TOWARDS A RELIABLE AND SUSTAINABLE SOURCE OF ELECTRICITY FOR MICRO AND SMALL SCALE LIGHT INDUSTRIES IN THE KUMASI METROPOLIS

By

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DECLARATION

I hereby declare that this submission is my own work toward the MSc. and that, to the best of my knowledge, it contains neither materials previously published by another person or materials which have been accepted for the award of any other degree by this or any other university except where due acknowledgement has been made in the text.

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ABSTRACT

Access to energy is a key factor in a country's socio-economic development agenda. Based on this premise, immediately after independence Ghana endeavoured to ensure that there is reliable and sustainable access to electricity. However, due to the increasing demand for electricity and the effects of climate on the Hydro Electric Power (HEP), Ghana's electricity supply has been rendered unreliable and unsustainable. The situation is expected to be more critical in the coming years since demand for electricity is expected to increase considerably by 2030. Thus, there is a growing demand for alternatives that neither depend on the weather nor fossil fuel for survival. The thrust of this study was to contribute to the discourse in search for alternatives that can continuously supply the electricity needs of micro and small scale industries (MSI) for productive activities. The search for the alternatives was preceded with an examination of the effects of Ghana's electricity supply and tariffs structure on the operations of MSIs. The study directly interviewed 320 MSIs and 8 institutions for primary data with the help of questionnaires and interview guides to supplement secondary data from literature. The study identified that Ghana's intermittent electricity supply is a major challenge to the MSIs. Some of the MSIs interviewed have acquired alternative sources of electricity such as petrol/diesel-powered generators to ensure continuous supply of electricity with extra operational costs ranging from GH¢10.5 to GH¢16.5 every month besides the perceived high tariffs they paid to the Electricity Company of Ghana (ECG). Consequently, 82.5 per cent of the entrepreneurs wished for a more reliable and sustainable source of electricity. The study further revealed that Ghana has identified the solution to the intermittent power supply to lie with the exploitation of five non-conventional Alternative Sources of Electricity (ASEs). Subjecting the five ASEs to further analysis revealed that solar energy can immediately be used to supply the MSIs' electricity needs. However, its exploitation is constrained by the lack of legislative instruments, high cost and thefts of movable parts. Based on these challenges, the study recommended the immediate passing of the renewable energy bill into law to serve as a regulatory framework for solar energy development. Additionally, the study recommended for the adoption of flexible terms of payment to enable the industrialists to pay for the solar system.

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LIST OF ABBREVIATIONS AND ACRONYMS

AGI	Association of Ghana Industries
AEI	Alternative Energy Institute
ASEs	Alternative Sources of Electricity/Energy
CEPA	Centre for Policy Analysis
CO_2	Carbon dioxide
COP 15	15th Conferences of the Parties
CRA	Charles River Associates
DCs	Developed Countries
DFID	Department for International Development
ECG	Electricity Company of Ghana
GDP	Gross Domestic Product
GEDP	Ghana Enterprises Development Commission
Gov't	Government
Gp	Ghana Pesewas
GSS	Ghana Statistical Service
GW	Gigawatt
GWh	Gigawatt hour
HEP	Hydro Electric Power
ICAX	Interseasonal Capture and eXchange
IEA	Institute of Economic Affairs
ILO	International Labour Organisation
ISSER	Institute for Statistical Social and Economic Research
KDI	Korea Development Institute
KNUST	Kwame Nkrumah University of Science and Technology
LDCs	Less Developed Countries
LSE/LSI	Large Scale Enterprises/Large Scale Industries
MDG	Millennium Development Goals
MOE	Ministry of Energy, Ghana
MoFEP	Ministry of Finance and Economic Planning
MSEs	Micro and Small Scale Enterprises/Industries
MSF	Ministry of Strategy and Finance, Republic of Korea
MW	Megawatt
n.d.	No date

NBSSI	National Board for Small Scale Industries
NDPC	National Development Planning Commission
NEP	National Energy Policy
NHIL	National Health Insurance Levy
PV	Photovoltaic
RETs	Renewable Energy Technologies (Alternative Sources of Energy)
SMEs	Small and Medium Scale Enterprises
SNEP	Strategic National Energy Plan
TEDA	Tamilnadu Energy Development Agency
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational Scientific and Cultural Organisation
US	United States
VALCO	Volta Aluminium Company
VAT	Value Added Tax
VRA	Volta River Authority

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CHAPTER ONE
GENERAL INTRODUCTION

1.1. Background to the Study

Energy is the key which unlocks all other resources, and will continue to be the answer to human's physical prosperity by fuelling the modern world (NDPC, 2008: p.182). The per capita availability of energy to humans directly or indirectly determines their material standard of living (Youngquist, 2000: p.1). Thus, energy serves as the backbone to all industrial productions in the world (including micro and small scale industries that dominate in Ghana). In view of this, a sustainable and adequate energy source is required for the continued existence of industries in Ghana premising on the fact that industrialisation holds the key to a country's socio-economic development (NDPC, 2008: p.58).

Providing adequate energy for the current and future generations introduces two major important issues, energy reliability and sustainability, that require policy actions toward energy for sustainable development. These concepts suggest that a country's energy resources should not only be readily available when needed but also meet both the current and the future needs without fear of depletion. Therefore, Ghana's middle income vision through growth and poverty reduction can better be enhanced if its energy supplies are reliable and sustainable (Ofosu-Ahenkorah, 2008: p.54). This argument is underpinned on the fact that the micro and small scale enterprises (MSEs) sub-sector is the fastest growing sub-sector in developing countries employing majority of the urban labour force and providing incomes to households and local & central governments (ILO cited in UNESCO, 1995; Owusu and Lund, 2004). It is through MSEs that Ghana can hope to reduce poverty significantly among its populace by 2015. These MSEs need reliable and sustainable supplies of energy to continue to play their poverty reducing roles of employment creation and income generation.

Based on the above background (the nexus between energy and poverty reduction), immediately after independence, Ghana identified the path to development to lie with industrialisation which in turn depended on adequate and reliable supplies of energy. Consequently, the First Republican Government (1957-1966) embarked upon import substitution industrialisation and reinforced import protectionism as part of its drive to reduce Ghana's economic dependence and the undue pressure on the balance of payments caused by rapidly increasing imports and stagnant export earnings (NDPC, 2008:p.58).

Ensuring the sustenance of these industries called for reliable electricity supplies for industrial production. Consequently, the Akosombo Dam was constructed in 1964 at a cost of £130 million to provide hydro electric power mainly to supply the Volta Aluminium Company (Ofosu-Ahenkorah, 1995). Hydro electric power has been the highest contributor to the total amount of electricity produced in Ghana, increasing from 52.2 per cent in 2007 to 73.7 per cent in 2008 and falling to 66.7 per cent in 2009 (Wuddah-Martey, 2009). Due to this, industrialisation in Ghana is heavily dependent on electricity supplied from the hydro electric power sources (Akosombo and Kpong dams).

Despite their significance in Ghana's industrialisation, the dams have not only been characterised by inability to supply enough electricity to meet a middle income economic status (evident in electricity backlog of 3,615 megawatts in 2009 estimated to decrease slightly to 2,135 megawatts by 2012) but also unreliability due to unfavourable weather conditions. For instance in 2007, due to the low amount of rainfall, the level of the water in the Akosombo reservoir reduced to an unprecedented level of 240.00 feet, about 15.8 per cent lower than the minimum water level required to render the turbines effective and efficient (Otchere, 2006).

Whilst Ghana is besieged with a deficit of 3,615 megawatts as of 2009, the Government of Ghana not only wishes to extend electricity to cover the two-thirds non-served population but also hopes to export electricity by 2012 and 2013 (Daily Graphic, 22/04/09; Ofosu-Ahenkorah, 1995;). This implies that in its bid to ensuring "a universal access to modern energy forms to all Ghanaians by 2020", the government needed to augment the level of investment in the energy sub-sector. In responding to this, the government is constructing the Bui dam at a cost of US$630 million to provide additional 400 megawatts of electricity (Akuffo, 2008: p. 20).

However, global trends indicate that the world's climate is ever changing in the face of global warming which is an indication that the rainfall pattern is forever going to be erratic (Gyau-Boakye, 2001; Niasse, 2005; DFID, 2008). Thus, any energy source that depends on the rainfall regime is not sustainable (DFID, 2009: p.11). This debates the reliability and sustainability of the Bui Dam Project (Liqa-Sally *et al*, 2006). It is important to also state that the rivers (Black Volta and River Volta) on which the two dams (Akosombo and Kpong) have been established are international ones with geopolitical implications (Gyasi, 2008: p

57). Thus the unreliability of electricity supply in Ghana threatens the operations of MSEs which in turn mitigate the growth and poverty reduction agenda of the Government of Ghana. Emanating from the above concerns, what is the way forward towards a "rainfall-free' source of electricity for MSEs particularly light industries in Kumasi? This study will attempt to provide the answers to this complex question.

1.2. Problem Statement

The contribution of the informal sector, mainly MSEs to national development has been enormous. The micro and small scale industries continue to be the fastest growing sector of the economies of developing countries employing about 61 per cent of the urban labour force (ILO cited in UNESCO, 1995). Despite this, their operations have been engulfed by inadequate and unreliable power (electricity) supply rendering them unproductive and inefficient.

The inadequacy in power supply stems from the country's electrical energy backlog of 3,615 megawatts (MW) as at the end of 2009. The current total installed power generation capacity in the country is 1,385 MW whilst about 5,000 MW are required to sustain all industrial operations toward a middle income economy (Daily Graphic, 22/04/09). The operational power generation capacity, though expected to rise to 2,665 MW by the year 2015, will still leave a backlog of 2,335 MW (46.7 per cent of the required quantity). Besides inadequate electricity supply, the current sources of electricity are unreliable and this is evident in the interrupted power supplies (Gyasi, 2008: p.71). Due to the unreliable electricity supply, industries in Ghana ranked interrupted power supply highest among 13 other problems. Several firms shut down during the 2007 power rationing in Ghana (Adomako, 2007). Hence, CEPA (2007) argues that the continued growth and development of MSEs is threatened.

Ghana's precarious electricity situation is further compounded by global warming which is rendering all rainfall-dependent sources shaky (Gyau-Boakye, 2001; DFID, 2008). Sadly, 60 per cent of Ghana's total electricity supplies are in the form of hydro electric power (HEP) whose efficiency depends on the rainfall regime (Koffi, 2009). Thus, HEP is unreliable and unsustainable with evidence from the 1983/84, 1998 and 2007 erratic rainfall regimes that resulted in power rationing (CEPA 2007). The increasing temperatures and the diminishing volumes of the tributaries of River Volta (White Volta, Black Volta, River Oti, etc.) further compound the situation (Gyau-Boakye, 2001; Niasse, 2005). It is without doubt therefore that the sustenance of the industrial operations and their "trickle down effects" in Ghana depends on the sustenance of the Akosombo and the Kpong dams as well as the Bui dam under construction.

Realising the inadequacy, unreliability and non-sustainability of the hydro electric power and the difficulties faced by the industrial sector in their operations (expensive power supply), the government of Ghana has resolved to provide universal access to and choice of modern energy forms to all Ghanaians. It also hopes to be a net exporter of electricity by 2012 and 2013 (Daily Graphic, 22/04/09). These policy goals can only be realised with alternative sources of electricity (ASEs) technologies that are understood to be sustainable and environment-friendly. This subsequently calls for the examination of available ASEs for the supply of the electricity needs of MSIs in Kumasi.

1.3. Research Questions

This study provides answers to the following questions:

- How does Ghana's electricity supply and tariff structure affect the operations of micro and small scale light industries;
- Which ASEs are able to provide the electricity needs of the micro and small scale light industries?
- How ready is Ghana for ASEs to supply the electricity needs of consumers?
- How ready and able are the entrepreneurs for the adoption of ASEs for their electricity needs?
- What challenges should Ghana overcome in order to fully exploit the potentials in the ASEs? and
- What is the way forward?

1.4. Research Objectives

Emanating from the research questions, the general objective of the study was to examine the extent to which ASEs could supply the electricity needs of MSIs, identify the challenges against their (ASE's) development and suggest possible ways of managing them (challenges).

Specifically, the study sought to achieve the following objectives:

- To examine the effects Ghana's electricity supply and tariff structure have on the operations of micro and small scale light industries in Kumasi.

- To identify the ASEs that can supply the electricity needs of the micro and small scale light industries.
- To assess Ghana's readiness to exploit its ASEs potentials for the supply of electricity to consumers.
- To examine the micro and small scale light industries' readiness for and ability to adopt ASEs.
- To identify the challenges that Ghana needs to overcome in order to fully exploit the potentials in the proposed ASEs.
- To recommend ways to manage the identified challenges.

1.5. Justification of the Study

In view of the ever-increasing global demand for energy, the difficulty in expanding the conventional sources of energy to meet the growing demand and the effects posed on the environment by fossil fuels, the ultimate goal for the global community has been two-track. The two-tracked goal of the global community focuses on the provision of reliable energy and the mitigation of climate change by reducing carbon dioxide (CO_2) emissions. Accordingly, countries around the world are working around the clock to identify for full exploitation, reliable and sustainable sources of energy to sustain their industries and cater for other users of energy. This study will thus contribute to identifying the reliable and sustainable source(s) for the required breakthrough.

Additionally, this study's findings and recommendations will help manage the problems of inadequate and unreliable electricity supply in Ghana which adversely affect the industrial sector. The sustainable and reliable sources to be identified will enable the micro and small scale light industries which employ about 5 per cent of the labour force in the informal sector, to enjoy sustained growth toward Ghana's poverty reduction agenda.

Furthermore, this study will be used as a point of reference for future studies that will hope to examine the effects unreliable sources of electricity pose on the operations of micro and small scale light industries. Moreso, the study will have policy implications especially on the revelation of Ghana's electricity tariff structure on the operations of MSEs. In sum, this study has empirical information having policy significance on the formulation of energy policies that will better respond to the contemporary needs of Ghana amidst increasing demand for energy.

1.6. Scope of the Study

For easy clarity in the study, the scope of the study has been compartmentalised into three sections namely, geographical, contextual and time scopes.

1.6.1 Geographical Scope

The study was undertaken in three light industrial clusters in the Kumasi Metropolis. The light industrial clusters included the Suame Magazine Industrial Enclave, Sokoban Wood Village and the Central Business District (CBD). Within the Suame Magazine Industrial Enclave, straightening and welding firms, and spraying firms were selected for the study. Similarly, the wood processing firms were selected from the Sokoban Wood Village (erstwhile Anloga Wood Industry). Lastly, light industries such as cold stores, dressmaking firms, printing presses, sachet water producing firms and grinding mills within the CBD were selected for the study.

1.6.2. Contextual Scope

The study examined the effects Ghana's electricity supply and tariff structure pose on the operations of micro and small scale industries. The study identified the alternative sources of electricity that can provide MSE's electricity needs. Following this, the study examined the extent to which Ghana's energy policies make provisions for the exploitation of ASEs for the supply of the electricity needs of consumers including micro and small scale industries. The study further examined the challenges against the use of alternative energy sources in Ghana and suggested practicable ways to manage them (challenges).

1.6.3. Time Scope

The study is limited to the period between 2006 and 2020 though 2030 projections were considered. First, the Strategic National Energy Plan (SNEP) that forecasts energy demands in Ghana was reviewed. The National Energy Policy (NEP, 2010 - 2015) which emanated from the SNEP to guide all interventions in the energy sub sector was also reviewed. These two documents (SNEP and NEP) revealed Ghana's preparedness to exploit its potentials in the provision of clean, safe, reliable and environment-friendly energy. Thus, the provisions made for the exploitation of ASEs for electricity supply was assessed.

1.7. Limitations of the Study

The first limitation of the study was the improper records keeping behaviour of the entrepreneurs. This constrained the study's attempt at empirically determining the extent of effect the unreliable nature of Ghana's electricity supply has on the operations MSIs. Due to the entrepreneurs' poor record keeping attitude, the study discussed the effects from their perspective without any other source of information to triangulate it.

The Suame Magazine Mechanical Association (MMA), the main mouthpiece of the industrialists within the Suame Magazine Industrial Enclave, was oblivious of the total membership size of the individual enterprises. Thus apart from their total membership size, the MMA could not provide the number of straighters and welders, and sprayers. This constrained the study in its determination of a sample size. However, Obeng (2000 cited in Adeya, 2006: p.2) estimates the total number of enterprises at 16,000. Based on this the study determined the sample sizes for the firms on the assumption that they had the same numerical strength.

Lastly, Ghana's energy policies have not provided for ASEs such as ocean thermal and tidal energy, and hydrogen and fuel cells which are believed to provide safe and reliable energy. Due to the lack of policy support for the above ASEs, the study could not consider them in the analysis. The study thus made use of wind energy, solar energy, wood fuels power, small and mini-hydros power and landfills that were considered in the energy policies. Additionally, landfill gas which is about 40-60 per cent methane, and emits dioxins is seen as non-green energy in the literature. However, it is considered as an ASE by Ghana's energy policies. Thus, the study was compelled to analyse landfill gas among the other ASEs.

CHAPTER TWO

CONCEPTUAL ISSUES IN THE USE OF ALTERNATIVE ENERGY FOR MICRO AND SMALL SCALE LIGHT INDUSTRIES

2.1. Introduction

This chapter first provides a general overview of micro and small scale industries (MSIs) in Ghana and the role electricity plays in their development. Though chapter one identified the electricity supply backlogs and unreliability in Ghana, this chapter further elucidates the effects the expansion difficulty has on the sustenance of MSIs. The effects are linked to the skyrocketing demand for energy and the depletion of the conventional sources of electricity. The chapter further recounts the need for the exploitation of non-conventional sources of electricity for industrial development. The chapter also conceptualises that the exploitation of alternative sources of electricity could facilitate poverty reduction and ensure environmental sustainability.

2.2. The Role of Micro, Scale Small and Medium Scale Industries (MSMIs) in National Development

The examination of the role that MSMIs play in national development is done by first defining MSMIs and light industries. The definitions gave prominence to definitions used by authorities in Ghana. This is based on the differences that exist among countries' definitions of MSMIs. Definitions of light industries were also reviewed.

2.2.1. Definition of MSMIs

Storey (1994, cited in Kayanula and Quartey, 2000: p.5) argues that there is no universally accepted definition for the term micro and small scale industries (MSMIs). Definitions that emphasise the size of firms (number of employees, turnover, profitability, etc.) when applied to a sector could lead to all firms being classified as small, while the same size criterion when applied to a different sector could lead to a different result (Abor and Adjasi, 2007 cited in Kufour, 2008: p.3). Thus, firms differ in their levels of capitalisation, sales and employment. This has challenged any attempts at deriving a uniform definition for MSMIs. Despite this challenge, attempts have been made to distinguish between small and medium scale industries.

Kayanula and Quartey (2000: p.6) reveal that the first attempt to overcome the definition challenge was by the Bolton Committee in 1971. The Bolton Committee used different criteria (number of employees, assets and turnover) to classify industries as small, medium and large scale industries (SMIs). The attempt did not provide a definition for micro scale industries. Thus, the definitions of micro scale enterprises were given a consideration in the latter years (1990s).

Under the manufacturing, construction and mining and quarrying sub-sectors, the number of employees was used as the indicator for distinguishing small scale enterprises from medium scale and large scale enterprises. Whilst manufacturing firms that employ less than 200 workers are considered small, enterprises in the construction and mining sectors are classified as small if they employ less than 25 workers.

In using a firm's turnover as another distinguishing feature, the Committee pointed out that a turnover of 50,000 pounds sterling or less is used to classify retail firms, miscellaneous firms and service firms as small. Additionally, a turnover of 100,000 pounds or less is used to classify motor firms and wholesale firms as small. Thus, whilst a turnover of 50,000 pounds or less is used to classify retailing firms, miscellaneous firms and service firms as small, turnover of 100,000 pounds or less is used to classify motor trades and wholesale trades as small. In the case of road transport firms, the number of vehicles owned by the firm is used as the index for the classification. A road transport firm is classified as small if it owns five vehicles or less.

In terms of ownership of SMIs, the Bolton Committee argues that there is a difficulty distinguishing between ownership and control. Thus, owners of SMIs play dual function (controllers and owners). From the above, the study notes that different criteria are used for classifying firms into different scales.

Kayanula and Quartey (2000: p.7) criticise the Bolton Committee's definitions for using three different upper limits of turnover for the different sectors and two different upper limits of employees. They assert that the definition is complex and do not allow for cross-country comparison. Additionally, the use of monetary units as a basis for comparison is problematic. Using monetary units requires frequent updating to take account of general price changes. Due to the difficulty in defining SMIs especially having a definition that applies to all countries, Storey (1994 cited in Kufour, 2008: p.3) argues that there is a wide range of measurements for SMIs that vary from country to country.

Premising upon the differences that exist among countries' definition of SMIs, this study considered definitions from official sources in Ghana as most relevant. The most commonly used criterion in Ghana is the number of employees (Kayanula and Quartey, 2000: p. 9). The Ghana Statistical Service (GSS) (2006) considers firms with less than 10 employees as small scale and those with more than 10 employees as medium and large-sized regardless of the sector. Thus, the GSS uses the 'employees criterion' used by the Bolton Committee to define small scale enterprise. Ironically, GSS in its national accounts considers companies with 9 employees as medium scale enterprises. These inconsistencies in the employees cut off point breed confusion.

