical Products	427,426	960,920	1,037,203	587,040	792,200	679,739
Rubber & Plastic Products	377,480	234,734	201,495	1,127,798	1,521,004	1,716,740
Petroleum Products Except Refinery	146,172	144,630	147,378	115,200	108,000	110,052
Non-Metallic Mineral Products	384,659	532,731	555,897	2,905,898	3,484,081	3,618,917
Cement Products	203,576	384,750	403,298	1,211,150	1,535,876	1,609,917
Other Non-Metallic Products	181,083	147,981	152,599	1,694,748	1,948,205	2,009,000
Basic Metal Industries	980,085	1,496,719	1,635,012	7,897,372	7,934,960	9,333,571
Iron and Steel	-	-	-	216,000	283,500	389,060
Non-Ferrous Metal Industries	980,085	1,496,719	1,635,012	7,681,372	7,651,460	8,944,511

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VALCO	204,545	424,071	437,641	1,218,867	3,043,552	3,140,946
Basic Household Alum Goods	144,680	282,959	373,496	5,578,091	3,600,549	4,752,598
Cutlery & Other Non-Ferrous Metal	630,860	789,689	823,875	884,414	1,007,359	1,050,968
Manufacture of Machinery & Equipment	98,263	69,735	72,036	950,907	1,087,475	1,123,362
Electricity Gas and Water	313,913	313,277	326,435	313,913	313,913	313,913
Water Supply & Treatment	313,913	313,277	326,435	313,913	313,913	313,913
Construction	585,177	451,421	478,958	68,073,701	52,513,848	55,717,193
SERVICES SECTOR	619,347,281	718,754,255	720,265,322	565,432,262	659,649,335	723,711,270
Wholesale/Retail Trade, Hotels & Rest	1,088,078	938,065	850,250	9,761,482	8,540,324	7,992,045
Wholesale/Retail Trade (Commerce)	357,191	337,491	351,521	6,765,129	5,669,418	5,818,030
Cold Storage Companies	600,222	404,752	350,700	2,300,166	2,286,020	1,462,708
Hotels & Restaurants	130,665	195,823	148,029	696,187	584,887	711,308
Restaurants	11,361	59,361	58,606	123,353	103,301	77,666
Hotels	119,304	136,462	89,423	572,834	481,586	633,642
Transport, Storage & Communication	590,013,161	692,570,367	694,810,744	512,350,285	611,391,624	674,959,819
Transport and Haulage	589,467,742	692,162,402	694,451,812	509,129,582	608,245,879	671,866,328
Posts and Telecommunication	545,419	407,965	358,932	3,220,703	3,145,745	3,093,491
Finance, Insurance, Real Estates & Business	6,699,439	6,699,751	6,642,800	4,355,603	4,558,779	4,446,867
Community Social and Personal Services	21,546,604	18,546,072	17,961,529	38,964,893	35,158,608	36,312,538
Government Services	6,217,566	5,275,848	4,920,688	16,326,055	15,422,728	15,610,854
Community Service	2,903,746	3,491,796	4,141,821	9,630,684	9,560,843	11,876,303
Public Safety, Law and Order	1,123,200	1,668,480	1,123,200	4,922,474	4,964,390	6,572,400
Educational Services	726,229	768,599	1,557,872	500,734	798,422	1,614,357
Research & Allied Institutions	356,067	314,128	685,422	842,370	747,785	956,391
Health, Medicare & Nutrition	-	-	-	1,714,300	1,767,885	1,502,780
Recreation and Cultural Services	663,964	709,192	741,750	1,390,852	1,010,148	1,010,000
Personal and Household Services	34,286	31,397	33,577	259,954	272,214	220,375
Producers of Private Non-Profit Services	6,522,210	5,213,214	5,549,760	7,440,574	5,980,857	5,420,285
International & Extra-Territorial Organizations	5,903,082	4,565,214	3,349,260	5,567,580	4,194,180	3,405,096

Source: Based on Energy Intensity Survey, 2002 (Energy Commission and CEPA, Accra)

Appendix Table A.2: Residual Fuel Oil and Heavy Distillates Consumption by Economic Activity