Similarly, Osei *et al*. (1993, cited in Kayanula and Quartey, 2000: p.9) use an employment cut off point of 30 workers, different from the cut off point used by the GSS, to define small scale enterprises. Osei *et al*'s definition, however, disaggregates small scale enterprises into three categories: micro, employing less than 6 people; very small, employing 6-9 people; small, employing between 10 and 29 employees and large; employing 30 and above employees. Relating the GSS definition to that of Osei *et al*. reveals a sharp contrast. Whilst firms employing more than 10 workers but less than 30 workers are described as small by Osei *et al*, the GSS describes them as medium.

Due to these differences, the National Board for Small Scale Industries (NBSSI) in Ghana uses both fixed asset and number of employees to define SMIs. The Board defines a small scale industry as one with not more than 9 workers with plant and machinery value (excluding land, buildings and vehicles) of not exceeding US$ 10,000. In adding to NBSSI's definitions, the Ghana Enterprise Development Commission (GEDC) uses a US$ 1,000 upper limit definition for plant and machinery that are excluded from the GSS's definition. Thus, a small scale enterprise is one with not more than 9 workers with plant and machinery value of not exceeding US$ 10,000 and land, buildings and vehicles value of US$ 1,000. Though, the currency criterion requires that the definition is updated frequently to take care of general prices changes, the relative stability of the US Dollar poses little problems (Mensah, 2004: p.1).

In his definition, Mensah (2004) combines the employment criterion with the value of assets owned by an enterprise to categorise industries into micro, small and medium scale enterprises. He describes micro enterprises to include all enterprises employing up to 5 workers with fixed assets (excluding estate) not exceeding US$ 10,000. For an enterprise to be classed as a small scale enterprise, it ought to employ between 6 and 29 workers with a total fixed assets value ranging from US$ 10,000 to US$ 100,000. A medium scale enterprise must also employ between 30 and 99 workers with fixed assets value ranging between US$ 100,000 and US$ 1,000,000. Mensah's definition, though comprehensive relative to the others, does not consider the 'ownership criterion' contained in the Bolton Committee's definition.

Informed by the limitation in Mensah's definition, this study defines micro scale enterprises as firms managed by their owners which employ up to 5 workers with fixed assets (excluding estate) not exceeding US$ 10,000. Similarly, the study defines small scale enterprises as enterprises managed by owners (or part owners in a personalised way, and not through the medium of a formalised management structure) which employ between 6 and 30 workers with total fixed assets value not exceeding US$ 100,000. The similarity in the definitions of micro and small scale enterprises is the type of ownership. Micro scale enterprises are wholly managed by ownership whilst the management of small scale enterprises also involves the owners.

On the other hand, medium scale enterprises are enterprises that are managed by owners or involve owners in a personalised way, and employ between 30 and 99 workers with fixed assets value between US$ 100,000 and US$ 1,000,000. The definitions of MSMIs satisfy both the number of employees criterion, the type of ownership and the financial criteria, argued by Kufour (2008: p. 4) as issues that all definitions of MSMIs should consider. The definition of small scale enterprise takes care of micro scale enterprises and did not attempt to distinguish between them.

2.2.2. The Concept of Light Industries

A light industry is a manufacturing activity that uses moderate amounts of partially processed materials to produce items of relatively high value per unit weight (Tuebal, 1973; Wikipedia Encyclopaedia, 2010). Thus, a light industry adds value to intermediate commodities to produce higher quality (measured in terms of weight and price) products. This definition overly concentrates on the high value of the products from the light industries with no consideration given to the industries' spatial harmony and employment creation through labour intensiveness.

Based on the identified shortcomings of the above definitions, Sullivan and Steven (2003: p. 493) define a light industry to refer to a part of an economy's secondary industry that is usually less capital intensive and more consumer-oriented (i.e., the products are produced for end-users rather than as intermediates for further production). They further indicate that light industries have less environmental effects and due to this, zoning laws are more likely to permit them (light industries) near residential areas. Thus, residential land-uses can perform multiple functions (for dormitory purposes and industrial purposes) (Anitei, 2008: p.1).

The Land Use Planning Division of the Multnomah County of the State of Oregon in the United States of America adds that light industries have unique characteristics described under 5 sub-headings: – *site development, environmental impact, employment characteristics, transportation impact and visibility*. Under site development, the Division points out that light industries are 'light-clean industries' that usually occupy small land areas (usually from 1-6 acres). Under environmental impact, the Division asserts that light industries have little or no air or water pollution, no noise or objectionable odours and the wastes are easily disposed off. Under employment characteristics, the Land Use Planning Division maintains that light industries have 20 employees per acre, 25 per cent or more female employees and operate on one shift basis. The Division further argues that light industries have little truck-traffic and little process visibility discussed under the sub-headings transportation impact and visibility respectively.

From the above, the study defines light industries with cognition given to the meaning of MSMIs above. Light industries are defined to mean a part of an economy's secondary industry characterised with labour intensive methods of production, are consumer oriented and the production of high quality products with very little environmental effects. The micro and small scale light industries employ less than 100 workers with an overall asset value not exceeding US$ 100,000. Due to the less environmental consequences of light industrial operations, zoning laws less affect them and operate on relatively lower surface areas measured in acres of land occupied.

2.2.3. The Role of Micro, Small and Medium Scale Light Industries (MSMIs) in National Development

The MSF and KDI (2009: p. 34) argue that MSMIs play diverse roles in the development of national economies. Similarly, Kayanula and Quartey (2000: p.11) and NDPC (2003: p.22) point out that MSMIs have been recognised as the engines through which the growth objectives of developing countries can be achieved. They are potential sources of employment and income generation in many developing countries. Gibson and van der Vaart (2008: p.1), however, indicate that there is a considerable disagreement within development policy circles against the notion that MSMIs provide efficient jobs for national development. This contrasting argument considers the role of the overall business environment in any given country to national development and not the MSMIs in isolation. The critics further maintain that MSMIs are characterised by high degrees of inefficiencies and low productivity and thus their contribution to national development has been marginal. This explains why countries with MSMIs dominance are observed to be underdeveloped (Bartlett and Bukvi, 2004: p.1)

The MSF and KDI (2009: p. 34), strongly oppose the claim that MSMIs play marginal roles in national development. They point out that the MSMIs sub-sector is the highest contributor of employment in many countries employing more than 70 per cent of the labour force in most Less Developed Countries (LDCs). Albaladejo (2002 cited in MSF and KDI, 2009: p.34) aligned to MSF and KDI's assertion also maintains that MSMIs employ about 60 per cent of the workforce in Ghana, 55 per cent of the workforce in Canada, 70 per cent in the European Union and at least, 70 per cent of private sector workforce in South Korea. In 2006, MSMIs employed around 4.1 million people (42 per cent of total labour force) in Australia (CRA International, 2007: p.2; Bala Subrahmanya, 2008). Thus, in terms of employment creation, MSMIs' roles have been significant.

The point that MSMIs' absorb the labour force in employment made by several authors, is further reaffirmed in an article dubbed the "Export Strategy for the Romanian Light Industries Sector (Textiles; Clothing and Leather)" published about the Romanian economy. The article claimed that the light industrial sector was accountable for 5.5 per cent of GDP, 20.4 per cent of total employment, 9.9 per cent of the industrial production volume and 34 per cent of exports in the year 2004 (Government of Romania, 2010).

Albaladejo (2000 cited in UN, 2006: p.224) and Sullivan and Steven (2003: p. 493) argue that MSMIs tend to be more labour intensive than LSIs. Thus, MSMIs offer a viable source of income to a nation's workforce than LSIs. The more MSMIs that a country has, the higher the sources and rates of employment it is likely to enjoy.

In its contribution to the MSMIs role in national development, UNESCO (n.d.) emphasises that micro and small scale industries are effective tools for rural development. This argument was espoused based on the industries' contribution to the development of Dujaila (in Iraq) through a small scale textile industry established by the Iraqi government in collaboration with the International Labour Organisation (ILO).

The development of large corporations in developing countries is highly dependent on the presence of MSMIs. Rostow explains this in "the Process of Economic Growth" (1952 cited in Malerba and Orsenigo, 1994: p.1) and "Stages of Economic Growth" (1960 cited in Malerba and Orsenigo, 1994: p. 1). He argues that the dynamics of industries usually starts with a take off (small or medium scale but efficient) and then moves to technological maturity, usually associated with high mass consumption (large scale firms that employ high level of factors of production). The MSF and KDI (2009: p.35) reaffirm the claim that MSMIs influence largely the development of LSIs. They maintain that MSMIs cater for the supply and subcontracting needs of the large corporations. MSMIs are more flexible in developing a competitive niche and thereby become specialised suppliers of certain products to LSEs. In addition, healthy and competitive MSMIs are more likely to grow into healthy and competitive large businesses which consequently foster national competitiveness as a whole (MSF and KDI 2009: p.35). The CRA International (2007: p.3) adds that Australia's estimated 1.426 million actively trading MSMIs supply products to larger firms whilst at the same time provide market for their (LSE's) products.

2.3. The Role of Energy in the Development of MSMIs

The important role played by the light industrial sector of an economy will largely be possible if industries have access to energy for their operations (AusAID, 2001: p.2; Velázquez, 2006: p.4-6). Thus, the continuous supply of human needs by industries largely depends on sustainable and affordable energy supplies for industrial operations. This section of the study reviews the link between energy, particularly electricity, and industrial development for national development.

2.3.1. The Role of Energy in Industrial Development

In the view of Oviemuno (2006: p.1), one of the pre-requisites for the development of the manufacturing industries is affordable and abundant supply of energy, particularly, electricity for driving the industries' machinery. This argument is underpinned by the fact that manufacturing industries are the major users of any country's stock of energy. Oviemuno claims that it is due to the significant role energy plays in the development of manufacturing industries that manufacturers always stress on the provision of affordable and reliable electricity for production. Thus, the availability and reliability of energy for industries in a country determines the level of development of the country in question. This is evident in the high quantity of energy consumed by the developed countries relative to that of the developing world (Smith 2005: p.7). Thus, the developed countries are developed mainly because they consume higher amount of energy (AusAID, 2001: p.2; Todaro and Smith, 2009: p.505).

Similarly, Kahane and Squitieri (1987: p.223) reveal that the manufacturing sector of the United State's (US's) economy consumes about 650 billion kWh per year (30 per cent) of the US total electricity production. Due to the manufacturing sector's importance in national development and its large share of energy, mainly, electricity consumption, the proliferation of industries has an important implication for energy sector planning. Thus, the stock of energy in a country needs to be expanded to meet the growing demands of electricity for manufacturing industries for sustained growth of national economies.

In contributing to the significance of energy (electricity) to the development of the manufacturing sector, the NDPC (2008: p.58) points out that the first Government of Ghana sought to build the Akosombo dam to supply electricity to drive her import substitution industrialisation policy. Additionally, the Centre for Policy Analysis - CEPA (2007: p.14) and the MoFEP (2008: p.35) reveal that due to the power rationing exercise in Ghana, the manufacturing sector's contribution to GDP slacked from 9.5 per cent in 2006 to 7.4 per cent in 2008. Unreliable electricity supply in Ghana is subsequently ranked first among 13 problems identified to affect the manufacturing sector (NDPC, 2008: p.64).

Similarly, Velázquez (2006: p.1), pointed out that the rising cost of electricity in the US has affected the operations of industries mainly the MSMIs because they did not have the capacity to invest in production methods that are energy efficient or did not create alternative methods of production (methods that do not rely heavily on energy use). Velázquez further argued that the rising cost of electricity is one of the reasons for inflation in the US.

From the above, Velázquez (2006: p.4-6) concluded that energy was one of the factors that determined manufacturing industries' cost of production which in turn determined the extent of inflationary pressures in an economy. This accentuates the claim by NDPC (2008: p.182) and Youngquist (2000: p.1) that energy is the key which unlocks all other resources, and will continue to be the answer to human‘s physical prosperity by fuelling the modern world. ISSER (2005: p.2) also asserts that the aspirations of developing countries for higher living standards can only be satisfied through sustained development of their electric power markets as part of their basic infrastructure. Thus, the role of energy in national development is indispensable. Oteng-Adjei (2008: p. 103) sums up the link between energy and the development of MSMIs by remarking that "most economic activity would be impossible without energy, even the small-scale village and household enterprises in developing countries that are the main source of income for the poor in those countries".

2.3.2. Electricity Supply for Industries in Ghana

Due to the significant contribution of electricity to national development, this section of the study reviews the efforts that have been made in Ghana to provide adequate and affordable electricity for the development of industries.

Since electricity is observed as a major tool for national development, vigorous efforts have been made to ensure that industries have access to reliable and affordable electricity in Ghana (NDPC 2008: p.182). Electricity in Ghana has thus gone through a period of evolution since the colonial era to present day Ghana. According to the Institute of Statistical, Social and Economic Research (ISSER) (2005: p.16), electricity provision in Ghana has evolved through three stages identified as the 'before Akosombo', 'the hydro-years' and the 'thermal complementation'.

The 'before Akosombo' is the period preceding the first hydro-electric power project in Ghana (before 1966). During that time, diesel generators were used to generate power for industrial, health and private consumption purposes (ISSER, 2005: p.16). The first public electricity supply generated in Sekondi in the Western Region, was mainly for railway system operations. Regional capitals like Accra and Koforidua received their first supply in 1922 and

1926 respectively. By 1955 towns like Cape Coast, Tema, Bolgatanga, Tamale, Kumasi, Nsawam, Dunkwa, and Oda had been supplied with electricity from three major power stations at Cape Coast (1932), Swedru (1948) and Keta (1955). The electricity supplied from these sources were said to be inadequate to meet the demands of the time.

The ‘hydro-years’ came about as a result of the insufficient and unreliable power supplied in the ‘before Akosombo’ years for industrial purposes. Due to Ghana’s endowment with bauxite deposit, there was the need for a more reliable and less costly electricity supply alternative. The Akosombo dam was thus constructed to provide industries with reliable and cost effective source of power (ISSER 2005: p. 17). According to Turkson and Amadu (1999: p.22), as at 1972, the Akosombo dam could generate 912MW of electricity. By the end of 1975, the total installed power generation capacity in Ghana had risen to 1,072MW after the construction of the Kpong dam. Despite the increased amount of electricity generated in Ghana, ISSER (2005: p. 20) asserts that the total domestic consumption doubled from 540GWh in 1967 to 1,300GWh in 1976 and has since been increasing steadily. This implied the need to expand the electricity generational capacity in Ghana.

Despite the increasing pattern of electricity consumption in Ghana, the available sources have been unreliable. According to Edjekumhene *et al*. (2001: p.7), a prolonged drought in 1983-84 severely curtailed the power generation capabilities of the plants as the water level in the Volta Lake reduced drastically beyond the minimum operational level of 278 feet. The 1983 drought led to mandatory power rationing, hence curtailment of power to all customers of VRA. The drought led to a 50 per cent cut in electricity exports to Togo and Benin and 95 per cent cut to VALCO. This introduced the ‘thermal complementation period’ which is run by fossil fuel (crude oil) with the major thermal stations located in Tarkoradi (Thermal Station -550MW) and Tema (Diesel Power Plant at Tema -30MW). Currently, due to several energy crisis and dwindling water levels in the various dams, the Bui dam is under construction to produce 400MW to relieve dependence on the other power generators in the country.

2.3.3 Assessing the Electricity Sufficiency in Ghana

Gand (2009: p.2) and ISSER (2005: p.23) indicate that there is an increasing demand for electricity for industrial, commercial, administrative and residential purposes in Ghana. Based on this exposition, this section of the study compares the current and future demand of electricity with the capacity to supply electricity to meet the increasing demand.

According to Gand (2009), the demand for electricity has been increasing at an average annual rate of 12 per cent since the last 10 years (1999-2009). In its contribution to the claim that electricity consumption has increased over the years, ISSER (2005: p.23) revealed that domestic electric energy consumption in 2004 was 6,004 GWh but was expected to increase to 9,300 GWh by 2010 (a percentage increase of 58.9 within 6 years). There is also the potential for significant electricity exports and supply to VALCO. However, the capability of Ghana's hydro system is about 4,800 GWh and represents about half of the projected domestic consumption for 2010. This implies that at least 50 per cent of Ghana's electricity requirement will be provided from thermal sources by the year 2010 (ISSER, 2005: p. 23). In a similar vein, Aboh (2009: p. 20-23) reveals that Ghana's electricity demand is expected to experience 23.5 per cent growth rate between 2008 and 2030 as depicted in Table 2.1.

Table 2.1: Electricity Requirement Forecast for Ghana between 2008 and 2030

Stakeholders	Years			Growth Rate (%)	
	1970	2008	2030	1970 -2008	2008-2030
Total Household Electricity Use (GWh)	212	288.6	15,094	0.8	18
Total Commercial and Industrial Electricity Use (GWh) - VALCO Excluded	570.8	3,433.1	50,145.6	4.7	12.2
Total	**782.8**	**3721.7**	**65239.6**	**4.1**	**23.5**

Source: Aboh, 2009; p. 20-23

Though, forecasts of Ghana's electricity consumption have been observed with inconsistencies particularly on the growth rate as argued by different authors, the underlying element is that electricity demand will increase considerably by 2030. The increasing demand for electricity implies the need to step-up investments toward expanding the operational power generation capacity.

The response from the Government of Ghana has been diverse. ISSER (2005: p.23) identifies the electricity generation expansion projects to include the expansion of the Takoradi power station to generate additional 110-MW steam unit and the construction of the Bui hydro electric dam to generate 400MW of electricity. The other projects include the 300MW combined cycle thermal power plant located at Tema of which its operation is intended to be synchronised with the delivery of natural gas through the West African Gas Pipeline Project.

According to DFID (2009: p.11), any power source that depends on the rainfall pattern is unsustainable due to the effects of climate change. Additionally, Kemfert (2006: p.45-49) and Youngquist (2000: p.1) argue that oil prices are bound to increase substantially due to increasing demand coupled with the highly inelastic nature of supply. Youngquist (2000) further pointed out that though there will always be oil, the cost required to exploit the remaining reserves will outpace its value. The result will be substantial increases in the prices with their effects on industries and human welfare in general.

From the above, the responses from the government of Ghana to increase the available electricity generation capacity have not been spared by the incidence of global warming and fossil fuel reserve depletion.

2.3.4. Effects of Climate Change and Fossil Fuel Depletion on Ghana's Electricity Supply

Climate Change and Electricity in Ghana

Ghana's electricity supply has not been spared by the incidence of climate change that is afflicting the world (DFID, 2009: p.11). Three periods in the history of electricity supply in Ghana are used by this study to accentuate the claim that Ghana's electricity supply is under threat with its sustainability doubtful.

In 1983/84, Ghana experienced a major drop in the quantity of rains recorded annually. The consequence was a less than 15 per cent total inflow into the Akosombo reservoir. Indeed this characteristic was not for the Volta Lake only but affected all rivers in the tropics (ISSER, 2005: p. 20). Though the total installed electricity generation increased from 540 GWh to about 1,300 GWh between 1967 and 1976, the 1982-1984 drought decreased the capacity to 1,000 GWh. Electricity supply during this period was consequently rationed. Supply to VALCO was completely curtailed and export supplies to Togo and Benin reduced. Ghana resorted to the use of thermal energy as a complement.

Additionally, in 1998, the power system in Ghana experienced another crisis resulting in the rationing of power to consumers. This crisis was also brought about mainly by poor rainfall and consequently low inflows into the Volta Lake thereby affecting power generation. In order to deal with the power shortage, the Government of Ghana resorted to complement HEP with thermal power installed in Tema to generate up to 60MW of power (ISSER, 2005: p. 22).

The power crises also set the basis for the addition of power plants to the generation system in Ghana through the private sector for the expansion of the Takoradi Thermal Power Plant.

Thirdly, due to low amount of rainfall in 2007, the total electricity generated in Ghana was affected. The level of the water in the Akosombo reservoir reduced to 240.00 feet, 38 feet below the required level (278 feet) of water to render the turbines effective and efficient (Otchere, 2006: p.1). The effects were power rationing in the country. Additionally, whilst the VALCO smelter was shut down, several industries also collapsed during the period. Adomako (2007: p.1) asserts that a total of 33 companies and an unknown number of micro and small scale industries collapsed due to the 2007 power crisis. Three years after the power crisis in 2007, the Daily Graphic in its Thursday, Feb 4, 2010 edition reports that another power crisis was imminent attributing it to the financial difficulties facing the VRA; the result of low tariffs, and low repayment rate from manufacturing industries and MDAs.

From the above, the study notes that Ghana's electricity is not only dependent on the amount of rainfall recorded in a period but also highly subsidised. However, DFID (2009: p.11) maintains that climate change is causing the rainfall patterns to be erratic. This thus implies that Ghana's electricity supply is threatened due to its dependence on rainfall. Based on the unreliability of electricity in Ghana, the AGI in its 2006 Business Climate Survey identified that power crisis was the highest ranked among the 13 identified problems affecting industries in Ghana (NDPC, 2008: p.64).

Not only has climate change affected Ghana's electricity supply, the increasing prices of crude oil on the global market has also had a grave impact due to the complementary use of hydro electric power and thermal power in Ghana. As indicated in Table 2.2, the price of crude oil has more than tripled between 2000 and 2008; increasing from US$ 28.36 per barrel to US$ 101.8 per barrel (Energy Commission 2008: p.42). This is partly due to the increasing cost of exploitation of the mineral (crude oil) (Kemfert, 2006 p. 45-49). It is anticipated that the prices will witness further upsurge.

Table 2.2: Annual Average Crude Oil Prices (US$/barrel) and Electricity Tariffs

Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008
				Crude oil prices					
Crude Oil Price US$/barrel Oil	28.36	24.54	24.98	28.78	37.99	55.66	67.03	74.68	101.8
				Electricity Prices					
EUT (Ghp/kWh)	-	3.0	6.23	7.19	7.4	7.4	9.44	11.96	11.96

Source: Energy Commission (2008: p. 40 & 42)

The increasing price of crude oil on the international market has rendered thermal power very expensive. The amount of light crude oil used by one thermal plant is estimated at 890m^3 to generate 2.5GW of electricity a day (VRA, 2006b: p.1). This has subsequently affected electricity tariffs; increasing from 3Gp/KWh to 11.96 Gp/KWh between 2000 and 2008.

From the above, Ghana's electricity sources can be said to be unreliable with their sustainability questionable. Thus, Ghana needs alternative sources of electricity supply especially for the growing number of light industries that are mostly affected by the unreliability of the conventional sources of electricity generation. This is especially the case when Ghana aims to become a middle income economy by 2015 (NDPC, 2003: p.30).

2.4. The Concept of Alternative Energy

Having indicated Ghana's need for sustainable sources of electricity supply, this section of the study introduces the concept of alternative energy and identifies and explains the available alternative sources that can be used for industrial purposes (with cases from other countries).

2.4.1. Definition of Alternative Energy

According to Gritsevskyi (2008: p.3), defining alternative energy is a little tricky. He argues that the nature of what were regarded alternative energy sources has changed considerably, and today because of the variety of energy choices and differing goals of their advocates, defining some energy types as alternative is highly controversial. Despite these controversies, attempts have been made to define the concept.

The term 'alternative' presupposes a set of undesirable energy technologies against which 'alternative energies' intend to replace. MacKay (2007: p.1-2) remarks that "alternative energy" is an umbrella term that refers to any source of usable energy intended to replace fuel sources without the undesired consequences of the replaced fuels. This definition is espoused due to the inability of non-renewable energy (traditional) sources to replenish themselves within a short period whilst at the same time their environmental impacts resulting from the emission of carbon into the atmosphere are beyond measure.

Similarly, Sorenson (1979, cited in Banks and Schäffler, 2006: p.13) defines alternative energy as energy that is converted from resources that are used at a rate not faster than that at which they are replenished. Similarly, Gritsevskyi (2008: p. 6), maintains that energy obtained from sources that are unlimited, rapidly replenished or naturally renewable are termed as alternative sources of energy. Unlike MacKay's definition above, Gritsevskyi's and Sorenson's definitions are silent on the environmental friendliness of alternative sources of energy. Thus, alternative energy is clean/non-polluting energy (i.e. does not harm the environment by emitting carbon dioxide) and is generated from sources that easily replenish themselves.

From the above, this study notes that alternative energy is environmentally-friendly source of energy that easily replenishes itself to sustain the supply of the energy needs of consumers. This definition does not consider nuclear energy as an alternative source of energy. MacKay (2009: p.161) argues that nuclear reactors generate very little waste relative to fossil-fuel power stations. Additionally, Cohen proposed in 1983 that uranium dissolved in seawater, when used in fast neutron reactors, is effectively inexhaustible and constantly replenished by rivers, and could therefore be considered a renewable source of energy. However, this idea is not universally accepted, and issues such as peak uranium and uranium depletion are ongoing debates. Additionally, the prospect of increased nuclear power deployment was seriously undermined in the world as a result of the 'Three Mile Island disaster' in Pennsylvania and 'Chernobyl Disaster' in Ukraine. Furthermore, the problem of safely disposing spent nuclear fuel remains unresolved. Due to these unresolved issues, USA has not built a new nuclear facility in over twenty years (University of California, 2009: p.5). Thus, nuclear power is not considered as renewable source of energy by this study.

2.4.2. Reasons for Promoting Alternative Sources of Electricity

The foremost reason for the promotion of alternative energy is its role in sustainable development (Ogunlade and Youba, 2001 cited in UNEP, 2001: p.1; World Bank Group, 2009: p.5). The concept of sustainable development as put forward by the Brundtland Commission refers to development that meets the need of the present generation without compromising the ability of the future generation to meet their needs (Todaro and Smith, 2009: p.485). The role of energy in sustainable development was echoed with greater emphasis by the June 1997 Special Session of the UN General Assembly that reviewed Agenda 21. The role energy plays in sustainable development is further explained by Youngquist's when he argued that energy is the key that unlocks all other resources and influences the living conditions of mankind (Youngquist 2001: p.1). Similarly, Ogunlade and Youba (ibid) maintain that sustainable patterns of energy production, distribution and use are crucial to influencing the standard of living of people. Stern (2007 cited in the World Bank Group, 2009: p.2) further claims that lack of access to energy services constitutes a major obstacle to the world's access to water, food production, health, and use of land and the environment.

Improved access of the poorer sections of the population to energy services contributes directly to poverty reduction (UN-Energy, 2008: p.6). However, AusAID (2001: p.5) argues that it is not automatic that access to energy will lead to poverty reduction, but the energy should be seen as a development issue rather than an energy issue. Thus, access to affordable and readily available energy services should grow significantly to serve the energy needs of the growing population. However, the major sources of energy, fossil fuels, are considered non-renewable thereby compromising the concept of sustainable development. Additionally, the widely used renewable source, HEP, has been rendered unreliable by climate change. These two major sources of energy cannot continue to render the required energy services for the development of mankind. Ogunlade and Youba (ibid) thus argue that the world in general and Africa in particular, need to embark on an energy growth paradigm that departs from the well-known conventional paths for sustained growth and structural transformation of the society. The new paradigm should focus on environmental-friendly sources that easily replenish themselves to sustain the energy services required for industrial, commercial, administrative and residential purposes in poverty stricken Africa. Kemfert (2006: p.45-49) and Smith (2005: p.4) claimed that the solution lies with alternative sources of energy.

Secondly, alternative sources of energy have gained currency in contemporary development parlance due to the effects of fossil fuel exploitation on climate change. Smith (2005: p.9) and World Bank Group (2009: p.5) claim that carbon dioxide emitted from the use of fossil fuels is provoking the environment. In arguing further, Smith (2005: p.10) points out that there is widespread evidence of climate change citing the frequent closure of the Thames Barrier to prevent flooding as one of the evidences. In a similar vein, Gyau-Boakye (2001: p.1) reveals that the inflows into the Volta Lake have reduced by about 20 per cent due to the increasing global temperatures that emanate from carbon emission from fossil fuel exploitation. According to the UN-Energy (2008: p.4) and World Bank Group (2009: p.2) global energy-related carbon dioxide emissions will increase by about 50 per cent between 2004 and 2030 unless major policy reforms and technologies are introduced to utilise alternative energy. In the view of the UN Secretary General, Ban Ki-Moon, without a shift to cleaner energy supplies it will be impossible to adequately tackle climate change (UN-Energy, 2008: p.1). Additionally, the IEA estimates that a 50 per cent reduction in carbon dioxide emissions by 2050 would require an increase to 46 per cent share of renewable energy in global power generation. Thus, renewable energy technologies hold the answer to the incidence of global warming (IEA cited in UN-Energy, 2008: p. 11, World Bank Group, 2009: p.2).

The third major reason for the promotion of alternative sources of energy is the upsurge in the prices of energy on the global and national markets. Bank and Schäffler (2006: p.vi) and the World Bank Group (2009: p.5) claim that greater use of renewable energy would reduce developing countries' economic vulnerability to the variable and escalating costs of imported fuels. Similarly, van Kooten and Timilsina (2009: p. 1) claim that the global energy supply system faces price volatility and environmental challenges, particularly regarding local air pollution and global warming. Thus, renewable energy sources allow countries to limit their exposure to volatile international energy prices. International and local communities are therefore increasingly trying to find ways to shift economies towards greater reliance on renewable energy (World Bank Group, 2009: p.5). Whilst the cost of petroleum products has been increasing, Ghana's thermal plants continue to use on the average 890m^3 of light crude oil to generate 2.5GW of electricity a day (VRA, 2006a: p.1). This therefore implies that electricity tariffs will continue to increase since petroleum prices are projected to continue to increase as indicated in Table 2.2 (refer to page 21).

The benefits derived from the use of alternative sources of energy are conceptualised in Figure 2.1. This framework provides a basic understanding of the relationship between the use of alternative energy supply, climate change and poverty reduction.

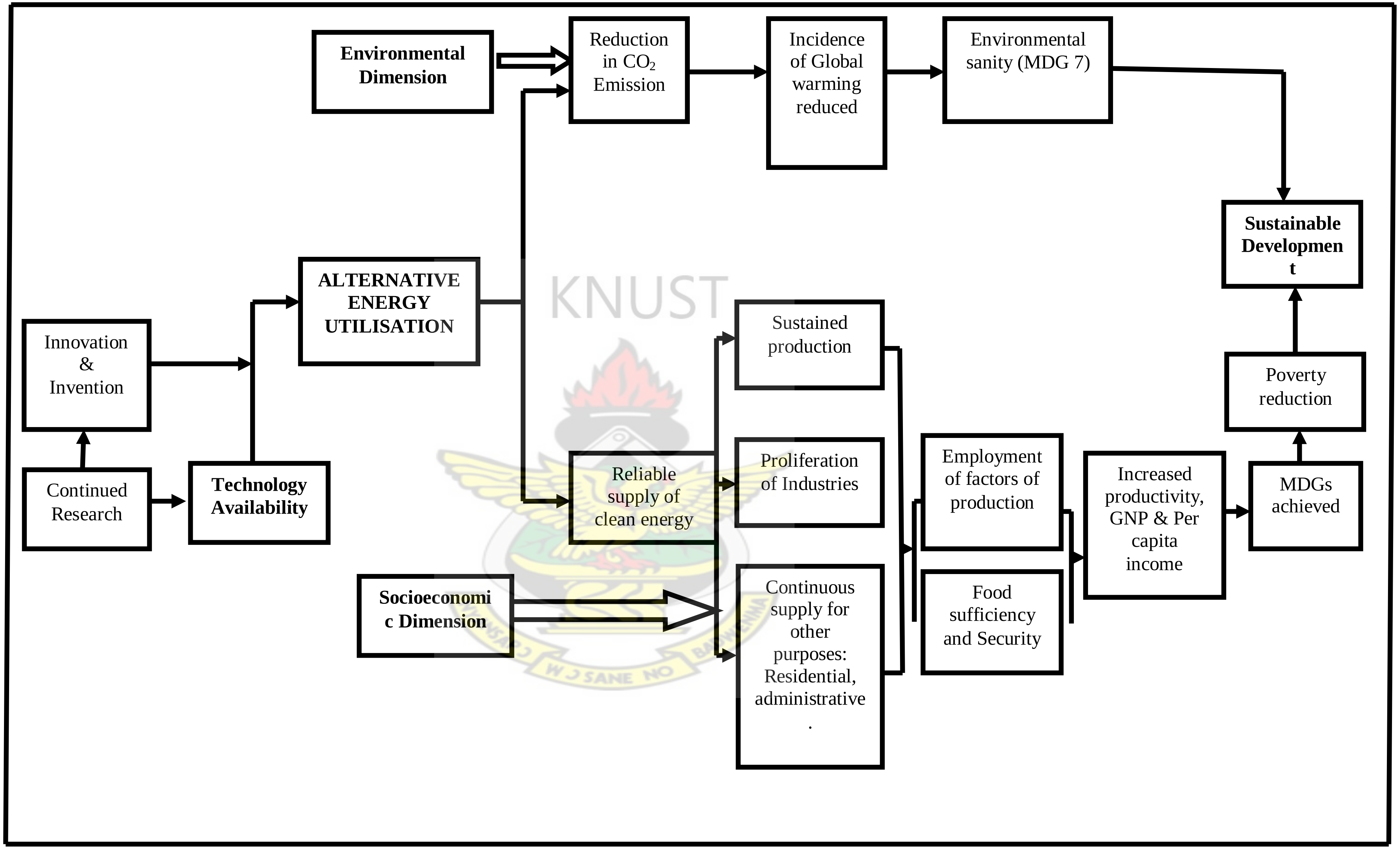

Figure 2.1: Alternative Energy, Climate Change and Sustainable Development

Tackling global warming has been central in the agenda of the global community (World Bank, 2010: p.1). This is evident in the Kyoto Protocol (that aims to reduce CO_2 emission to an acceptable level – 1990 level), the Millennium Development Goal (Goal number 7) and the Copenhagen Climate Change Summit (Frondel *et al*, 2008: p.4; World Bank 2010: p.1). Global warming has been the result of the increasing exploitation of fossil fuel for human consumption. Fossil fuel is used primarily for the generation of electricity for human consumption. The continuous use of fossil fuel for electrification purposes especially in thermal plants has in turn affected other efficient means of electricity generation, the hydro electric power system through rising temperature. Thus, the efficiencies of the HEP dams in water-stress countries have declined remarkably. The result is the inability of the world to generate enough electricity to meet the ever increasing electricity needs. However, according to Todaro and Smith (2009: p.485) the world's poverty problem can be fought sustainably if mankind has access to affordable and reliable electricity. Furthermore the UN-Energy (2008: p.4) reveals that the answer to access to reliable and affordable energy lies in the use of alternative sources of energy.

Figure 2.1 illustrates that the effective use of alternative sources of energy depends mainly on the available technology which in turn depends on innovation and invention arising out of continued research on the part of researchers. The results of effective renewable technology are 2-sided as illustrated by Figure 2.1.

The first effect captioned as 'socioeconomic', refers to the supply of clean and reliable energy to manufacturing firms for production. The clean energy is derived from the exploitation of alternative sources of energy. Additionally, manufacturing entrepreneurs who otherwise will not have been able to start their businesses due to expensive and unreliable electricity will be able to set up their businesses. This argument is underpinned by the fact that one of the factors influencing the location behaviour of firms is physical infrastructure of which energy is instrumental. These will have implications for the proliferation of firms with their concomitant effects on employment and utilisation of factors of production. Figure 2.1 again depicts that the availability of clean and reliable electricity will serve other purposes including but not limited to commercial (retail and wholesale), health, educational, administrative, construction and agricultural energy needs (agro-processing). With factors of production put to effective use with the aid of reliable and affordable energy supply from alternative sources, governments' goal of sustaining increase in GDP per capita could be a reality. This will then enable developing countries get on track to achieving the MDGs. Specifically, the employment creation effect of the use of alternative source of energy can contribute to achieving the MDG 1 (halving the share of the world population living in extreme poverty and hunger by 2015). Access to electricity will not only contribute to improving educational performance (especially for rural schools) but also improve the health care system in both the rural and urban areas (Obeng and Hans-Dieter, 2009: p.5). Thus, the electricity's link to education and health care improvement could contribute to realising the MDG 2, 4 and 5 (to ensure universal primary education; to reduce child mortality; to promote maternal health). With the MDGs used as the benchmark for measuring a country's progress in reducing poverty, the study asserts that poverty will be reduced towards sustainable development with the aid of alternative sources of energy.

The second effect also captioned as 'environmental effects' is underpinned by Smith (2005: p. 4) and the UN-Energy's (2008: p.1) claim that one of the solutions to the increasing global temperatures is the use of alternative energy. The switch over from fossil fuel to the use of alternative energy will reduce by 46 per cent the amount of CO_2 emitted into the atmosphere (IEA cited in UN-Energy, 2008: p. 11). Thus, countries will be on track to achieving the Kyoto Protocol that aims to reduce CO_2 emission to the 1990 level. Subsequently, the increasing global temperatures may be curtailed to ensure environmental sustainability, MDG 7. Consequently, the environment can continue to provide the needs of both the current and unborn generation (i.e. sustainable development). The following section of the chapter identifies the major alternative sources of electricity that can be exploited for industrial purposes.

2.4.3. Alternative Energy Technologies

According to AusAID (2001: p.3), Gantenbein (2010: p.1) and UN-Energy (2008: p. 11), the main forms of alternative energy are the wind power, hydropower, solar energy, bio-fuel and geothermal energy.

Wind Power

According to Cross (2007: p. 40), wind energy is a clean source of energy that can be tapped for industrial purposes. Similarly, Granovskii *et al* (2007: p.i) revealed that energy derived from the wind produces no greenhouse gases such as carbon dioxide and methane during operation. However, the use of wind energy depends on strong and more constant speed of the wind (Gantenbein, 2010: p.1). Due to these conditions, sites in offshore and high altitude areas that are characterised by strong and constant speed of the wind are preferred locations for wind farms. The generation of wind energy is possible with the use of wind turbines. Cross (2007: p. 40) revealed that the technology uses turbines that convert mechanical energy created by the rotation of blades into electrical energy. Wind turbine efficiencies are presently around 43 - 44 per cent and are envisaged to increase modestly to about 46-47 per cent by 2030.

According to van Kooten and Timilsina (2009: p.3), the evolution of windmills into wind turbines did not happen overnight and attempts to produce electricity with windmills date back to the beginning of the 20th century. However, after World War II, the development of wind turbines was totally hampered due to the installation of conventional power stations using fossil fuels available at lower cost. But the oil crisis of 1973 heralded a definite breakthrough in harnessing wind energy. Many European countries have started developing the wind turbine technology for industrial purposes. Germany, USA, Spain, Denmark and India are among the world's leading nations in the acquisition of wind energy. Denmark now generates 8 per cent of its electricity from wind power (AEI n.d.). According to Parvaiz (2010: p.1), Denmark is the world leader in wind energy production and consumption, with 20 per cent of its electricity coming from wind resources and are used for both industrial and domestic purposes. van Kooten and Timilsina (2009: p.3) reveal that the installed global wind generating capacity expanded rapidly from 10 megawatts (MW) in 1980 to 94,124 MW of installed capacity by the end of 2007 with Europe and North America accounting for 80.5 per cent of global wind power capacity.

Hydropower

In the view of Cross (2007: p. 39), hydropower represents the largest share of existing alternative energy supply capacity. Similarly, the US Department of Energy (2001: p. 1) argues that the most commonly used energy is the hydropower since water is about 800 times denser than air. Large hydropower is very competitive, with excellent efficiencies (i.e. between 75-90 per cent of the energy input can be converted into electricity). This explains why countries that aimed to industrialise their economies invested so much into hydro electric power generation through the construction of large scale dams. Hydro electric plants, just as wind and thermal plants transform mechanical energy to electricity.

In producing hydropower, power generators are placed inside dams. Water flowing through the dams spins the turbine blades which are connected to generators to produce electricity (Perlman 2009: p.3). Hydroelectric energy is produced by the force of falling water. The capacity to produce this energy is dependent on both the available flow and the height from which it falls.

Perlman (2009: p. 2) maintains that hydroelectric power use has gained currency due to its relatively lower amount of pollution. It has relatively lower operations and maintenance costs whilst the technology is reliable and proven over time. Hydroelectric power is also praised for its efficiency and inexpensiveness as hydro turbines can convert as much as 90 per cent of the available energy into electricity. However climate change has reduced its efficiency in water-stressed countries. The best fossil fuel plants are only about 50 per cent efficient. Additionally, the Alternative Energy Institute (n.d.) claimed that the use of hydropower prevents the burning of 22 billion gallons of oil or 120 million tons of coal each year.

The Alternative Energy Institute (n.d.) however, argues that hydroelectric dams require high capital cost and is no longer possible to significantly increase its capacity in several parts of the world for environmental reasons. Hydroelectric power is unable to replenish itself quickly due to climate change with Ghana, Nigeria and many other countries experiencing unreliable electricity generation. This debates the inclusion of hydro power among the category of alternative sources of energy (Harrison *et al*. 2006: p. 2).

Solar Energy

According to Sidhu (n.d. cited in Cassin and Zolin, 2009), solar power was once considered ‘too cheap to meter’ but this proved illusory because of the high cost of photovoltaic cells and limited demand. Experts however believe that with mass production and improvement in technology, the unit price would drop to enable the poor to have access.

Solar energy for power purposes was first developed in 1839 in France. By the 1880s, selenium photovoltaic (PV) cells had been developed that could convert light into electricity with 1-2 per cent efficiency. This low efficiency level was blamed on the little understanding of the photoelectric effect of the sun energy. In the 1900s, Albert Einstein proposed an explanation for the "photoelectric effect" of the sun energy which led to the development of solar photovoltaic devices with higher efficiencies. According to the Alternative Energy

Institute (AEI) (n.d.), solar energy had been neglected due to the availability of fossil fuels that were more affordable and available. However, with the growing concern for the environment coupled with the increasing cost of fossil fuel exploitation, attention has been given to solar energy.

According to Ishengoma (2002: p. 14), there are several advantages of photovoltaic solar power that makes it one of the most promising alternative energy sources in the world. Among its advantages are: reliability, low operating costs, non-polluting and availability. Aligned to this, AEI (n.d.) also maintains that photovoltaic solar power is non-polluting and has no moving parts that could break down. Additionally, it requires little maintenance, no supervision and has a lifespan of 20-30 years with low running costs. Ishengoma (2002), however, contends that the two main obstacles against using solar energy are the high initial capital costs and the very low PV cell conversion efficiency. Despite this contention, AEI (n.d.) argues that the efficiency of PV has improved considerably over the years through research and this has reduced the cost of installation (AusAID, 2001, p3).

Biomass/Biogas

Biomass is yet another important source of alternative energy with the potential to generate power to supply developing countries' energy requirements. Biomass is produced from living organisms or from metabolic by-products (organic or food waste products). In order to be considered a bio-fuel the fuel must contain over 80 per cent renewable materials (Banks and Schäffler, 2006: p.32).