	Residual Fuel Oil (liters)			Heavy Distillates (liters)		
	1999	2000	2001	1999	2000	2001
ALL ECONOMIC ACTIVITIES	56,543,665	55,859,098	58,402,527	24,712,133	28,750,501	20,353,704
AGRICULTURAL SECTOR	-	-	-	22,869,412	25,927,444	17,425,272
Marine Fishing	-	-	-	22,869,412	25,927,444	17,425,272
INDUSTRIAL SECTOR	56,543,665	55,859,098	58,402,527	1,842,721	2,823,057	2,928,432
Mining and Quarrying	-	-	-	25,632,184	27,946,111	26,382,972
Gold Mining	-	-	-	25,632,184	27,946,111	26,382,972
Manufacturing	56,543,665	55,859,098	58,402,527	1,842,721	2,823,057	2,928,432
Food & Alcoholic Beverages	20,047,563	18,534,247	19,235,197	1,654,418	2,619,064	2,717,888
Food Processing	10,399,807	8,771,218	9,139,609	1,254,028	1,998,120	2,082,041
Alcoholic Beverages	9,022,156	8,931,457	9,244,058	-	-	-
Tobacco Products Manu	625,600	831,572	851,530	400,390	620,944	635,847
Textiles, Wearing Apparel & Leather Tanneries	9,879,975	12,230,618	12,756,535	-	-	-
Paper & Paper Products, Printing & Publishing	87,133	66,691	68,625	49,853	44,993	46,298
Chemical Products Other than Petroleum	121,515	114,231	118,343	-	-	-
Rubber & Plastic Products	121,515	114,231	118,343	-	-	-
Petroleum Products Except Refinery	17,987	19,523	19,894	-	-	-
Non-Metallic Mineral Products	1,808,550	1,822,500	1,879,372	-	-	-
Other Non-Metallic Products	1,808,550	1,822,500	1,879,372	-	-	-
Basic Metal Industries	24,241,552	22,680,938	23,921,329	-	-	-
Iron and Steel	1,296,000	1,512,000	2,074,985	-	-	-
Non-Ferrous Metal Industries	22,945,552	21,168,938	21,846,344	-	-	-
VALCO	22,945,552	21,168,938	21,846,344	-	-	-
Manufacture of Machinery and Equipment	339,390	390,350	403,232	138,450	159,000	164,247

Source: Based on Energy Intensity Survey, 2002 (Energy Commission and CEPA, Accra)

Appendix Table A.3: Consumption of Kerosene and Liquefied Petroleum Gas by Activity

	Kerosene Consumption (liters)			Liquefied Petroleum Gas (kgs)		
	1999	2000	2001	1999	2000	2001
ALL ECONOMIC ACTIVITIES	239,348	737,839	833,808	6,472,762	5,811,190	6,002,191
INDUSTRIAL SECTOR	213,437	658,539	799,938	3,817,615	3,623,696	3,768,801
Mining and Quarrying	-	-	-	209,814	233,215	224,156
Gold Mining	-	-	-	197,325	218,626	206,397
Diamond Mining	-	-	-	12,489	14,589	17,759
Manufacturing	213,437	658,539	799,938	3,805,126	3,609,107	3,751,042
Food & Alcoholic Beverages	69,824	71,750	74,261	568,255	418,213	435,766
Food Processing	-	-	-	565,319	416,489	433,982
Alcoholic Beverages	69,824	71,750	74,261	2,936	1,724	1,784
Textiles, Wearing Apparel & Leather Tanneries	-	-	-	83,712	99,876	104,171
Wood & Wood Products	-	-	-	28,524	19,475	20,312
Paper & Paper Products, Printing & Publishing	30,655	79,662	81,972	537,500	516,000	530,964
Chemical Products Other than Petroleum	-	-	-	230,723	205,871	213,282
Chemical & Pharmaceutical Products	-	-	-	12,071	12,025	12,534
Rubber & Plastic Products	-	-	-	218,652	193,846	200,748
Petroleum Products Except Refinery	-	-	-	80,000	111,500	113,619
Basic Metal Industries	83,694	459,333	594,333	2,073,944	1,998,109	2,084,943
Non-Ferrous Metal Industries	83,694	459,333	594,333	2,073,944	1,998,109	2,084,943
VALCO	-	-	-	1,041,630	979,242	1,010,578
Basic Household Alum Goods	-	416,068	549,195	36,366	41,172	54,346
Cutlery & Other Non-Ferrous Metal	83,694	43,265	45,138	995,948	977,695	1,020,019
Manufacture of Machinery and	29,264	47,794	49,371	202,468	240,063	247,985
SERVICES SECTOR	25,911	79,300	33,871	2,655,147	2,187,494	2,233,391
Wholesale/Retail Trade, Hotels & Rest	-	-	-	790,729	761,948	819,785
Cold Storage Companies	-	-	-	350,000	364,083	364,083
Hotels & Restaurants	-	-	-	440,729	397,864	455,702
Restaurants	-	-	-	94,195	52,119	107,589
Hotels	-	-	-	346,534	345,745	348,113
Transport, Storage & Communication	-	-	-	8,601	5,691	8,171
Posts and Telecommunication	-	-	-	8,601	5,691	8,171
Finance, Insurance, Real Estates & Business Serv	-	-	-	9,672	7,472	5,788
Community Social and Personal Services	25,911	79,300	33,871	1,846,146	1,412,384	1,399,647
Government Services	-	-	-	-	-	-
Community Service	25,911	79,300	33,871	1,846,146	1,412,384	1,399,647
Educational Services	1,911	1,000	804	1,124,054	895,804	818,054
Research & Allied Institutions	24,000	28,800	33,067	73,438	58,526	53,446
Health, Medicare & Nutrition	-	-	-	647,865	457,190	525,290
Personal and Household Services	-	49,500	-	789	864	2,857