According to the Cross (2007: p.40), biomass may be converted into energy in several ways, most often by direct combustion. In stand-alone firing, biomass plant efficiencies are relatively low, currently in the region of 32 per cent, and are not projected to rise any higher than 35 per cent by 2030. In co-firing however, the use of biomass is much more efficient, currently reaching approximately 45 per cent, with forecasts of 50 per cent by 2030. The use of biomass in co-firing also shows a better economic return.

Karve (2005: p.74) argues that biomass causes pollution especially when used by household for domestic purposes. According to the World Health Organisation cited by Karve (2005) about 500,000 women and children die prematurely in India due to air pollution caused by cooking fires in rural households. The pollution associated with the use of biomass may contest the claim that biomass is an alternative energy source. In reducing the level of pollution resulting from the use of the technology, the fuel is provided with sufficient air, so that it burns completely and reduces automatically the carbon monoxide and the particular matter in the fuel gases. Apart from using biomass for domestic purposes, Karve (2005: p.76) maintains that biogas can also be used as fuel in internal combustion engines. Standardisation of the biomass enables the fuel to be used for engine combustion purposes.

The disadvantage as claimed by Cross (2007: p.40) is that production of biomass in any form requires the use of land. Additionally, chemical fertilisers used in the production of biomass, need large quantities of fossil fuel in their production. Thus, the environment may be polluted due to attempts at producing biomass as a renewable source of energy to replace fossil fuels. Karve (ibid) however claims that agriculture without using chemical fertilisers is the solution. This concept is based on the assumption that soil micro-organisms degrade the soil minerals to provide the green plants with all the mineral nutrients that they need. If the soil micro-organisms are adequately fed with organic matter, there is theoretically no need to apply chemical fertilisers to the soil. Traditional agricultural scientists recommend the application of organic matter in the form of compost.

Geothermal Energy

Geothermal energy is energy obtained by tapping the heat of the earth itself, both from kilometres deep into the Earth's crust in some places of the globe or from some meters in geothermal heat pump in all the places of the planet. It is expensive to build a geothermal power station but operating costs are low resulting in low energy costs for suitable sites.

Three types of power plants are used to generate power from geothermal energy: dry steam, flash, and binary. Dry steam plants take steam out of fractures in the ground and use it to directly drive a turbine that spins a generator. Flash plants take hot water, usually at temperatures over 200°C, out of the ground, and allows it to boil as it rises to the surface then separates the steam phase in steam/water separators and then runs the steam through a turbine. In binary plants, the hot water flows through heat exchangers, boiling an organic fluid that spins the turbine. The condensed steam and remaining geothermal fluid from all three types of plants are injected back into the hot rock to pick up more heat.

Geothermal power sources exist in certain geologically unstable parts of the world such as Chile, Iceland, New Zealand, United States, the Philippines and Italy. Iceland produced 170MW geothermal power and heated 86 per cent of all houses in the year 2000.

Ocean Thermal and Tidal energy

The vast energy potentials of the seas and oceans (that cover about three-fourth of the earth's surface) can make significant contributions in the supply of the energy needs of mankind. The ocean contains energy in the form of temperature gradients, waves and tides and ocean current, which can be used to generate electricity in an environment-friendly manner. Technologies to harness tidal power, wave power and ocean thermal energy is being developed to make it commercially viable.

Harnessing energy from these open-ocean currents requires the use of turbine-driven generators anchored in the ocean current streams. In one concept, large turbine blades would be driven by the moving water, similar to windmill blades being moved by the wind; and the blades used to turn the generators and thus harness the energy of the water flow (Banks and Schäffler, 2006: p.32).

Countries with exceptionally high wave resources include the UK, Ireland, Italy, the Philippines, Japan and parts of the USA. Few studies have been undertaken to determine the total global marine current resource, although it is estimated to exceed 450GW (POEMS, 2005).

Hydrogen and Fuel Cells

In hydrogen cells, electricity is produced through an electro-chemical reaction between hydrogen and oxygen gases. The fuel cells are efficient, compact and reliable for automotive applications. Hydrogen gas is the primary fuel for fuel cells also. Hydrogen can be produced from the electrolysis of water using solar energy. It can also be extracted from sewage gas, natural gas, naphtha or biogas. Fuel cells can be very widely used once they become commercially viable.

2.4.4. Challenges with the Exploitation of Alternative Sources of Energy

The AusAID (2001: p.3) and World Bank Group (2009: p.52) argue that the foremost of all the challenges of harnessing the fullest potential and the transformative promise of alternative sources of energy is financial constraints. Similarly, Banks and Schäffler (2006: p.15-31) claim that the use of alternative energy sources largely depends on the cost of exploitation, their efficiency, ease of storage and transmission, and a multitude of other factors. The World Bank Group (2009) revealed that the exploitation of the potentials inherent in alternative sources of energy will require additional upfront investments of US$ 9,300 billion during the period 2010–30, including US$5.7 trillion for energy efficiency measures. These factors have often prevented governments of developing countries from investing in alternative energy.

Additionally, the US Department of Energy (2006 cited in Wikipedia Encyclopedia, 2010) reveals that marketing, institutional and policy impediments are the major barriers hindering the use of alternative sources of energy. The marketing impediments involve the lack of information and consumer awareness on the available alternative energy sources and the inadequate financing options for renewable energy projects. Additionally, the policy impediment is observed from the lack of policies and regulations supporting the development of alternative energy technologies.

2.5. Application of Alternative Sources of Energy in Some Selected Countries

Despite the above challenges with harnessing the potential of alternative sources of energy, interest in them (renewable energies) has increased in recent years due to environmental concerns about global warming and air pollution, reduced costs of renewable energy technologies, and improved efficiency and reliability (AusAID, 2001: p.3). According to Wohlgemuth and Monga (2007), in developing countries, industry accounts for more than a third of total final electricity consumption. Thus, the sustenance of the industrial operations largely depends on the reliability and sustainability of electricity in these countries. In the search for reliable alternative electricity for light industries the study considers cases of alternative energy use for industrial purposes from some countries.

2.5.1. Alternative Energy Use in India

India has since the 1980s used electricity generated from renewable sources for both domestic and industrial purposes. With the establishment of the Tamilnadu Energy Development Agency (TEDA) in 1985 to promote and coordinate the use of non-conventional sources of energy, a total of 1612MW of electricity is generated by renewable energy technology. Out of this quantity, wind energy contributes the highest with biomass and solar energy following in that order.

India's wind energy is produced largely from the Tamil Nadu region. The region is endowed with lengthy mountain ranges on its western side with three prominent passes in its length. The mountain ranges provide the required wind in terms of quantity and velocity. India uses wind energy for pumping water and in sugar mills for the manufacture of sugar and ethanol. The rest of the energy generated is fed into the national grid for a variety of functions.

India's biomass/bio-fuel energy production is sustained by its agrarian economy. The biomass energy is derived from rice husks, wild bush, straws, shells of coconut, jute and cotton. Smith (2005: p.8) reveals that India's biomass industry has the capacity of producing about 50 per cent of the counties energy requirements. India uses bio-mass in three major ways; first, in the form of gas through gasifiers for thermal applications, second, in the form of methane gas to run gas engines to produce electricity and third, through combustion to produce steam for electricity. Bio energy in India is used in sugar mills, livestock farms, educational institutions and central prisons.

Additionally, India has encouraged the use of solar photovoltaic systems particularly at the household level for household energy provision in remote areas not reached by national transmission lines. These households use the energy provided by the solar photovoltaic panels to run pumps and operate household electrical appliances.

The Government of Tamilnadu encouraged the use of solar water heating systems for domestic water heating. It also installed solar water heating systems in 12 Government buildings, mostly hostels and hospitals. The government has also promoted solar air heating technology for tea/fruit processing and grain drying. A total of 14 systems have been installed in Tamil Nadu to supply the energy needs of the citizenry. This process of pre-heating using solar energy saves nearly 25 per cent of fossil fuels or firewood.

2.5.2. Alternative Energy Use in South Africa

Deichmann *et al* (2009: p. 2) revealed that South Africa has renewable potential that is 1.3 times the current consumption. Similarly, Banks and Schäffler (2006: p.vii) claim that biomass energy is currently the largest renewable energy contributor in South Africa, estimated to range between 9 and 14 per cent. Most rural households and several hundred thousand low-income urban households rely on fuel wood for cooking and space heating. Some sugar mills burn bagasse (cane residues and waste), and paper and packaging mills burn biomass to produce cess steam that generates approximately 210 GWh of electricity per year (DME, 2003b cited in Banks and Schäffler, 2006: p.27). According to Creamer (2004, cited by Banks and Schäffler, 2006: p.27) several biodiesel production facilities are in the planning stages intended to generate electricity from biomass for industrial purposes.

Additionally, photovoltaic modules are already widely used in South Africa, serving about 200,000 households alongside several thousand rural institutions and water pumps. PV panels are primarily used to provide electricity for telecommunications and customer equipment, power for institutions, households, water pumps and security systems in areas that are remote from the grid. There are already approximately two hundred thousand ‘off-grid’ installations in the country. Wind powered water pumps are common in South Africa, with an estimated 30,000 systems installed.

Banks and Schäffler (2006: p.45), point out that the private sector in South Africa has been encouraged to produce electricity from renewable sources. For instance, Eskom started to generate electricity from three wind turbines at the Klipheuwel site in 2002 for industrial use. The project is able to supply enough electricity to about 1,000 middle-income households and for industrial use.

2.5.3 Alternative Energy Use in Nigeria

According to Sambo (2005: p.17), Nigeria has made some attempts over the year to harness its renewable energy potential despite their rich fossil deposits. Currently, there are many solar thermal systems especially solar water heaters and solar dryers in use in many parts of Nigeria. However, solar photovoltaic applications have wider current installation than any other non-conventional source of electricity. The installed solar photovoltaic systems are used for water pumping systems, powering vaccine refrigerators and for powering telecommunication repeater stations. There are also solar photovoltaic power plants that are providing electricity to entire villages, rural health centres and television viewing centres.

Nigeria has also introduced many versions of efficient wood-burning and charcoal stoves used in many parts of the country with the overall objective of curtailing the amount of trees that are perennially cut to provide fuel wood and charcoal (Sambo, 2005: p.18). Biogas digesters, which are capable of producing biogas for domestic and industrial uses, have also been developed in many parts of Nigeria.

Another source of electricity for Nigerians is wind energy though not fully utilised. According to Sambo (2005: p.18), wind energy was used for the provision of water in some parts of northern Nigeria in the 1950s and 1960s. However, the technology was abandoned when the development of the petroleum industry reached advanced stages. Currently, due to threats of fossil fuel exhaustion, a renewed attention is being given to wind energy. The development of the Poldow wind pump in Bauchi and the wind electricity generator currently supplying electricity to Sayya Gidan Gada in Sokoto State are examples.

2.6. Theoretical Framework for Alternative Energy

The underpinnings for the use of alternative energy sources are built on two important arguments. First, alternative energy use will lead to sustainable economic growth of economies and second, it will sustain the environment by reducing carbon emission. It is against this background that the study is seen to be in tandem with the concept of sustainable development espoused during the 1992 United Nations Conference on Environment and Development (Agenda 21) and the Structuralist School's conviction that industrialisation with access to sustainable energy is the key to sustainable growth of economies.

2.6.1. The Concept of Sustainable Development

Access to reliable sources of energy is seen as a direct means to reducing poverty in the third world (UN-Energy, 2008: p.6). This implies that the present generation as well as the future generation require adequate supplies of energy for development. Despite this, the world's supplies of energy to meet the growing demands have been depleting. This is due to the finite nature of non-renewable sources that serve as the major sources of energy. The carbon emission from the non-renewable sources has increased global temperatures that has rendered HEP inefficient and unreliable (Kemfert, 2006: p.45-49; and Smith 2005: p.10). Thus, the ability of the future generation to meet their energy needs is compromised. Ogunlade and Youba (2001, cited in UNEP 2001: p.1) argue that the world needs to embark on an energy growth paradigm that departs from the well-known conventional and exhaustible paths for sustained growth and structural transformation of the society. The answer is seen to lie in the use of alternative sources of energy (IEA cited in UN-Energy, 2008: p.11).

The arguments for the use of alternative sources of energy is therefore seen to be in tandem with the concept of sustainable development espoused by the World Commission on Environment and Development in the 1992. Alternative energy exploitation will reduce carbon emission to ensure environmental sustainability and as well sustain socioeconomic growth of both the present and unborn generation. This explains why in the face of fossil fuel depletion and increasing global temperatures, the concept (sustainable development) has been revisited (Todaro and Smith 2009: p.485). Subsequently, alternative supplies of energy have featured prominently in the Kyoto Protocol, UN Millennium Declaration, MDG 7 and the Copenhagen Climate Change Summit.

2.6.2. The Structuralist School of Development Economics

The Structuralist School of Development Economics holds the belief that industrialisation is the answer to the economic development problems of the third world. This school led by Latin American Economists argue that focussing on the mechanisms by which the LDCs transform their domestic economies from a traditional subsistence base to a modern economy is the key to economic development (Contrera, n.d.).

A modern economy was defined to include an economy in which most of its population is urban and the bulk of the country's output is in the form of manufactured products or services. The objective of development under this theory is the structural transformation of underdeveloped economies so as to permit a process of self-sustained growth. The modern economy (dominated by manufacturing industries) has played instrumental roles in the development of both DCs and LDCs. These impeccable roles have been possible due to the firms' access to affordable supplies of energy. With the world's energy supplies being unreliable, the manufacturing industries face the risk of collapse. This is evident in the impact of the power rationing exercise on the operations of manufacturing industries in Ghana. Thus, the ability of the manufacturing industries to continue to supply the human needs through production lies with their access to affordable and reliable sources of energy. The answer to this rests with the exploitation of renewable and inexhaustible sources of energy for mankind (IEA cited in UN-Energy, 2008: p. 11; World Bank Group, 2009: p.2).

2.7. Lessons from the Review of Literature

The literature has revealed that MSMIs are major stakeholders in the Government of Ghana's poverty reduction agenda. Thus, MSMIs play impeccable roles in national development. These roles are sustainable if the manufacturing industries have access to reliable, affordable and sustainable energy supplies. However, the operations of MSMIs and manufacturing firms in general are saddled by difficulties in accessing affordable and reliable supplies of electricity. This problem was subsequently ranked highest by MSMIs in Ghana during the AGI's Business Climate Survey in 2006. Additionally, in 2009 electricity supply problems were ranked second in the "AGI policy perspectives". The energy unreliability is noted to be the result of the reduced efficiency of the hydro electric power dams in Ghana due to the increasing global temperatures. Again, the increasing electricity tariff in Ghana is explained by the upsurge in the prices of the crude oil (operationalising thermal plants) on the international market. The problem is further compounded by the increasing demand for electricity in the face of increasing human population. Thus, the literature has revealed that the conventional (non-renewable) sources of electricity cannot continue to meet the increasing demand for energy due to the problems of fossil fuel depletion and the increasing cost of exploitation. Additionally, the continuous exploitation of fossil fuel for electricity generation will continue to increase the global temperatures which will render HEP ineffective.

The literature subsequently revealed that the solution to the problems of energy unreliability and non-sustainability lies with the exploitation of alternative sources of electricity. These sources were identified to be self-replenishing and can thus continue to meet the increasing global need for electricity. The level of pollution experienced from the use of alternative sources of electricity is low. This explains why alternative sources of electricity are tagged as clean.

The literature, however, failed to consider issues of affordability and willingness to pay on the part of prospective users of the alternative sources of energy. The cost of the preferred option, affordability and willingness to pay are fundamental issues that need to be considered before introducing people to new ways of life. The options (e.g. types of solar panels or wind turbines) under each of the alternative sources and their lifespan have not been indicated in the literature. The lifespan and the regularity of maintenance are some of the significant factors that will determine the cost of each option and will eventually influence their use.

Additionally, the literature failed to highlight the alternative(s) that can easily be installed to supply the electricity needs without much difficulty. Thus, the literature did not highlight the alternative(s) that can be installed to provide off-grid electricity to MSMIs. Identifying the type of technology that can provide the off-grid electricity will be useful in influencing prospective users' decision to use the alternative without problems of choice.

Though, the literature indicated that HEP is the most widely used electricity in Ghana, it was silent on the level of subsidies given to consumers to encourage its use. This may be helpful in comparing the full cost of HEP (cost without the subsidies) to the cost of alternative sources of energy for an evidence-based conclusion.

Based on the identified gaps from the review of literature, the analysis and discussion of the study first identified an alternative that in the short term can provide the off grid electricity required by MSMIs. The cost of installing the preferred option was given equal attention. Of significance were the income and expenditure levels of the industries as well as their credit worthiness. These are the relevant factors that determine the readiness (willingness and ability) to utilise the alternative sources of electricity for production purposes.

2.8. Linkage between Literature and the rest of the study

The review of literature has re-echoed the need for alternative sources of energy. This need is based on the increasing global temperatures and the exhaustion and unreliability of the available conventional sources of energy. However, Sambo (2005: p.12) argues that the effective use of alternative sources of energy depends on the availability of policies and programmes of action to harness the implicit potentials in the non-conventional sources. Thus, the availability of sound policies and programmes of action determines a country's preparedness to exploit its renewable energy towards sustainable poverty reduction. Based on this assertion, chapter four reviews Ghana's energy policies in order to assess its preparedness to switch to the use of alternative sources of energy for the pursuit of its poverty reduction agenda. Chapter four is preceded by chapter three that indicates the methods the study employed in the review of the energy policy. Chapter three also outlines the methods the study employed to examine micro and small scale light industries' preparedness to adopt the renewable energy alternatives.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

Having revealed the solution to the interrupted and unsustainable power supply in Ghana to lie with ASEs that are said to be “green”, this chapter discusses the methods employed by this study in eliciting the required responses to the research questions. The methodology details the study’s design framework with emphasis on the research design approach, study population, method of determining the sample size and the sampling techniques used to select the required respondents for the study. Finally, the chapter provides an overview of the methods used to collect and analyse data for the study.

3.2 Research Design Approach

In the view of Adelman *et al*. (1977 cited in Bell, 2004: p.10), a case study is an umbrella term for categories of research designs having in common the decision to focus on an inquiry around an instance. Bell (2004: p.10-11), also claims that the case study research design is appropriate for studies that require an in-depth information about a phenomenon within a limited period where a large scale survey may not produce the true results. Similarly, Frankfort-Nachmias and Nachmias (1996 cited in Quansah, 2009: p.31) and Denscomber (1998 cited in Bell, 2004: p.11) argue that a case study design is very useful in investigating a contemporary phenomenon from a selected case. However, the case study research design is criticised on the grounds that generalisation is often difficult to make (Bell 2004: p. 11). In countering the argument against the case study, Denscomber (1998 cited in Bell 2004: p.11) claims that results from a case study research may be generalised when the phenomena have similar characteristics. Thus, a case study research design can be used for studies that require detailed information about a phenomenon within a limited time span.

Underpinned on the preceding descriptions of and arguments for the case study research design, especially on the grounds that it is most appropriate for studies that are required to be carried out within a limited time span, the study used the case study research design. The case study research design was used to examine the challenges faced by the entrepreneurs in the Kumasi Metropolis when electricity supply is intermittent, and their willingness and ability to adopt ASEs.

3.3 Key Variables of the Research and Unit of Analysis

According to Frankfort-Nachmias and Nachmias (1996: p.55), a variable is an empirical property which can take on two or more values/forms. Thus, if a property can change either in quality or quantity, it can be termed as a variable in a research. Using variables as key elements of a research problem helps to move the research from conceptual level to empirical level. Based on these, the study's variables are indicated in Table 3.1.

Table 3.1: Research Variables, Definitions and Purpose

Variable	Definition/Indicators	Purpose
Amount of electricity consumption	Measured in terms of units/kilowatts per hour consumed and amount paid as electricity tariffs per period. Ghana's electricity tariff structure of 0 – 50 units, 51 – 300 units, 300 – 600 units and 601 units and above were used to measure the consumption level of enterprises.	Helped to identify the alternative technologies that can provide the required amount of electricity for the firms.
Tariffs paid for electricity consumption	Measured along the lines of Ghana's tariffs structure. Consumers of: ▪ 0 – 50 units pay 9.5Gp per unit consumed. ▪ 51 – 300 units pay 12Gp per unit consumed. ▪ 300 – 600 units pay 16Gp per unit consumed. ▪ 601 units and above pay 19Gp per unit consumed. (Tariffs are as of May, 2010).	Helped the study to determine the number of years entrepreneurs will use to cover the full cost of the alternative sources through electricity bills only.
Perception about the tariff paid by the entrepreneurs	Used a three-interval likert scale to assess the perception about the tariffs paid for electricity consumption. 1 – High 2 – Moderate 3 – Low	Influenced the entrepreneurs' willingness for an alternative source of electricity.
Willingness to adopt the ASEs.	A Yes and No response/criterion was used to assess the entrepreneurs' willingness to adopt the alternative source of electricity. Reasons for the MSIs' willingness or otherwise to use ASEs were also provided.	This variable will influence the policy recommendations for the use of the ASEs.
Ability to pay for the ASEs.	The study used the industrialists' current electricity tariffs to assess their ability to pay for the ASEs under six scenarios.	The study used the current tariffs in order not to put any strain on their current profit margins. It enabled the study determine the number of years required by the industrialists to cover the full cost of the ASEs.

Source; Author's construct, 2010

Unit of Analysis

The unit of analysis of a research is the empirical units, objects and occurrences which must be observed or measured in order to study a particular phenomenon (Kumekpor, 2002: p.54). Frankfort-Nachmias and Nachmias (1996) add that unit of analysis is the most elementary part of a phenomenon being studied. Based on these definitions, the units of analysis for this study were wood processors, Mechanics (straighters and welders and sprayers), dressmakers, cold store operators, printing press operators, sachet water producers and grinding millers. The others were the Ministry of Energy (MOE), Ghana Energy Commission (GEC), Ghana Energy Foundation (GEF), Volta River Authority (VRA), Kumasi Institute of Technology and Environment (KITE) and Wilkins Engineering Limited and DENG Engineering Limited.

3.5. Sampling Procedure

This study purposively selected three light industrial enclaves (Sokoban Wood Village, Suame Magazine Industrial Enclave and Kumasi CBD) within the Kumasi Metropolis to examine the ability and readiness of micro and small scale light industries to adopt alternative energy sources of electricity for their operations. The industrial enclaves were purposively selected based on the fact that they (the enclaves) are the major areas of the Kumasi Metropolis where light industries (the primary units of analysis) are concentrated. Industrialists operating in the selected industrial enclaves were stratified into six groups as indicated in Table 3.2. The stratification became necessary in view of the fact that the industrialists' operations were different. The stratification thus enabled the study give attention to each of the primary units of analysis (the industrialists). Sachet water producing firms and dressmaking firms were however selected from across the Metropolis since they were not concentrated in any cluster.

3.4.1 Sample Frame

The sample frames were the total number of industrialists in the eight strata under subsection 3.4. The sample frames were determined for each of the eight stratum in order to give adequate representation of the industrialists in the sample size. As indicated in Table 3.2, the total membership sizes of the entrepreneurs' associations were used as the sample frames for cold store operators, printing presses, grinding millers, dressmakers and sachet water producers. However, MMA in the Suame Magazine Industrial Enclave was oblivious of its numerical strengths. This thus challenged the reliability of the sample frame for the straighters and welders, and sprayers. However, Obeng (2000 cited in Adeya, 2006: p.2) estimated the total number of artisans within the Suame Magazine Industrial Enclave at

80,000 with an average of five workers employed in each firm. This worked out to give the total number of enterprises operational in the Suame Magazine Industrial Enclave as approximately 16,000. This facilitated the determination of the sample size.

3.4.2. Sample Size Determination

The study used a mathematical approach to determine the sample size at a 92 per cent confidence level for each of the enterprises (see Appendix 1). The sample sizes for the enterprises are indicated in Table 3.2.

Table 3.2: Sample Sizes for the Eight Clusters of Enterprises

SN.	Type of Industry	Total Population	Sample size	Number of Questionnaire distributed	Response Rate (%)
1	Sprayers	n.a.	18	18	100
2	Straighters and Welders	n.a.	18	18	100
3	Wood Processing	4,000	66	66	100
4	Cold Stores	400	58	58	100
5	Sachet Water Production	362	57	57	100
6	Dressmaking	93	39	39	100
7	Grinding Mills	70	35	35	100
8	Printing Presses	50	29	29	100
	Total	**-**	**320**	**320**	**100**

3.4.3. Response Rate

The study had a 100 per cent response rate from the respondents as indicated in Table 3.2. This high response rate underpins the reliability of the study’s findings. The direct interface methodology adopted by the study accounts for the high (100 percent) response rate. Additionally, the high response rate was due to the industrialists need for alternative sources of electricity based on the unreliability of the current sources of electricity.

3.4.4. Sampling Techniques

Kumekpor (2002:p.150) reveals that a multi-stage sampling methodology is relevant for studies that do not have a more elaborate sample frame. Based on this strength, the research adopted the multi-stage sampling technique to select the respondents.

First, purposive sampling technique was used to select the areas within the Kumasi Metropolis where the micro and small scale light industries are concentrated. The result of the purposive sampling procedure was the identification of the Sokoban Wood Village (wood processors), Suame Magazine Industrial Enclave (straighters and welders, and sprayers) and the CBD of the metropolis (cold store operators, printing presses and grinding millers). With sachet water production and dressmaking gaining prominence in urban areas of Ghana, the researcher decided to include them in the study. Thus, the selected sachet water producing firms and dressmakers were not in the three industrial clusters but dotted across the metropolis.

Stratified sampling procedure was then used to group the micro and small scale light industries into different strata based on the type of activity/nature of production as indicated in Table 3.2. The total members of each of the stratum represented a sample frame from which a sample size was determined (see Table 3.2). Through, simple random sampling technique, the required numbers of wood processors, sachet water producers, dressmakers, cold store operators and printing presses were selected from their clusters for the study. The simple random sampling technique was operationalised by assigning numbers to the enterprise owners. The assigned numbers were kept in a box and handpicked till the sample sizes were exhausted. The snowball sampling technique was also used to select the sprayers, straighters and welders from the Suame Magazine Industrial Enclave. With the snow ball sampling technique, the first sprayer was identified through a reconnaissance survey. The sprayer was then asked to lead the researcher to identify the other 17 sprayers within the industrial enclave. Similarly, in the case of the welders and sprayers, the first welder and sprayer was identified. He then led in the identification of the other 17 straighters and welders located in the enclave. The Snowball sampling technique became necessary due to the inability of MMA to identify the exact locations of the industrialists.

3.6. Sources of Data and Methods of Data Collection

The study used both secondary and primary sources of data to provide the required responses to the research questions. The secondary sources included both published and unpublished reports on topics related to the use of alternative sources of electricity. Journals and reports provided the conceptual and theoretical frameworks within which alternative sources of energy derive their justification. The conceptual issues that were derived from the secondary sources of data included the meaning of the concept of alternative energy; the link between alternative energy and sustainable poverty reduction and environmental quality; and the available technologies referred to as alternative energy sources.

Additionally, the secondary sources revealed the industrial sector's need for alternative sources of energy through projections of energy consumption patterns related to energy capacity expansion. Lastly, Ghana's readiness to exploit its renewable (alternative) energy potentials was derived from the review of the Strategic National Energy Plan (2006-2020) and the National Energy Policy (2010-2015).

The primary data were also gathered through the researcher's observations and interviews that were carefully granted with respondents using questionnaires. The sources of the primary data included the owners of the micro and small scale light industries identified under the units of analysis. The other sources of primary data were the Ministry of Energy (MOE), Ghana Energy Commission (GEC), Ghana Energy Foundation (GEF), the Volta River Authority (VRA) and Kumasi Institute of Technology and Environment (KITE). The rest were Deng Engineering Company and Wilkins Engineering Company.

The primary data enabled the research to determine the ability and readiness of the small and medium scale light industries to adopt the alternative sources of electricity considered in the study (issues the secondary sources of data could not address). Thus, the primary and secondary sources of data were used as complements.

In gathering the primary data, a total number of 328 questionnaires (i.e. 8 institutions and 320 firms) were administered with the respondents. Tables 3.2 and 3.3 provide details of the number of questionnaires administered.

Table 3.3: Institutional Questionnaires Administered

Institution	Number of Questionnaires
The Ministry of Energy	1
Ghana Energy Commission	1
Ghana Energy Foundation	1
Volta River Authority	1
KITE	1
PURC	1
Renewable Energy Producing companies	2
Total	**8**

Source: Author's construct 2010.

3.6. Method of Data Analysis

The data collected from secondary and primary sources were analysed in two forms to provide answers to the research questions. The analysis of the first form of data started after editing and coding of the responses, with rationalisation using Statistical Package for Social Sciences (SPSS). Additionally, SPSS was used to generate the measures of central tendency and dispersion (mean, median and range) that were required in establishing the average profits of the entrepreneurs, average amount of electricity consumed per period, average cost of the renewable energy options and average lifespan of the available renewable energy technologies. The policy implications of the statistics generated by SPSS were made by the researcher after carefully studying the data. The likert scale was also used to assess the willingness of the entrepreneurs to adopt renewable energy technologies.

Finally, the analysis of the second form of data involved making comprehensive statements and analytical descriptions about the policy meanings of statements that were made by the entrepreneurs and institutions themselves. Thus, the second form of data were analysed from the entrepreneurs' perspectives.

CHAPTER FOUR
PROFILE OF KUMASI METROPOLITAN AREA

4.1. Introduction

Having provided an account of the methodology used by the study to elicit the required responses to the research questions, this chapter gives an overview of the study area from which the methods were applied. The profile of the Kumasi Metropolis specifies its location, the size of the metropolis' population and its implications on the operations of MSIs. The profile also gives an overview of the selected industrial clusters with emphasis on the nature of production and the sources of electricity for their operations.

4.2. Location and Size of the Kumasi Metropolis

Kumasi Metropolis is about 270 kilometres north of the national capital, Accra, as indicated in Figure 4.1a. The Metropolis covers an area of about 254 square kilometres and is located at the geographical centre of the Ashanti Region as indicated in Figure 4.1b. The Metropolis encompasses about 90 suburbs, many of which were absorbed into it as a result of the process of growth and physical expansion resulting from its ever increasing population.

4.3. Demographic Characteristics of the Metropolis

As indicated in Table 4.1, the Metropolis' population increased from 496,628 in 1984 to 1,170,270 in 2000 indicating a population growth rate of 5.2 per cent. The Metropolis' population growth rate is 52.9 per cent and 92.6 per cent higher than the regional and national population growth rates respectively as indicated in Table 4.1. Similarly, the population growth rate of Kumasi is 62.5 per cent and 48.6 per cent higher than the population growth rates of Accra and Tamale Metropolises of 3.2 per cent and 3.5 per cent respectively.

Table 4.1: Population of Kumasi (1960 – 2010)

Year Area	1960	Growth rate	1970	Growth rate 1960-70	1984	Growth rate 1970-84	2000	Growth rate 1984-00	Estimated 2010
Kumasi	218,172	-	346,336	4.5	496,628	2.5	1,170,270	5.2	1,961,531
Ashanti	1,481,698	-	2,090,100	3.8	2,948,161	3.8	3,612,950	3.4	
Nation	6,726,320	-	9,632,000	2.4	12,296,081	2.6	18,912,079	2.7	

Source; Population Census Report (1960, 1970, 1984, 2000) in KMA 2006

The Kumasi Metropolitan Assembly (2006) revealed that the high population growth rate of Kumasi is attributed to its vibrant commercial activities. The ever increasing population provides demand for services rendered by economic actors in the metropolis. Thus, the micro and small scale enterprises are sustained by the high population growth rate.

4.4. The Micro Economy of the Kumasi Metropolis

According to KMA (2006: p.3) about 86 per cent of the Metropolis' labour force is employed in the MSE sector. The micro economy is propelled by the service sector (commerce inclusive) which employs about 71 per cent of the labour force. The industrial sector and agricultural sector employ 24 per cent and 5 per cent respectively of the metropolis' labour force.

Due to the occupational status of the people of the metropolis, the major land use patterns of the metropolis are made up of residential (43.8 per cent), commercial (2.4 per cent), industrial (7.4 per cent), educational (17.5 per cent) and civic and culture (14.4 per cent). These land use patterns complement each other in sustaining the local economy.

Due to Kumasi's high population coupled with its geographic centrality, it has established itself as a major service centre providing services to people from all parts of the country. Commercial activities which are the heart of the service sector are centred on wholesaling and retailing with ancillary services offered by banking and non-banking financial institutions. Other areas worth mentioning under the service sector are the professionals in planning, medicine, engineering, teaching, law practice, etc.

Kumasi also plays an important industrial role to people in and around the metropolis. There are three major industrial estates in the Metropolis absorbing majority of the labour force employed in the industrial sector (KMA, 2006: p.3). The first is the industrial estates for large industries located along the Asokwa-Ahinsan-Kaase stretch. These large scale industries are engaged in timber milling, plywood manufacturing, brewery, etc. The second industrial estate is the Suame Magazine Industrial Enclave where small engineering-based industries are sited.

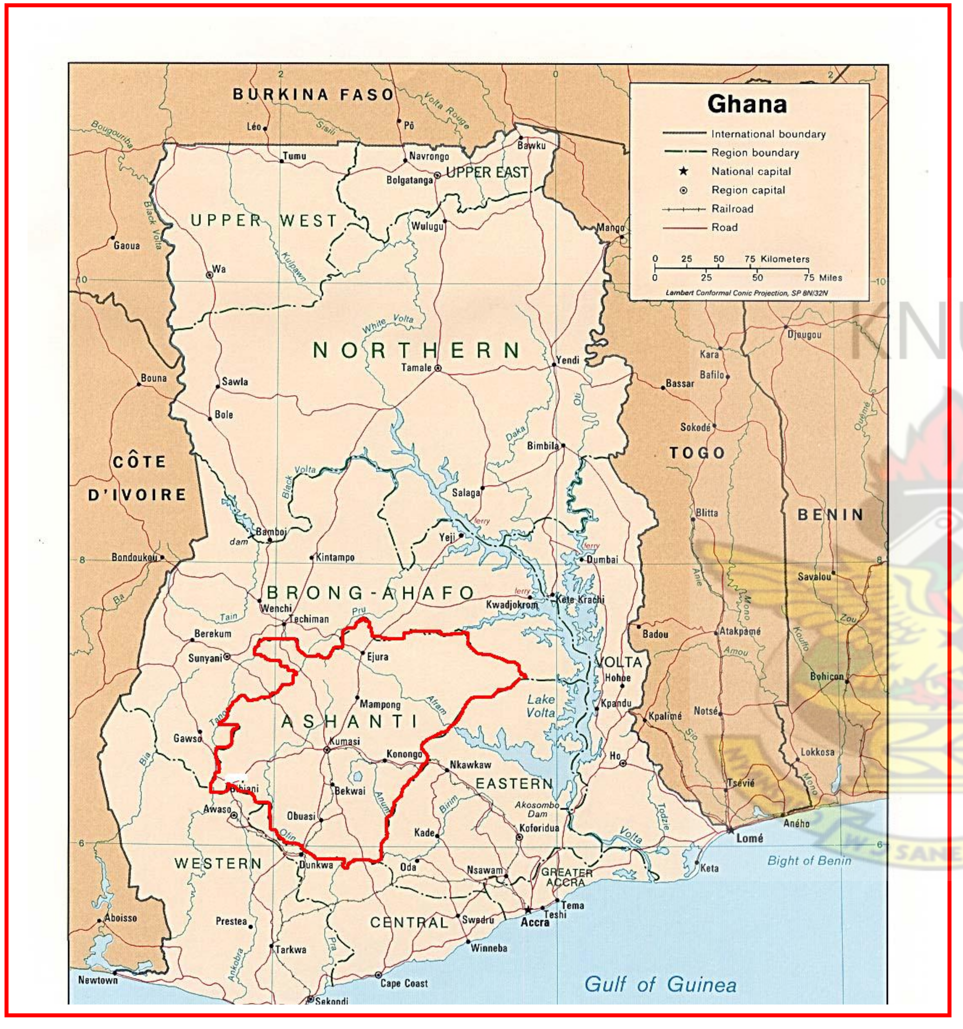

Figure 4.1a: Ashanti Region in the National Context

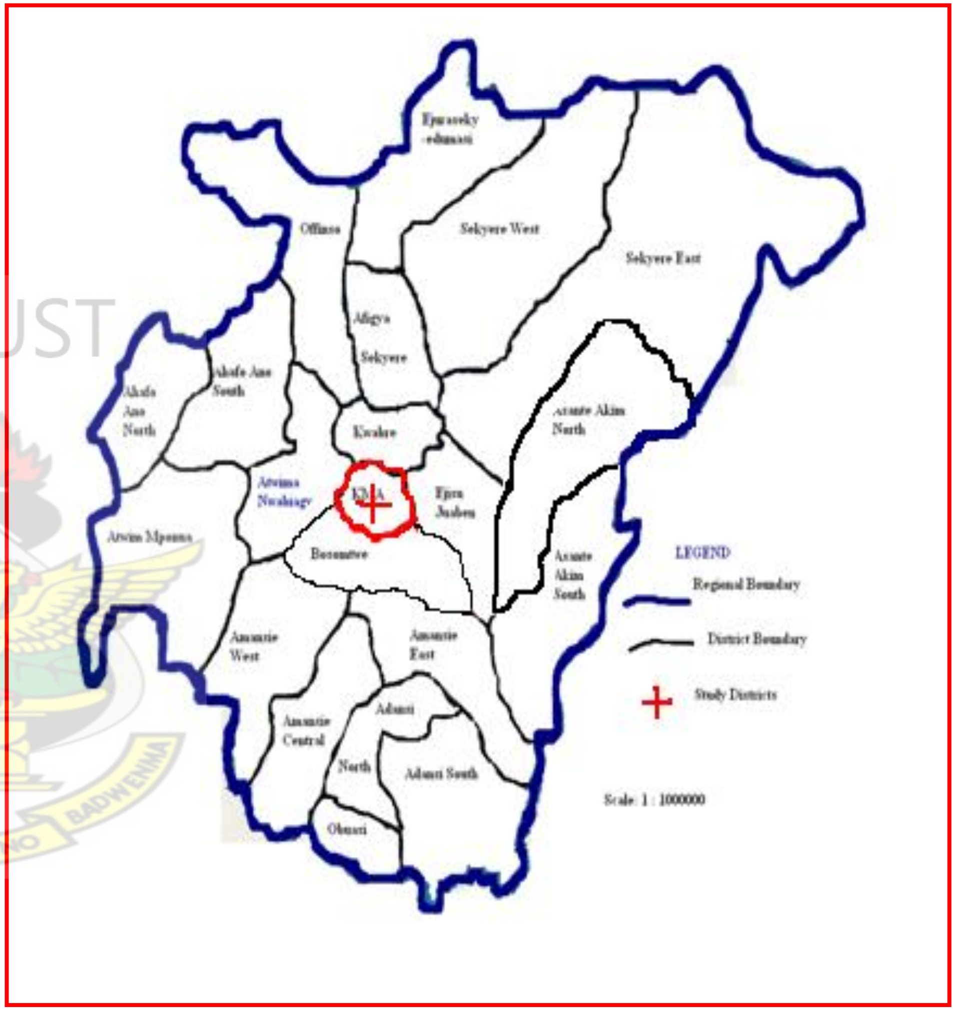

Figure 4.1b: Kumasi Metropolis in the Regional Context

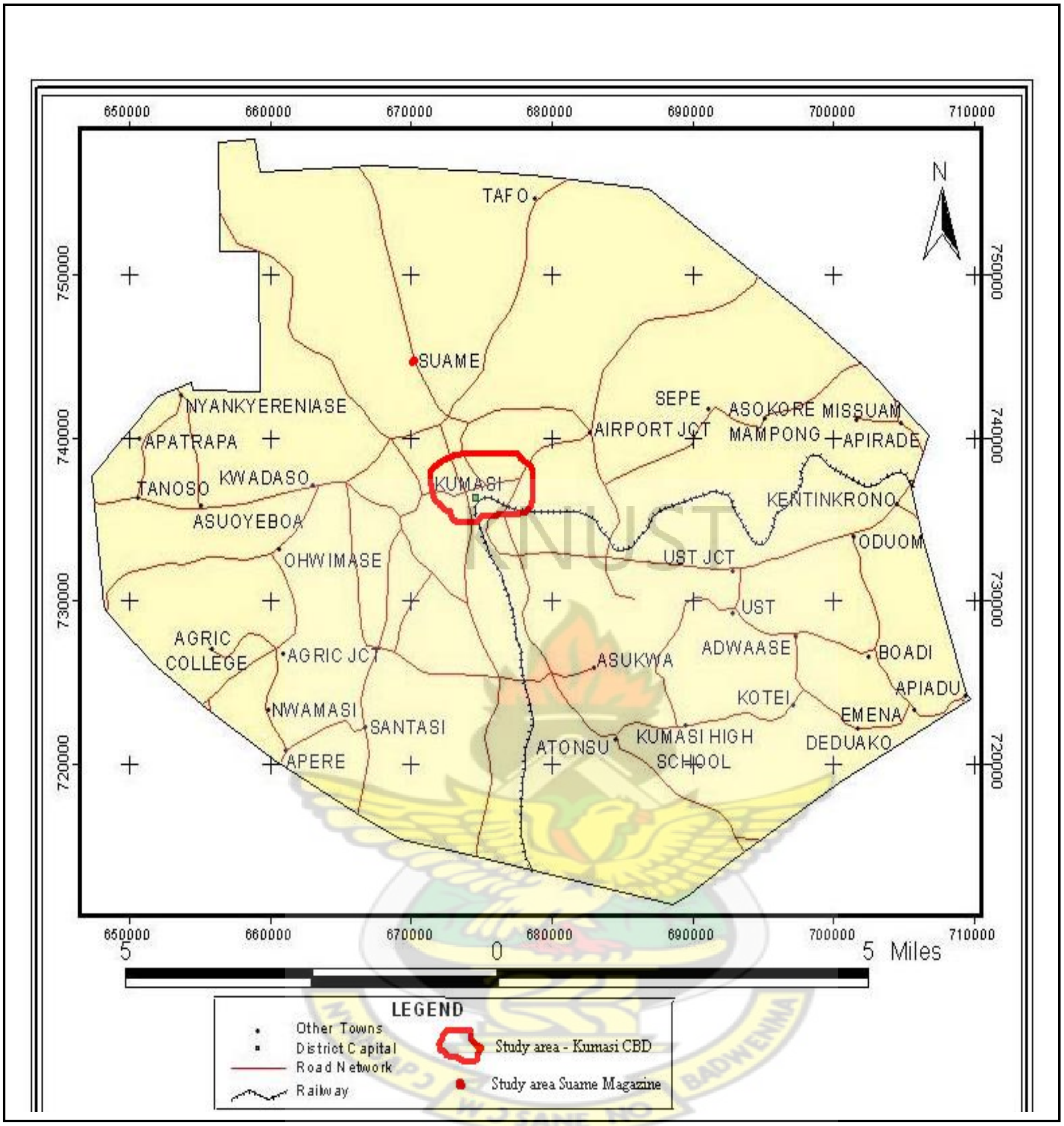

Figure 4.2: Map of Kumasi Metropolitan Assembly

The last estate, the Sokoban Wood Village (formerly at Anloga), processes timber logs to meet the needs of clients from all parts of the country and beyond. It is worthwhile to mention that light industries are also clustered in the CBD due to their environment-friendly methods of productions. With the focus of the study on micro and small scale light industries, the next section of the chapter provides a brief description of the light industrial outlets where the study was concentrated.