Source: Based on Energy Intensity Survey, 2002 (Energy Commission and CEPA, Accra)

Appendix Table A.4: Consumption of Woodfuels by Activity

	Charcoal Consumption (kilograms)			Firewood Consumption (kilograms)		
	1999	2000	2001	1999	2000	2001
ALL ECONOMIC ACTIVITIES	9,676	10,704	12,523	597,552	449,802	469,601
INDUSTRIAL SECTOR	-	-	-	525,338	386,188	402,696
Manufacturing	-	-	-	525,338	386,188	402,696
Food & Alcoholic Beverages	-	-	-	8,829	7,008	7,302
Food Processing	-	-	-	8,829	7,008	7,302
Wood & Wood Products	-	-	-	490,820	369,611	385,504
Chemical Products Other than Petroleum	-	-	-	6,054	4,625	4,792
Chemical & Pharmaceutical Products	-	-	-	6,054	4,625	4,792
Non-Metallic Mineral Products	-	-	-	19,635	4,944	5,098
Other Non-Metallic Products	-	-	-	19,635	4,944	5,098
SERVICES SECTOR	9,676	10,704	12,523	72,214	63,614	66,904
Wholesale/Retail Trade, Hotels & Rest	2,911	3,222	4,175	-	-	-
Cold Storage Companies	667	765	875	-	-	-
Hotels & Restaurants	2,244	2,457	3,300	-	-	-
Hotels	2,244	2,457	3,300	-	-	-
Transport, Storage & Communication	337	339	312	-	-	-
Posts and Telecommunication	337	339	312	-	-	-
Finance, Insurance, Real Estates & Business Serv	-	-	-	-	-	-
Community Social and Personal Services	6,429	7,143	8,036	72,214	63,614	66,904
Community Service	6,429	7,143	8,036	72,214	63,614	66,904
Educational Services	6,429	7,143	8,036	29,214	25,714	23,214
Research & Allied Institutions	-	-	-	25,000	25,400	28,690
Health, Medicare & Nutrition	-	-	-	18,000	12,500	15,000

Source: Based on Energy Intensity Survey, 2002 (Energy Commission and CEPA, Accra)

Appendix Table A.5: Consumption of Premix and Aviation Jet Fuel by Activity

	Premix Fuel (liters)			Aviation Jet Fuel (liters)		
	1999	2000	2001	1999	2000	2001
ALL ECONOMIC ACTIVITIES	49,133,086	43,647,103	41,066,164	28,786,450	35,648,509	40,150,941
AGRICULTURAL SECTOR	49,133,086	43,647,103	41,066,164	-	-	-
Marine Fishing	49,133,086	43,647,103	41,066,164	-	-	-
SERVICES SECTOR	-	-	-	28,786,450	35,648,509	40,150,941
Transport, Storage & Communication	-	-	-	28,786,450	35,648,509	40,150,941
Transport and Haulage	-	-	-	28,786,450	35,648,509	40,150,941

Source: Based on Energy Intensity Survey, 2002 (Energy Commission and CEPA, Accra)