4.5. Energy Consumption within the Metropolis

Industrial establishments in the Metropolis require energy to sustain their operations. Based on this premise, the study examined the types of energy used by MSIs in production. The study identified that the industrial establishments in the Metropolis depend on electricity, wood fuels (charcoal, fuel wood and saw dust) and petroleum products (petrol, diesel oil and liquefied petroleum gas) for production. However, for the purposes of this study, the electricity sub-sector is considered.

The total amount of electricity consumed in the Metropolis is estimated at 120 MW as at 2001, a 33.3 per cent increase over the 1990 consumption level of 90 MW. The percentage increase in electricity consumption is attributed to the ever increasing number of consumers who are mostly households and firms. The major consumers include households, breweries and a bottling plant, wood processing plants, hotels, foundries, Komfo Anokye Teaching Hospital (KATH) and the Owabi and Barekese Water Works. The Metropolis is served by five Bulk Electricity Supply Points that consist of two-161/33KV transformers rated 25/33 MVA, two-161/11KV transformers rated 10/13 MVA and one 161/33KV rated 66 MVA. Kumasi has 231km of overhead lines and 140.6km underground cables. In sum electricity supply in the Kumasi Metropolis has been the responsibility of ECG from the national electricity grid. Hence the intermittent power supply from VRA through ECG and NED has not spared the MSIs within the Kumasi Metropolis.

4.6. Description of the Light Industrial Outlets of the Kumasi Metropolis

The light industrial outlets selected for the study included the Suame Magazine, the Sokoban Wood Village (erstwhile Anloga Wood Industry) and the Central Business District.

4.6.1. Description of the Suame Magazine Industrial Cluster

Suame industrial cluster is also known as ‘Suame Magazine’ because the site once housed a military magazine (Adeya, 2006: p.2). The site was created when the entrepreneurs were relocated from Kumasi city centre in the 1950s and 1960s to the current place of occupation. Thus, the increasing need for aesthetics in the city centre compelled city authorities to relocate the entrepreneurs whose activities were seen to be in conflict with the principles of space economy and environmental aesthetics to their current location.

Prior to their relocation, micro and small scale industries had started clustering at the former armouries in Kumasi as early as 1935. The key turning point on their full development was in the mid-1970s when Ghana introduced tight restrictions on the importation of new vehicles and spare parts (Dawson, 1988 cited in Adeya, 2006: p.2). This led to a down-turn for large enterprises which were capital-intensive and relied on imports; therefore, micro and small scale enterprises filled the gap as they were able to improvise spare-parts that were previously imported. However, in the 1980s under the Economic Recovery Programme (ERP), the importation of spare parts and vehicles resumed but the large enterprises did not regain their previous dominance. Since then, the micro and small scale sub-sector has been growing rapidly.

In 1984, over 40,000 people were working in the Suame Magazine Industrial Enclave (Powell 1986 cited in Adeya, 2006: p.2). By the late 1990s, the number of workers in the Enclave had increased to about 80,000 entrepreneurs with about 16,000 firms. Underpinned on this increase, the Technology Consultancy Centre (TCC) estimated that the labour force of the Suame Magazine cluster would grow at approximately 8 per cent (Obeng, 2000 cited in Adeya, 2006, p3). Thus, industrial activities in the Metropolis have witnessed a remarkable improvement since the 1980s.

Due to the ever increasing number of entrepreneurs within the Suame Magazine Industrial Enclave, congestion has become a major problem. Newly trained entrepreneurs have thus settled outside the enclave which has led to the development of other relatively smaller industrial clusters within and outside the metropolis. The 'Sofoline industrial cluster', 'Asafo Fitters' and 'Kwadaso-Edwenase fitters' are few examples of the newly developed industrial clusters. Entrepreneurs within these newly developed clusters hold allegiance to the associations within the Suame Magazine enclave. The major associations are the Suame Magazine Garages Association and the Magazine Mechanical Association. Industrialists such as sprayers, straighters and welders, vulcanisers, electricians, heavy and light duty mechanics, blacksmiths, etc. inhabit the Suame Magazine Industrial Enclave.

4.6.2. Sokoban Wood Village

The Sokoban Wood Village is inhabited by the resettled wood processors from the former Anloga Wood Industry. The relocation of the wood processors was necessary to pave way for the construction of the Anloga-Asokwa bypass road. The erstwhile Anloga Wood Industry cluster accommodated 4,000 wood processors who had occupied the land since the 1940s.

The Sokoban Wood Village supplies all the wood products required by carpenters and other consumers within and around the Kumasi Metropolis. Logs are processed into boards and planks by the wood processors.

4.6.3. Industries within the Central Business District

Unlike the Suame Magazine industrial cluster and the Sokoban Wood Village that accommodate entrepreneurs with similar lines of operation, the CBD is inhabited by different categories of entrepreneurs who produce different products. The operations of the industries within the CBD are seen to have limited environmental consequences. The light industries selected from the CBD for the study included grinding millers at the race course and central markets, printing presses at Adum, and cold stores operators at Asafo and the central market. The sachet water producers and dressmakers were selected from across the Metropolis.

4.7. Summary

The high population growth rate of 5.2 per cent has sustained the operations of MSIs within the metropolis. Thus high demand for goods and services has contributed to the proliferation of MSEs including light industries in the Metropolis. The increase in the number of industrial establishments has also led to the increase in the ECG's supply of electricity to consumers from 90 MW to 120 MW between 1990 and 2001.

CHAPTER FIVE

GHANA’S READINESS TO GENERATE ELECTRICITY FROM RENEWABLE TECHNOLOGIES; A REVIEW OF SNEP (2006-2020) AND NEP (2010-2015)

5.1. Introduction

Following from the identification of the alternative energy technologies in chapter two, this chapter examines Ghana’s readiness to exploit its renewable energy potential towards providing reliable and sustainable access to electricity by consumers towards growth and poverty reduction. The review of the energy policies considered issues such as the policies’ background, goals, objectives and strategies. These issues enabled the study to determine the arrangements made in providing clean energy in a sustainable manner.

5.2. Overview of Ghana’s Energy Situation

The prevailing development plans within the context of the Ghana (Growth and) Poverty Reduction Strategy (GPRS 1 and 2) forecast an average real GDP growth of 7-10 per cent for the period 2003 to 2015. The projected growth of GDP is expected to achieve a per capita income of US$1,000 by 2015 from less than US$400 in 2001. The drivers of the expected economic growth according to the GPRS 1 and 2 are agro-processing (agricultural sector), manufacturing (industrial sector) and Information and Communication Technology (Energy Commission, 2006: p.4). The drivers of the economic growth in turn depend on the availability of a reliable energy. However, total primary energy production is inadequate to sustain the desired rate of economic growth for a middle income status.

In elucidating the claim that the desired economic growth depends on access to reliable energy, the Energy Commission (2006: p.5), asserts that Ghana’s middle income aspiration will only be possible depending on an adequate supply of energy. Based on its estimations, demand for wood fuels is expected to grow from about 14 million tonnes in 2000 to 38-46 million tonnes by 2015 and further to 54–66 million tonnes by 2020. Similarly, demand for electricity is expected to increase from 11,300–13,500 gigawatt/hour in 2000 to an estimated 20,100–22,300 gigawatt/hour (this estimation excludes transmission losses) by 2020 (Energy Commission, 2006: p.6). Similarly, Aboh (2009; p. 20-23*)* estimates that electricity consumption will increase to 65,239.6 gigawatt/hour from 3,721.7 gigawatt/hour between 2008 and 2030. As a consequence of increasing consumption, the Energy Commission (2006: p.7) in its high economic scenario, estimates that energy expenditure is expected to rise from about US$2 billion in 2004 to US$4.3 - 4.6 billion, 13-14 per cent of GDP by 2015; and US$5.2 – 5.6 billion, 8-9 per cent of GDP in 2020.

Despite the increasing demand for energy, the primary indigenous energy sources will continue to be dominated by biomass (90-95 per cent), hydro energy (5-10 per cent) and solar (less than 1 per cent). The dramatic increase in the use of wood fuels would put the nation's dwindling forest and its resources under undue pressure which could culminate into serious deforestation, with serious consequences on climate change, agriculture and water resources (Energy Commission, 2006: p.22). It is important to state that changes in the rainfall regime which is associated with climate change have long affected electricity supply in Ghana. In 1983/84, 1998 and 2007, Ghana experienced a major drop in the rainfall pattern which resulted into power rationing and frequent power outages that in turn affected the performance of the national economy. These periods are often used to accentuate the claim that HEP supply in Ghana is threatened by climate change.

In view of the increasing demand for energy and the effect climate change poses on electricity generation in Ghana, the Energy Commission in its publication titled 'Strategic National Energy Plan 2006 – 2020' argues that the quantum jump in demand for electricity has implications on the nation's balance of payment situation since Ghana imports crude oil to supplement hydro electric power generation. Thus, with an expanding economy and a growing population, Ghana faces major challenges in providing the required energy in a reliable, clean and sustainable manner. Besides the problem of climate change, the Energy Commission identifies the other constraints that inhibit the reliability of electricity supply in Ghana to include the following:

- Rapidly growing demand for energy by all sectors due to expanding economy and growing population.
- Risk of over reliance on imports to meet local shortfalls of conventional fuels, which could threaten the country's supply security, making it vulnerable to external pressures.
- Over reliance on wood fuels which could deforest the country's forest cover.

Following from the above, Kemfert (2006: p.45-49) and Smith (2005: p.4) claim that the solution to the precarious energy situation of the world lies in the exploitation of clean alternative sources. Thus, “green” technologies are neither affected by climate change nor high prices of fossil fuels. Based on this premising, the next section of the chapter examines the extent to which Ghana’s energy policies consider the non-conventional sources of energy.

5.3. Alternative Sources of Energy in the SNEP (2006-2020) and NEP (2010-2015)

The Strategic National Energy Plan (SNEP 2006-2020) and the National Energy Policy (2010-2015) aim to develop alternative sources of energy especially for communities inaccessible to the national electricity grid. Increasing energy coverage in the policy documents is justified by the fact that energy sector interventions can provide energy services to support micro, small and medium scale income generating activities thereby elevating individual incomes, improving employment opportunities and reducing poverty.

However, increasing the energy coverage is only possible through increased investment in the energy sub-sector. Additionally, the investment must go into technologies that provide reliable and sustainable supply of energy. Based on these arguments, SNEP and NEP aim to exploit alternative sources of energy which are considered “green”.

5.3.1. Energy Policy Statements in SNEP and NEP

SNEP and NEP’s overall policy goal is to develop an ‘energy economy’ that ensures sustainable production, supply and distribution of high quality energy services to all sectors of the economy in an environment-friendly manner. In consonance with the vision of the Ministry of Energy, SNEP and NEP do not only aim to ensure that energy consumers (both within and outside Ghana) have access to adequate and affordable energy, but also to clean and efficient sources of energy. Specifically, SNEP and NEP aim to achieve the following objectives:

- Stimulate economic development by ensuring that energy plays a catalytic role in economic development.
- Consolidate, improve and expand existing energy infrastructure.
- Increase access to modern energy services for poverty reduction in off-grid areas.
- Secure and increase future energy security by diversifying sources of energy supply.

- Accelerate the development and utilisation of renewable energy and energy efficiency technologies.
- Enhance private sector participation in energy infrastructure development and service delivery.
- Minimise environmental impacts of energy production, supply and utilisation.
- Strengthen institutional and human resource capacity in energy development.
- Improve governance of the energy sector.
- Sustain and promote commitment to energy integration as part of economic integration of West African states.

The above 10 objectives are aimed at ensuring that the nexus between energy and economic development is maximised. Thus, all the sources of energy (both conventional and non-conventional) are to be exploited efficiently to enhance the socioeconomic agenda of the Government of Ghana. The ten objectives are to ensure sufficient, cost effective but affordable high quality energy supply to meet the increasing demand for electricity. The reliable and affordable energy for the industrial sector is to be measured in terms of a-95 per cent uninterrupted electricity supply by 2015 and further to 98 per cent by 2020. Due to environmental concerns, the Ministry of Energy hopes to introduce pollution charges in high-energy intensity industries to encourage energy efficiency by 2015.

SNEP and NEP use a multi-dimensional approach to exploit all energy sources for socioeconomic development of both rural off-grid areas and urban areas. The multi-dimensional approach gives credence to infrastructural development in the energy sector to be supplied by both the private and public sectors. Additionally, SNEP and NEP's holistic approach aims to improve upon governance of the energy sub-sector through institutional capacity development. This is a step towards efficiency in the energy sub-sector.

However, the holistic approach may not be very appropriate due to the inability to have the required amount of resources to implement all the targets. This constraint thus calls for priority setting in areas of investment. Additionally, in view of the fact that the conventional sources of electricity have proven to be unreliable and expensive due to climate change and increasing cost of fossil fuel exploitation, attention ought to be concentrated on renewable energy sources.

A critical review of the objectives above indicates that the use of renewable sources of energy can directly achieve four objectives namely;

- minimising environmental impacts of energy production, supply and utilisation;
- increase access to modern energy services for poverty reduction in off-grid areas;
- secure and increase future energy security by diversifying sources of energy supply; and
- accelerate the development and utilisation of renewable energy and energy efficiency technologies.

SNEP and NEP do not only justify the need to exploit renewable energy resources and technologies especially for remote off-grid areas, but also justifies their use as means of reducing Ghana's contribution to global warming. Thus, the "green" alternative source of energy if well developed can ensure energy reliability and sustainability for a well meaningful poverty reduction agenda.

5.3.2. Renewable Energy Technologies identified in SNEP and NEP

Having revealed that Ghana's energy policies provide for the exploitation of alternative energy technologies, this section of the chapter identifies the types of green technologies outlined in the policy documents.

Wind Energy Generation

Ghana has some wind resources that could be tapped to supplement the amount of energy generated (Energy Commission, 2006; Ministry of Energy, 2009). However, the potential is confined to the coastline and the most economic exploitation based on current technology is at 50 metre-height with average wind speeds between 6.0 – 6.3 metres per second (m/s). About 300 – 400 megawatt power can reliably be tapped for now and the maximum energy that can theoretically be tapped from the available wind for electricity using available technology is about 500 – 600 gigawatt-hours every year. This implies that the wind energy can be generated to feed the national electricity grid in the medium to long term.

Solar Energy Generation

Solar energy use is not a new phenomenon in Ghana. It has been used in the field of agriculture for drying of cereals and other agricultural produce. Additionally, photovoltaic (PV) electric systems installed in the country are well over 5,000 with installed capacity of about one megawatt generating between 1.2-1.5 gigawatt-hours every year particularly for electricity and water heating. The energy policies have a promotional programme dubbed “solar power for every home” targeted at both rural and urban homes with a minimum of 100Wp system for lighting purposes. This is an opportunity for the Rural Electrification Programme especially for remote and inaccessible off-grid areas to have access to electricity for their productive activities. Similarly, there is a government programme to provide a set of solar-television systems (each consisting of a solar power unit and a television set) for basic schools in off-grid locations, since it offers pupils in deprived schools the opportunity to participate in televised educational programmes. To what extent can these programmes be used to provide the electricity needs of MSIs? The analysis is expected to provide the appropriate answer to the question. The review has revealed that the promotion of solar energy technologies has already started in Ghana.

Agro Biofuel Wastes and Wood Fuels Power Generation

Another renewable source of energy promoted by both SNEP and NEP is biomass. Biomass for electricity generation is expected to be tapped from logging and wood processing residues, agrofuels and municipal by-products, as well as plantations. Almost 2 million tonnes of wood residues are available in the country annually for energy and other purposes and this is expected to reach 3 million tonnes by 2020 as the agriculture sector grows (Energy Commission, 2006; Ministry of Energy, 2009). For electricity, most reliable data suggests that at least 95 megawatt capacity providing about 600 gigawatt-hours annually is expected to be tapped from farm-wastes, sawmill and logging residues between now and 2010. It is against this background, that the Government of Ghana seeks to harness the biomass potential of Ghana to provide reliable access to electricity for well meaningful poverty reduction.

The policy on biomass also aims to ensure that the energy share of traditional biomass (wood fuels) in the national final energy mix is reduced from about 60 per cent at present to at least 50 per cent by 2015 and eventually to 40 per cent by 2020. All these would be done by setting up a national agency dedicated solely to wood fuel production and marketing issues along the same lines as VRA and ECG for Electricity, and GNPC and GOIL for petroleum issues.

The review has also revealed that electricity generation from biomass is still at the first stage of planning whilst specific actions are yet to be implemented. This implies that electricity generation from biomass is a long term objective.

Small and Mini-hydros Power

Another source of renewable energy is the small to mini-hydro dams. Small to mini-hydro sites total around 25 MW but dispersed over 70 sites with Dayi River cascades (2,000 – 5,300 kWp) in the Volta Region as the most attractive (Energy Commission, 2006; Ministry of Energy, 2009). Small to mini-hydro dams are to be promoted as decentralised power systems for commercial agricultural projects and tourist sites. It is also to be tied to the grid to serve as supplementary power units. The small hydro power proposed for development is the Dayi River cascades which can be developed and connected into the distribution grid. The review of the energy policies has revealed that the generation of electricity from small and mini hydro dams is possible at some suitable sites. Additionally, electricity generated from small and mini hydro dams are to be fed into the national grid. These imply that electricity from small and mini hydro dams is a medium to long term policy target.

Landfills Energy Generation

Ghana's energy policies as stated in SNEP and NEP make provision for the tapping of electricity from closed landfills. The Energy Commission (2006) and the Ministry of Energy (2009) indicate that electricity generated from landfill sites is potentially the cheapest source of off-grid electricity for communities close to the landfill sites. Engineered landfills are proposed for all regional centres and large urban centres where they could serve as sources of supplementary power to the centralised grid for these urban communities.

Due to the methane gas that is associated with landfill energy, Ghana needs to develop mechanisms to check against the emission of the toxic methane gas. Additionally, metals, bottles and other wastes generated by households and firms must be separated from the biodegradable materials to allow for easy decomposition to pave the way for the generation of landfill energy. Until these are done, the landfill energy cannot be harnessed in the short term.

5.4. Institutional and Regulatory Framework for the Supply of Electricity in Ghana

Having identified that Ghana has policy instruments for the generation of clean energy for consumers, this section of the chapter provides an overview of the institutional and legislative arrangements for the accomplishment of that purpose.

5.4.1. Public Sector Institutions

Ghana's energy policies define the framework within which electricity is produced and regulated. As indicated in Figure 5.1, at the apex is the Ministry of Energy (MOE) mandated to develop and implement energy sector policies in Ghana. The Ministry also supervises the operations of subsidiary bodies such as the Volta River Authority (VRA) and Electricity Company of Ghana (ECG) under the electricity sub-sector. Supporting the Ministry of Energy in its operations is the Energy Commission (GEC) established by Energy Commission Act, (Act 541) to develop a competitive energy industry that provides affordable, reliable, efficient and secured energy to consumers. The GEC is mandated to develop a competitive energy industry that provides affordable, reliable, efficient and secured energy economy. The Commission develops, reviews and updates periodically indicative national plans to ensure that all reasonable demand for energy are met in a sustainable manner.

Public and non-public companies implement programmes and projects in line with the policy frameworks provided by the Ministry of Energy and Ghana Energy Commission. VRA established by the Volta River Development Act, (Act 46) is mandated to generate electric power and distribute it to the northern and southern parts of Ghana through the Northern Electricity Department (NED) and ECG respectively. Tariffs for the electricity produced by VRA are regulated by the Public Utility Regulatory Commission (PURC) under the Public Utility Regulatory Commission Act (Act 538).

5.4.2. Private Sector Participation in Renewable Energy Promotion

The private sector is considered to be efficient in the production of economic services. Due to this efficiency, SNEP and NEP have made provisions for the production of renewable energy with the active involvement of the private sector. Subsequently, several private manufacturing firms have undertaken investments in the energy subsector to produce clean energy to meet the needs of consumers. This section of the chapter provides an overview of the nature of the private sector involvement in the renewable energy sub-sector of Ghana.

The Energy Foundation is the first private establishment to mention regarding private sector involvement in Ghana’s energy system. The Energy Foundation is devoted to the promotion of energy efficiency and renewable energy as a strategy to managing Ghana's growing energy needs in a sustainable manner. This mandate is underpinned by the direct link between energy and poverty reduction. The foundation, established by the Private Enterprise Foundation, is to promote sustainable development and efficient consumption of energy in Ghana. The Foundation specialises in offering energy efficiency and renewable energy solutions to residential, industrial and commercial energy consumers.

The Foundation is composed of representatives of the energy sub-sector stakeholders including the major producer (VRA) and distributor (ECG) as well as major energy consumers. This gives it the flexibility and versatility to pursue programmes with maximum efficiency and minimum delays. The Foundation has and continues to implement programmes and activities in various areas of energy use. The Energy Foundation educates the public and undertakes institutional development and capacity building for energy efficiency and policy advocacy for the adoption of energy efficiency as a national strategy.

The second private organisation having a stake in Ghana’s electricity supply is the Kumasi Institute for Technology and Environment (KITE). KITE is a private organisation that is concerned with environmental conservation through the promotion of ASEs. KITE also helps to arrange financing for businesses in the field of renewable energy.

Since inception, KITE has focussed on the promotion of enterprise-centred approaches and models through technical support and financing as a sustainable option for the delivery of energy services. KITE has also promoted clean energy through its Clean Energy Technology and Investment Programmes (CETIP). CETIP is designed to provide enterprise development and financial services to MSMIs involved in the provision of technologies and energy services. Additionally, KITE’s programmes have focussed on facilitating harmony between the attainment of socio-economic development and environmental quality through its Energy and Environment Programme (EEP) and Rural Energy Supply and Utilisation Programme (RESUP).

The third category of private sector is the clean energy producers. Though there are several firms which produce renewable energy in Ghana, the GEC identified Wilkins Engineering Limited and DENG Engineering Limited that were used as part of the research's unit of analysis. Wilkins Engineering Limited was established in 1993 as an electrical engineering firm. The organisation has since its establishment invested in the provision of solar energy to supply both rural and urban needs.

Established in 1988 to provide renewable energy, DENG Engineering Limited has expanded its scope to include water filtration and irrigation, civil engineering, industrial supplies, precision scales and balances, project management and training and education. The relationship between both the public sector establishment and the private sector establishments are shown in Figure 5.1.

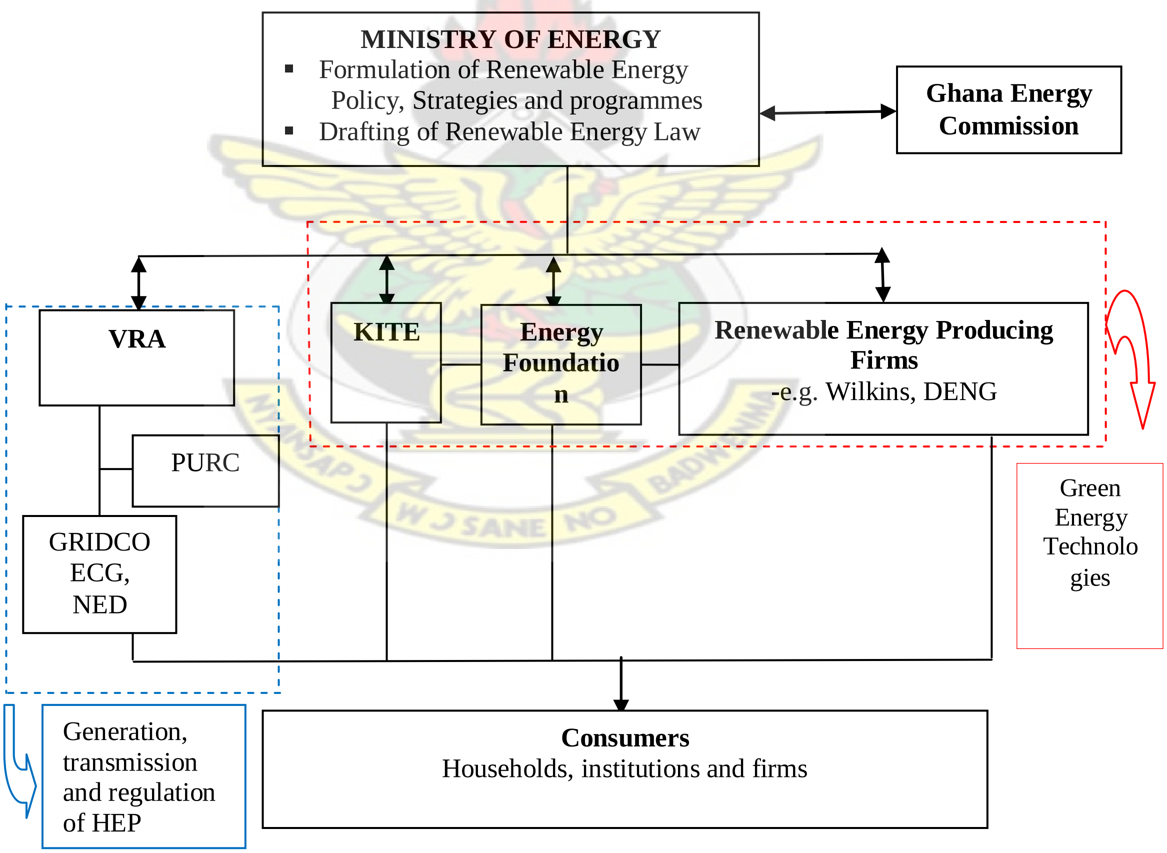

Figure 5.1: Analytical Framework – ASE Framework in Ghana

Though several public and private sector institutions have been tasked to produce energy to meet the requirements of consumers under various legislations, there is no single legislation on renewable energy. It came to light in an interview with GEC that the lack of a single legislation has inhibited investors from producing renewable technologies in Ghana. The Energy Commission has however drafted a Renewable Energy Bill for onward submission to Parliament for passage into Renewable Energy Law. The energy policies backed by the Renewable Energy Law will guide and regulate all investments in the renewable energy sub-sector. The passage of the Bill into Law would be complemented with the establishment of a Renewable Energy Authority in order to develop the sector as the case of the conventional sources of energy.

5.5. Lessons learned from SNEP and NEP on Ghana's readiness to invest in ASEs

Ghana has comprehensive policies aimed at harnessing its alternative energy potentials with emphasis on wind energy, solar energy, agro-biofuel wastes energy, wood fuels power, small and mini-hydro dams, and landfills and municipal waste energy. This implies that Ghana is ready to exploit environment-friendly sources of energy to supply the energy requirements of all consumers in a sustainable manner.

Despite this readiness, landfills and municipal waste energy that is treated as renewable source of energy in the two policy documents is questionable. According to Ewall (2007), landfill and municipal waste energy cannot be treated as renewable energy due to the emission of methane gas that is said to be unfriendly to the environment. This implies that for Ghana to harness electricity from landfill sites there should be the technology in place to capture the methane gas. Additional households and firms that generate waste will have to separate non-biodegradable materials from bio-degradable ones in order for landfills to be fully utilised. Similarly, water scarcity from global climate change poses a challenge on the use of mini and small dams for power generation. Investments in this direction (construction of the dams) should carefully follow detailed viability analysis.

In sum, the study has identified landfills energy, small and mini-hydros power, agro biofuel wastes and wood fuels power, solar energy and wind energy as the alternative sources that Ghana plans to exploit to supplement its energy supply.

CHAPTER SIX
WILLINGNESS AND ABILITY OF MICRO AND SMALL SCALE LIGHT INDUSTRIES TO ADOPT ALTERNATIVE SOURCES OF ELECTRICITY

6.1. Introduction

Following from Ghana's readiness to exploit its renewable energy potentials to deliver clean energy to consumers, this chapter identifies the significance of electricity in the operations of MSEs interviewed. The chapter also unveils the challenges the entrepreneurs encounter with the use of the current conventional sources of electricity (HEP and thermal). Subsequent to the identification of the entrepreneurs' frustrations with the current sources of electricity, the chapter identifies from Ghana's energy policy documents the alternative energy technology that in the short term can supply the electricity needs of the MSIs. Finally, the chapter examines the entrepreneurs' willingness and ability to adopt the alternative energy technologies.

6.2. Characteristics of the Enterprises

The sizes of the enterprises (number of employees, turnover and value of fixed assets) were used as the major criteria in examining their characteristics. All the enterprises studied fitted well into the category of micro and small scale enterprises as defined in chapter two.

6.2.1 Firms' Labour Absorption Capacity and Value of their Fixed Assets

In terms of employment of labour, the study identified that the labour strength (number of workers) of the spraying firms averaged six as indicated in Table 6.1 (also in Appendix 3). Additionally, the study identified that the total fixed assets value for the spraying firms averaged GH¢4,000 as indicated in Table 6.1 (see Appendix 3). In using the employment criterion for categorisation of enterprises, the study revealed that about 50 per cent of the spraying firms were micro scale enterprises (employing less than six workers), with the remaining 50 per cent being small scale enterprises (employing between six and ten workers). Furthermore, the 'fixed assets value' criterion also revealed that all the 'Spraying' firms are small scale since their fixed assets value did not exceed GH¢10,000 as indicated in Appendix 4.

'Straightening and welding firms' also employed an average of nine workers as indicated in Table 6.1. With reference to the employment criterion for the classification of industries, the study identified that all the ‘straightening and welding firms were small scale (with the number of workers ranging from six to twelve) as indicated in Appendix 3. The ‘fixed assets value’ criterion for the classification of industries revealed that all the ‘straightening and welding firms’ fit perfectly into the category of micro scale enterprises based on their average total fixed assets value of GH¢5,000 (see Table 6.1 and Appendix 4). The study further observed that though the total fixed assets value of all the spraying and straightening, and welding firms categorised them as micro scale enterprises, all the straighters and welders and 50.1 per cent of the sprayers employed more than five workers and thus categorised them as small scale enterprises. A probe however, revealed that between 75 and 80 per cent of the workers employed in the spraying, and straightening and welding firms were apprentices currently under training. Thus the non-payment of regular wages permitted them to engage many apprentices.

The labour strength (number of workers employed) of the wood processors was six as indicated in Table 6.1. In using the employment criterion for the categorisation of industries to assess the wood processors within the Sokoban Wood Village, the study identified that about 60.6 per cent and 39.4 per cent of them were micro scale and small scale enterprises which employed less than five workers, and between eight and ten workers respectively. Furthermore, the study identified that the fixed assets value of the ‘wood processors’ averaged GH¢20,000. Since all wood processing firms had total fixed assets value of more than GH¢10,000 but less than GH¢140,000 (US$100,000), they fitted perfectly in the category of small scale enterprises with reference to the Bolton Committee’s fixed assets value criterion.

As indicated in Table 6.1 and Appendix 3, the number of workers employed by the cold stores averaged three. The value of their fixed assets value averaged GH¢23,000. Though, the ‘cold stores’ by definition could be micro scale firms using the employment criterion, the value of fixed assets criterion puts them in the category of small scale enterprises. The study revealed that their relatively high fixed assets value is explained by the high costs of their stores (due to their location in the CBD) and refrigerators used for preservation of fish and production of ice blocks.

Though the printing presses employed nine workers on the average, about 13.3 per cent of them employed more than 30 workers as indicated in Appendix 3. Thus, the employment criterion puts the 13.3 per cent of the printing presses in the category of medium scale enterprises. However, none of the 'printing presses' had a fixed assets value exceeding GH¢140,000 (US$ 100,000) as their average total fixed assets value was GH¢17,000, about 87.8 per cent lower than the threshold required to categorise a firm as medium scale. Additionally, the study could not make a distinction between 'ownership' and 'control' of the printing presses (see sub-section 5.2.2). Thus, owners of the printing presses performed dual roles as owners and controllers. Hence, they were described as small scale enterprises.

Sachet water producing firms were identified by the study as the highest contributor to employment generation among the eight firms studied. The number of employees of the firms averaged 12 as indicated in Table 6.1. However, about 15.8 per cent of the sachet water producing firms employed about 50 workers as indicated in Appendix 3. Additionally, the average total value of the sachet water producing firms' fixed assets was GH¢90,000. A probe revealed that the high employment levels and value of fixed assets for all the sachet water producing firms have been influenced by the 15.8 per cent of the firms that employed more than 50 workers and the 12.3 per cent of the firms that had an average fixed assets value of not less than GH¢50,000. Thus by using the employment criterion to describe the sachet water producing firms, 57.9 per cent, 26.3 per cent and 15.8 per cent of the firms are micro, small and medium scale respectively. However, the fixed assets value criterion revealed that 94.7 per cent and 5.3 per cent of them are small and medium scale respectively.

As indicated in Table 6.1, the 'grinding mills' and 'dressmaking firms' employed workers averaging four and three workers respectively. The study further identified that the fixed assets value of the 'grinding mills' and 'dressmaking firms' averaged GH¢3,000 and GH¢4,000 respectively. By definition, all the 'dressmaking firms' and 'grinding mills' are micro scale enterprises.

Table 6.1: Number of Workers Employed by the Firms and their Fixed Assets' Value

Firms	Number of Employees	Value of Assets (GH¢)
Sachet Water Production	12	40,000
Cold Stores	3	23,000
Wood Works	6	20,000
Printing Presses	9	17,000
Straightening and Welding	9	5,000
Spraying	6	4,000
Dressmaking firms	3	4,000
Grinding Mills	4	3,000

Source; Field Survey, May 2010

The study identified that the number of workers employed by the firms depended on their level of capacity measured in terms of the total value of fixed assets as indicated in Appendix 5. In elucidating this claim, the study observed that 'straightening and welding' firms employed a limited number of workers (averaging nine) because the value of their fixed assets did not exceed GH¢10,000 (averaging GH¢5,000). Similarly, 'Spraying firms' were able to employ an average of 6 workers (with none of them employing more than 12 workers) because of low fixed assets value averaging GH¢4,000.

In a similar manner, the study identified that out of the 33 wood processors whose total assets value was less than GH¢20,000, about 78.8 per cent of them employed less than 6 workers. Additionally, out of the 23 wood processors whose total assets value ranged from GH¢20,000 to GH¢30,000, 52.2 per cent of them employed less than 6 workers with the remaining 47.8 per cent employing between 6 and 12 workers. However, only 20 per cent of the firms whose total fixed assets value ranged from GH¢30,001 to GH¢35,000 employed less than 6 workers. The remaining 80 per cent employed between 6 and 12 workers. Thus, as the value of the total fixed assets increased, number of workers employed also increased.

The cold stores provided further evidence to accentuate the claim that as the total value of the firms' fixed assets increased, the number of workers employed also increased. Out of the 55 cold stores which employed less than 6 workers, about 63.6 per cent had less than GH¢25,000 as the total value of their fixed assets. Additionally, all the 3 cold stores whose total average fixed assets value was more than GH¢45,000 employed between 6 and 12 workers.

Similarly, sachet water producing firms which employed the highest number of workers had the highest value of fixed assets. As indicated in Appendix 3, all the 9 sachet water producing firms which employed more than 30 workers had total fixed assets valued at GH¢45,000 and above.

Appendix 4 also indicates that the printing presses which employed more than 30 workers had total fixed assets value of more than GH¢20,000. The other printing presses whose total fixed assets value was less than GH¢20,000 employed not more than 12 workers. Appendix 4 further indicates that the fixed assets value for dressmaking firms was not more than GH¢15,000. Subsequently, only 1 (1.8 per cent) out of the 39 dressmaking firms studied employed between 6 and 12 workers. In a similar manner, only 3 (12 per cent) of the 35 grinding mills studied employed between 6 and 12 workers since none of them (grinding mills) had a total fixed assets value of more than GH¢15,000.

In sum, the study identified that the higher the value of a firm's fixed assets value, the higher its level of labour absorption capacity.

6.2.2. Firms' Ownership and Control

In elucidating further the claim that majority of the firms interviewed were micro and small scale enterprises (except the 15.8 per cent sachet water producers that exhibited medium scale characteristics), the study investigated their ownership and control situations. The study identified that all the firms were managed and controlled by their owners. Thus the study could not distinguish between the owners of the firms and the managers as owners administered and controlled the affairs of all the firms.

6.2.3. Firms' Turnover (Cost of production and Revenue)

The firms' turnovers measured in terms of the cost of production, total revenue and profit were also used to identify the characteristics of the firms.

Total Cost of Production, Revenue and Profits

An assessment of the total costs of production and revenue accrued to the enterprises helps to determine their profit margins which in turn determine the entrepreneurs' ability to afford the proposed alternative energy technologies. Based on this premise, the study sought to assess the profit margins of the enterprises by first examining their total costs of production and revenue and then their profit margins.

The total average monthly cost of production for the 'straighters and welders' was estimated at GH¢2,610.6 as indicated in Table 6.2 (also in Appendix 6). The total monthly cost comprised inputs (raw materials and labour), taxes and tariffs. On the other hand their estimated total monthly revenue averaged GH¢3277.3 as indicated in Table 6.2 (also in Appendix 6). This revealed an average monthly profit of GH¢666.7 as indicated in Table 6.2.

In a similar vein, the average total monthly production cost for the 'sprayers' was GH¢2,499.5 as indicated in Table 6.2 (also in Appendix 6). The cost components also included the cost of inputs, transport and taxes and tariffs paid to KMA. On the other hand, the sprayers' average total monthly revenue was estimated at GH¢2,777.3. The revenue and expenditure pattern for the sprayers revealed an average monthly profit of GH¢277.8 as indicated in Table 6.2.

The total monthly cost of production for the 'grinding millers' averaged GH¢246.6 as depicted in Table 6.2. Their expenditure covered inputs (labour), utility tariffs and taxes. The grinding millers earned an average total monthly revenue of GH¢492.4 as indicated in Table 6.2. The expenditure and revenue patterns of the grinding millers revealed an average monthly profit of GH¢245.8 as indicated in Table 6.2.

As indicated in Table 6.2 (also in Appendix 6), the average estimated total monthly cost of production for the cold stores was GH¢9,344.3. The average total monthly cost of production comprised cost of inputs (fish and meat and labour), transportation, taxes and tariffs. On the other hand, the estimated average total monthly revenue was GH¢10,413.3 as indicated in Table 6.2 and Appendix 6. The expenditure and revenue patterns of the cold stores revealed average total monthly profit of GH¢1,069.

The total monthly production expenditure of the wood processors averaged GH¢2,908.6. The expenditure comprised wages and salaries paid to workers, taxes and electricity tariffs. Similar to the sprayers and the straighters and welders' mode of operation, the wood processors process the goods (unprocessed wood) brought to them by customers who are mainly carpenters. Thus, the wood processors cut, saw, split, plane and mould logs into usable forms (such as planks and boards) for carpenters. On the other hand, the estimated total monthly revenue accrued to the wood processors averaged GH¢3,560.1 as indicated in Table 6.2 (see also Appendix 6). This revealed an average monthly profit of GH¢651.5.

The printing presses operate on contract basis where they execute contracts with their own operating capital after which customers reimburse them. Their total monthly cost of production averaged GH¢8,866.2. The total monthly costs comprised inputs (such as papers, inks, pins, wages and salaries paid to workers) and electricity. The printing presses earned an average monthly revenue of GH¢9,266.2 as indicated in Table 6.2 and Appendix 6. The expenditure and revenue pattern of the printing presses revealed a monthly profit of GH¢400 as indicated in Table 6.2.

The sachet water producers manufacture sachet water with their own capital (operating capital) after which the products are sold to customers to recoup their investments. The total cost of production averaged GH¢10,315.3 per month. The production cost comprised the cost of inputs such as polythene, filters, fuel and lubricants, and wages and salaries paid to workers. This mode of operation requires high operating capital. The study thus identified that the sachet water producers commanded the highest operating capital, next to the printing presses as indicated in Table 6.2. On the other hand, sachet water producers earned an average monthly revenue of GH¢11,824.1 and an average monthly profit of GH¢1,508.8 as indicated in Table 6.2.

The dressmakers procure materials in bulk and sew them into finished clothes for sale. These finished clothes are sold to customers through retailers. The dressmakers' monthly expenditure averaged GH¢1,679. The dressmakers' operating costs are largely made up of the cost of materials, transport, labour, utility tariffs and taxes. On the other hand the average total monthly revenue was estimated at GH¢2,012.3 which revealed an estimated total monthly profit of GH¢335.9 as indicated in Table 6.2.

Table 6.2: Firms' Total Monthly Expenditure, Revenue and Profits

SN.	Firms	Average monthly expenditure	Average monthly revenue	Average monthly profits
1.	Sachet Water production	10,315.3	11,824.1	1,508.80
2.	Cold Stores	9,344.3	10,413.3	1,069.00
3.	Straightening and Welding	2,610.6	3,277.3	666.70
4.	Wood Processors	2,908.6	3,560.1	651.50
5.	Printing Presses	8,866.2	9,266.2	400.00
6.	Dressmaking	1,679	2,012.3	333.30
7.	Spraying	2,499.5	2,777.3	277.80
8.	Grinding Mills	246.6	492.4	245.80

Source; Field Survey, May 2010

Relationship between Firms' Assets Value and Profit Margins

According to e Meirelles *et al*. (2006: p.5), firms' assets value influences their production margin which in turn reflects in their profit levels. Based on this premise, the study sought to examine the relationship between the firms' value of fixed assets and their levels of profits as indicated in Table 6.3.