Appendix Table B: Electricity Consumption in the modern Sector by Activity

	Electricity Consumption (kWh)		
	1999	2000	2001
ALL ECONOMIC ACTIVITIES	2,953,428,294	3,609,540,514	3,765,015,793
AGRICULTURAL SECTOR	657,469	840,679	639,486
Poultry & Livestock	448,505	371,979	336,972
Irrigation	208,964	468,700	302,514
INDUSTRIAL SECTOR	2,576,093,513	3,169,299,825	3,295,701,826
Mining and Quarrying	889,902,459	920,446,680	875,066,061
Gold Mining	870,266,101	900,388,183	850,025,834
Diamond Mining	11,241,230	11,814,320	14,381,290
Bauxite	3,243,590	3,304,776	4,692,779
Manganese	3,050,500	3,205,500	3,854,688
Stone Quarrying	2,079,835	1,681,901	2,013,398
Salt Mining	21,203	52,000	98,072
Manufacturing	2,398,318,487	2,981,463,080	3,097,869,258
Food & Alcoholic Beverages	94,423,948	87,183,692	90,616,985
Food Processing	62,171,975	58,383,313	60,835,412
Alcoholic Beverages	29,701,577	26,362,255	27,284,934
Tobacco Products Manu	2,550,396	2,438,124	2,496,639
Textiles, Wearing Apparel & Leather Tanneries	43,947,866	50,326,464	52,490,502
Wood & Wood Products	88,155,812	91,884,523	95,835,557
Paper & Paper Products, Printing & Publishing	11,998,825	12,800,237	13,171,444
Chemical Products Except Petroleum	76,933,793	64,755,809	68,109,276
Chemical & Pharmaceutical Products	47,415,866	28,968,705	29,341,225
Rubber & Plastic Products	29,517,927	35,787,104	38,768,051
Petroleum Products Except Refinery	5,043,753	4,762,772	4,853,265
Non-Metallic Mineral Products	78,100,759	71,561,779	74,918,616
Cement Products	73,075,220	66,091,980	69,278,129
Other Non-Metallic Products	5,025,539	5,469,799	5,640,488
Basic Metal Industries	1,989,348,100	2,588,125,606	2,687,479,362
Iron and Steel	17,086,268	31,402,757	43,095,401
Non-Ferrous Metal Industries	1,972,261,832	2,556,722,849	2,644,383,961
VALCO	1,928,826,066	2,505,316,797	2,586,060,261
Basic Household Alum Goods	18,440,655	16,959,546	22,386,003
Cutlery & Other Non-Ferrous Metal	24,995,111	34,446,506	35,937,697
Manufacture of Machinery & Equipment	10,365,631	10,062,198	10,394,251
Electricity Gas and Water	164,387,455	174,132,337	181,445,895
Electricity Generation & Distribution	10,405,342	11,134,326	11,601,968
Water Supply & Treatment	153,982,113	162,998,011	169,843,927
Construction	2,146,341	1,890,088	2,005,383
SERVICES SECTOR	376,677,312	439,400,010	468,674,481
Wholesale/Retail Trade, Hotels & Rest	81,902,557	96,758,006	106,972,874
Wholesale/Retail Trade (Commerce)	37,324,496	48,752,798	61,187,881
Cold Storage Companies	11,678,929	14,158,270	14,506,133

Hotels & Restaurants	32,899,132	33,846,938	31,278,860
Restaurants	5,091,254	5,429,173	4,504,998
Hotels	27,807,878	28,417,765	26,773,862
Transport, Storage & Communication	57,577,311	62,184,425	59,531,885
Transport and Haulage	38,672,042	39,441,850	36,729,545
Posts and Telecommunication	18,905,269	22,742,575	22,802,340
Finance, Insurance, Real Estates & Buss Serv	54,152,121	62,161,184	63,756,481
Community Social and Personal Services	183,045,323	218,296,395	238,413,241
Government Services	8,997,648	9,041,534	9,771,926
Community Service	116,445,192	122,455,306	121,448,884
Public Safety, Law and Order	30,040,037	31,971,660	32,276,225
Educational Services	31,736,207	35,332,129	32,929,113
Research & Allied Institutions	2,178,033	2,094,614	2,178,473
Health, Medicare & Nutrition	24,670,588	26,410,166	28,699,853
Recreation and Cultural Services	22,948,960	21,182,117	20,551,777
Personal and Household Services	4,871,367	5,464,620	4,813,443
Producers of Private Non-Profit Services	29,952,323	44,982,495	55,278,811
International & Extra-Territorial Organizations	27,650,160	41,817,060	51,913,620

Based on Energy Intensity Survey, 2002 (Energy Commission and CEPA, Accra)