Table 6.3: Relationship between Firms' Value of Fixed Assets and Profit Levels

Firms	Value of Fixed Assets (GH¢)	Rank in terms of Value of Assets	Profit Level (GH¢)	Rank in terms of Profit level
Sachet Water Manufacturing	92,456	1st	1,508.80	1st
Cold Stores	22,759	2nd	1,069	2nd
Straightening and Welding	4,722	5th	666.7	3rd
Wood Wor**ks**	19,924	3rd	651.5	4th
Printing Presses	16,667	4th	400	5th
Dressmaking	3,879	7th	333.3	6th
Spraying	4,162	6th	277.8	7th
Grinding Mills	3,071	8th	245	8th

Source; Field Survey, May 2010

The study observed a relationship between the firms' fixed assets value and profit margins as expressed in Table 6.3. The sachet water producing firms and cold stores commanded the highest value of fixed assets and subsequently earned the highest monthly profits. Except straightening and welding and dressmaking firms whose profits were not directly linked to the value of their fixed assets, the other firms' total fixed assets value correlated with their profit margins.

Premising on the observed relationship between the fixed assets value of the firms and their profit margins, the study used the product moment correlation coefficient (r) and coefficient of determination (r^2) adopted from Spiegel and Stephens (2008: p.350) to determine the nature and extent of the relationship. With the firms' assets value as the variable upon which the firms' profits depend, the study identified that the product moment correlation coefficient (r) and coefficient of determination (r^2) were 0.88 and 77 per cent respectively as indicated in Appendix 7. The positive correlation coefficient (r) imply that the relationship between the firms' assets value and profits is positive (i.e. the higher the value of fixed assets, the higher the firms' profit margins). Similarly, the coefficient of determination (r^2) of 77 per cent implies that 77 per cent increase in the firms' profits are explained by an increase in their fixed assets' value.

6.3. The Role of Electricity in the Development of the Micro and Small Scale Enterprises

Energy is a major requirement for economic growth and development (Energy Commission, 2006: p. 5). There is therefore a nexus between energy use, economic growth and standard of living. Based on this, this section of the chapter examines the role electricity plays in the development of the MSIs. In examining the role electricity plays in the development of the MSEs, the study considered the quantity of electricity (measured in units) consumed by the entrepreneurs in a month with its associated tariffs. This section also considers the amount of subsidies provided for electricity consumption and its effects on the MSEs.

6.3.1. Uses of Electricity by the Firms

The study identified that the micro and small scale light manufacturing industries located within and outside the selected industrial clusters within the Kumasi Metropolis depended on electricity supplied by VRA through ECG for their development. Straightening and welding firms located within the Suame Magazine Industrial Enclave used electricity to straighten and weld cars and other metals into desirable forms. Accident cars within and outside the metropolis are taken to the Suame Magazine Industrial Enclave for repairs by a number of artisans including the straighters and welders. The straighters and welders besides fixing accident cars, also manufacture metallic gates, canopies, scaffolds and burglar proofs in response to customers' demands. The products from the straightening and welding firms are forwarded to 'sprayers' as intermediate commodities to be sprayed or coated to prevent rusting and for beautification.

Similarly, wood processors within the Sokoban Wood Village used electricity to operate their machinery (planes, mortises, saws, etc) to cut, saw, split, plane, tread and mortise logs into usable forms for the manufacture of furniture, beams, boards and planks. Thus, the processed logs from the Sokoban Wood Village are used as inputs by carpenters for the manufacture of wood furnishings including beds, wardrobes and other furniture.

The study further identified that sachet water producers, dressmakers and cold store operators used electricity in their operations. The sachet water producers used electricity to produce sachet water. Similarly, dressmakers used electricity to operate their sewing machines to sew clothes and bags for sale to customers. Cold store operators also used electricity to power their refrigerators to produce and preserve iced blocks and meat respectively. Grinding millers within the Kumasi Central and Race Course markets also used electricity to drive their mills to process corn, cassava, 'kenkey', flour and vegetables in semi-finished goods for further production. Printing presses used electricity to power their computers, photocopiers and printers to print customers' works (publications, posters, etc).

6.3.2. Ghana's Electricity Tariff Structure and its effects on the MSIs

Before identifying the quantity of electricity consumed by the industrialists, the study first reviewed Ghana's electricity tariff structure. This enabled the researcher understand the effects the tariff structure has on the MSIs.

The study identified that Ghana's electricity tariff structure is tied to the quantity (measured in units) of electricity consumed. Thus, the higher a consumer's electricity consumption level the more he pays as tariff. Ghana's electricity tariff framework shows a four-tier structure as indicated in Table 6.4. The first category, also referred to as the "lifeline tariff category", represents consumers that consume between 0 and 50 units of electricity per month. In the second category (residential category) are consumers that use between 51 and 300 units of electricity per month. In the third and fourth categories are consumers that consume between 300 and 600 units, and over 600 units of electricity respectively.

Consequently, consumers within the lifeline tariff category (category one) pay 9.5Gp per unit of electricity consumed as indicated in Table 6.4. Similarly, consumers within categories two and three pay 12Gp and 16Gp respectively for a unit of electricity consumed. Lastly, consumers within the fourth category pay 19Gp for a unit of electricity consumed as indicated in Table 6.4.

The tariff structure enjoins electricity consumers to pay amounts of 4Gp and 2Gp as Government service levy and street light respectively as indicated in Table 6.4. The others are services charges of GH¢2.5 and Value Added Tax (VAT) and National Health Insurance Levy (NHIL) that constitute 15 per cent of the total amounts paid by non-residential users of electricity as indicated in Table 6.5.

Table 6.4: Ghana's Electricity Tariff Structure as at May, 2010

Category	Units consumed per month	Nonsubsidised Tariff per unit (Gp)	Subsidised Tariff per unit (Gp)	Other Monthly Charges		
				Street lighting Gp	Gov't Service levy Gp	Service charges GH¢
1	0 – 50	9.5	9.5	2	4	2.5
2	51 -300	12	7.2	2	4	2.5
3	300 – 600	16	9.6	2	4	2.5
4	600+	19	11.4	2	4	2.5

Source; Daily Graphic, Tuesday, June 1, 2010.

6.3.3. Amount of Subsidies provided for Electricity Consumption

Consumers that consumed more than 50 units of electricity per month received 40 per cent subsidy on the first 300 units of electricity consumed. Thus, firms that consumed between 51 and 300 units paid 7.2Gp (instead of 12Gp) for the units of electricity consumed per month as indicated in Table 6.4. Similarly, firms that consumed between 301 and 600 units paid 9.6Gp (instead of 16Gp) for the first 300 units of electricity they consumed. Furthermore, the firms that consumed more than 600 units of electricity paid 11.4Gp (instead of 19Gp) for the first 300 units of electricity they consumed. Thus the subsidy was introduced as a measure to make electricity tariffs affordable to both non-residential and residential users who consumed high units of electricity (Ardayfio-Schandorf, 2009: p. 28).

6.3.4. Quantity of Electricity Consumed by the Enterprises

Following from the identification of Ghana's electricity tariff structure, the study assessed the quantity of electricity consumed and the tariffs paid by the MSIs in a month vis-a-vis what they would have paid without the subsidy. The assessment of the quantity and amount of electricity consumed by the firms was justified on the grounds that they (the quantity and amount) would determine the type of alternative source of energy required by the MSIs. The evaluation of the effects the subsidy had on the payment of tariffs also enriched the studies arguments in its scenario generation as seen in sub section 6.7.5.

As indicated in Appendix 6, the study identified that none of the firms was in the lifeline tariff category (consumed 50 units or less). However, the firms consumed different amounts of electricity and subsequently paid different tariffs as indicated in Table 6.5 (also in Appendix 8).

Table 6.5: Quantity of Electricity Consumed and Tariffs Paid by the firms

Firms	Kilowatts hour of electricity per month	Monthly Tariffs				
		Amount required to pay (without subsidy) (GH¢))	Amount paid (i.e. subsidised)	Service charges (GH¢)	VAT & NHIL @ 15 per cent	Total (GH¢)
Cold Stores	936.5	207	149.8	2.5	22.47	174.8
Printing Presses	740.2	164	111.4	2.5	16.71	130.6
Wood Processing	650.2	145	93.6	2.5	14.04	110.1
Straightening & Welding	555.9	105	77.4	2.5	11.61	91.5
Sachet Water	545.5	103	72.1	2.5	10.815	85.4
Grinding Mills	337.6	49	39.8	2.5	5.97	48.2
Spraying	283.8	42	29.5	2.5	4.425	36.4
Dressmaking	247.3	37	24.1	2.5	3.615	30.2

Source: Filed Survey, May, 2010

From Table 6.5, the average quantity of electricity (measured in kilowatt hour) used by dressmakers and sprayers are within the residential category and thus paid the subsidised residential tariff of 7.2Gp per unit. Similarly, sachet water producers, grinding millers, and straighters and welders paid tariffs in the third category (301 - 600 units category). The highest consumers of electricity were the wood processors, printing presses and cold store operators which consumed more than 600 units and thus paid 19Gp per unit (but paid 11.4Gp per unit for the first 300 units consumed). The study identified that the firms which intensively used electricity for production paid the highest tariffs. They included the cold stores, printing presses, straightening and welding firms, wood processing firms and sachet water producing firms as indicated in Table 6.5.

According to Ardayfio-Schandorf (2009, p. 24), the Government of Ghana subsidises electricity tariffs with the aim of encouraging households and firms to shift from fuel wood to the use of electricity as the source of energy for their activities. The study identified that the Government subsidy has reduced significantly the tariffs paid by the micro and small scale enterprises. Table 6.5 shows that the introduction of the 40 per cent subsidy on the consumption of the first 300 units of electricity has reduced the tariffs of the cold stores, printing presses, wood processing firms, straightening and welding firms, and sachet water producing firms by 15.6 per cent, 20.4 per cent, 24.1 per cent, 12.9 per cent and 17.1 per cent respectively. Similarly, the subsidy has reduced the tariffs of the dressmakers, grinding millers and sprayers by 18.4 per cent, 1.6 per cent and 13.3 per cent respectively.

A further analysis revealed that the tariffs paid by the industrialists constituted an average of 3.6 percent of the firms' monthly expenditure. This proportion of the total monthly expenditure (3.6 per cent) is influenced by the grinding millers' high proportion (16.1 per cent) due to their relatively low monthly expenditure of GH¢ 246.6. An average of 1.8 per cent was arrived at with the exclusion of the grinding millers' proportion. Relating the average to the amount the industrialists would have paid without the subsidy, the study identified that the total monthly tariffs would have constituted an average of 2.6 per cent of the firms' total monthly expenditure (excluding the grinding millers and 4.7 per cent of firms' total monthly expenditure including the grinding millers) as indicated in Table 6.6. Thus, the Government's electricity tariff subsidy has reduced the tariff proportion of total monthly expenditure of the firms by 30.8 per cent as indicated in Table 6.6.

In a similar vein, the electricity subsidy has reduced by 15 per cent the tariffs the industrialists would have paid to ECG for the amounts of electricity consumed per month. The highest and least effects were felt by the wood processors and the grinding millers respectively as indicated in Table 6.6.

Table 6.6: Monthly Electricity Tariffs as a Percentage of Total Monthly Expenditure

Firms	Total Expenditure	Total Monthly Electricity Tariffs subsidised	Total Monthly Electricity Tariffs nonsubsidised	Effects of the subsidy on the tariff paid	Monthly subsidised Tariffs as a Percentage of Total Expenditure	Monthly nonsubsidised Tariffs as a Percentage of Total Expenditure
Grinding Mills	246.6	48.2	49	1.6	16.1	19.9
Wood Processing	2,908.6	110.1	145	24.1	3.2	5.0
Straightening & Welding	2,610.6	91.5	105	12.9	3.0	4.0
Dressmaking	1,679	30.2	37	18.4	1.4	2.2
Cold store	9,344.3	174.8	207	15.6	1.6	2.2
Printing Presses	8,866.2	130.6	164	20.4	1.3	1.8
Spraying	2,499.5	36.4	42	13.3	1.2	1.7
Sachet Water Manufacturing	10,315.3	85.4	103	17.1	0.7	1.0

Source: Filed Survey, May, 2010

6.3.5. Perception about the Electricity Tariffs

Following from the finding that the tariffs paid by the MSIs featured prominently among the monthly expenditure items of the firms, the study assessed the entrepreneurs' perception about the tariffs they paid.

Using a 3-interval likert scale to examine entrepreneurs' perception about the monthly electricity tariffs, the study identified that all the cold store operators considered the tariffs as expensive as indicated in Figure 6.1. Additionally, about 20.5 per cent, 37.1 per cent, 66.7 per cent and 47.4 per cent of the dressmakers, grinding millers, printing presses and sachet water producing firms respectively considered the tariffs they paid as expensive. Furthermore, 77.8 per cent, 33.3 per cent and 51.5 per cent of the straighters and welders, sprayers and wood processors respectively considered the tariffs they paid as expensive. Thus, an average of 54.3 per cent of the firms perceived the electricity tariffs as expensive despite the subsidy provided by the Government of Ghana.

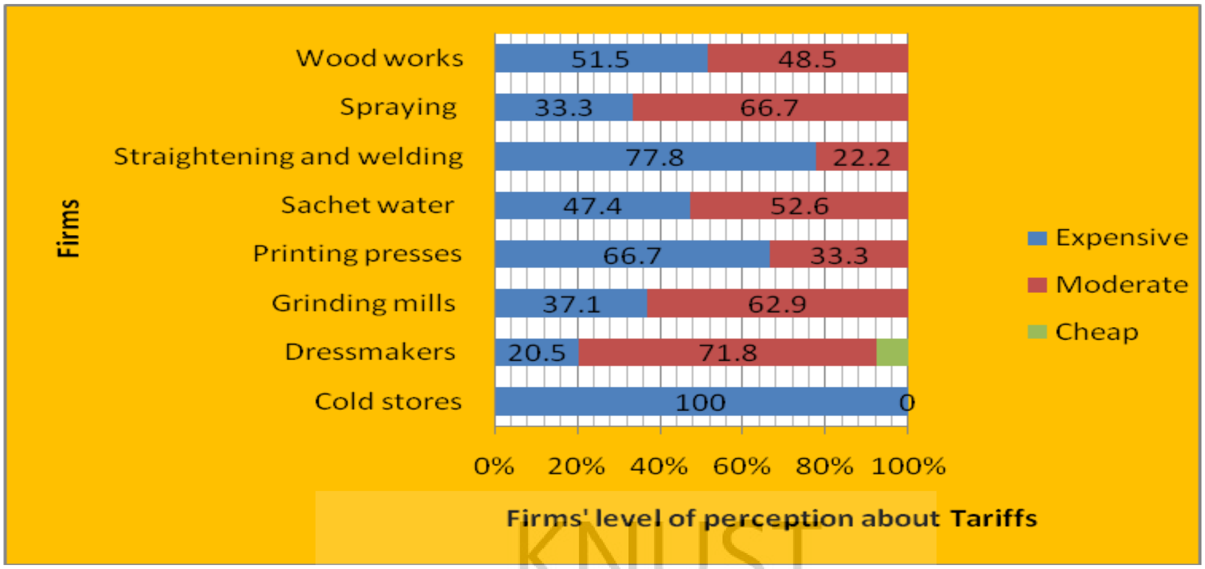

Figure 6.1: Entrepreneurs' Perception about Electricity Tariffs

On the other hand, about 71.8 per cent, 62.9 per cent, 33.3 per cent and 52.6 per cent of the dressmakers, grinding millers, printing presses and sachet water producing firms respectively considered the tariffs they paid as moderate as indicated in Figure 6.1. Similarly, 22.2 per cent, 66.7 per cent and 48.5 per cent of the straighters and welders, sprayers and wood processors respectively considered the tariffs they paid as moderate.

A further probe revealed that none of the entrepreneurs, except 7.7 per cent of the dressmakers, perceived the tariffs they paid for electricity consumption as cheap as indicated in Figure 6.1 (see also Appendix 9).

In a cross tabulation between the tariffs paid by the entrepreneurs for electricity consumption and their perceptions about the tariffs, the study identified that the firms' perceptions about the tariffs were informed by the amount of electricity they consumed as well as the tariffs they paid. Thus, the higher the quantity of electricity consumed, the more expensive the entrepreneurs considered the tariffs to be. In elucidating this claim further, the study observed that the 77.8 per cent of the straighters and welders and all the cold store operators that perceived the tariffs as expensive consumed more than 300 units of electricity monthly as indicated in Appendix 9. Thus, the group of straighters and welders, and cold store operators that perceived the tariffs as expensive paid a minimum of 16Gp (7.2Gp for a unit in the first three hundred units) for a unit of electricity consumed as indicated in Appendix 9.

All the grinding millers (37.1 per cent) that considered the tariffs as expensive consumed more than 300 units per month. The remaining 62.9 per cent consumed less than 300 units, paid a maximum of 12Gp (but 7.2Gp for a unit in the first three hundred units) per unit of electricity consumed, and thus considered the tariffs as moderate. Similarly, the 33.3 per cent of the sprayers that considered the monthly tariffs as expensive consumed more than 300 units of electricity. The study also identified that the category of sprayers that considered the tariffs as moderate (66.7 per cent) consumed less than 300 units and thus paid 12Gp (but 7.2Gp for a unit in the first 300 units) per unit of electricity as indicated in Appendix 9.

The exceptions were observed with sachet water producers and wood processors where 52.6 per cent and 39.4 per cent respectively consumed between 300 and 600 units of electricity but considered the tariffs as moderate (see Appendix 9). Nevertheless, majority of the sachet water producers (28.1 out of 47.4 per cent) and all the wood processors that considered the tariffs as expensive consumed more than 600 units of electricity as indicated in Appendix 9. In a similar vein, 63.3 per cent out of the 66.7 per cent of the printing presses that considered the tariffs as expensive, consumed more than 600 units and thus paid 19Gp (the highest tariff category) per unit of electricity consumed.

Lastly, all the dressmakers (3 per cent) that considered the tariffs they paid as cheap consumed units within the lifeline tariff category and thus paid the least amount (9.5Gp) per unit. Additionally, all the dressmakers that considered the tariffs as moderate consumed between 50 and 300 units per month as indicated in Appendix 9. Thus, the higher the amount of electricity consumed in a month, the higher the amount paid as tariffs.

6.4. Regularity of Supply of Electricity

Realising that electricity plays a significant role in the production cycle of the MSIs in the Kumasi Metropolis, the study examined the regularity of its (electricity) supply. The regularity of electricity supply to the enterprises was assessed by considering the difference between the number of hours of uninterrupted supply of electricity required by the industrialists for production and the number of hours of electricity that they actually received.

6.4.1. Number of Hours Electricity is Required by and Supplied to the Enterprises

The study identified that electricity is constantly required by all the cold store operators to keep their products preserved. As indicated in Figure 6.2 (also in Appendix 10), the cold stores required a 24-hour constant supply of electricity to keep fish, meat and water frozen.

On the other hand, the study identified that though the other enterprises required a constant supply of electricity, it was needed only during their working hours. The grinding millers, wood processors and printing press operators needed a constant supply of electricity to power their machinery. As indicated in Figure 6.2 (also in Appendix 10), the grinding millers required 10 hours constant supply of electricity to power their mills. Similarly, the wood processors and printing presses required 10 hours and 7.7 hours respectively of constant supply of electricity for their operations. Straighters and welders, sprayers, sachet water producers and dressmakers needed 6 hours, 5.5 hours, 6.2 hours and 5.4 hours respectively of constant supply of electricity as portrayed in Figure 6.2.

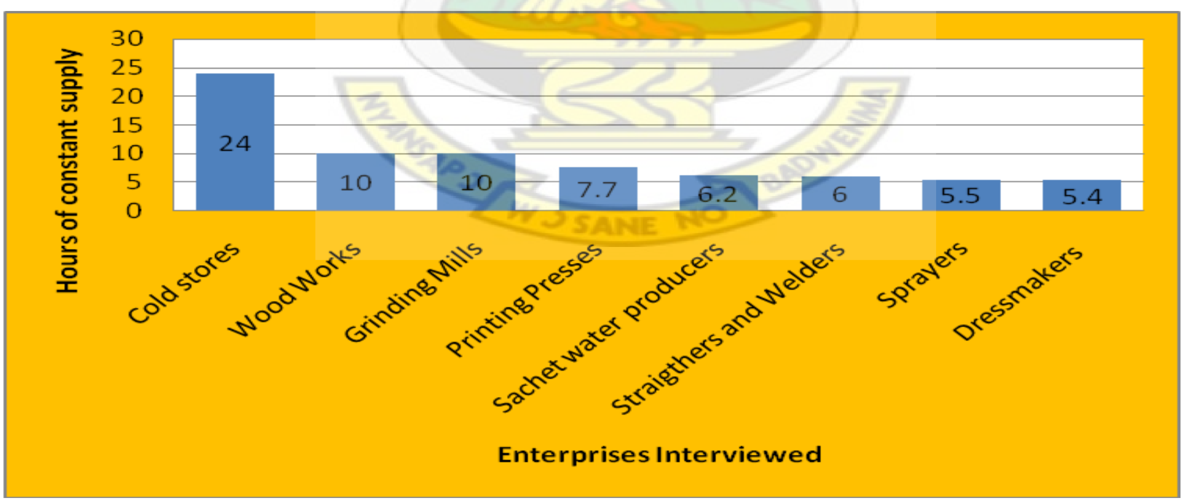

Figure 6.2: Hours of Constant Supply of Electricity Required by the Enterprises

Based on the finding that the enterprises required a constant supply of electricity for their operations, the study assessed the extent to which the firms are served with the required constant supply of electricity. All the enterprises remarked that they do not get constant supply of electricity due to power outages and some times low currents.

> *"We may get the required amount of electricity continuously for a day or two for our operations, but certainly not uninterrupted power supply for a whole week. The situation worsens during periods of energy crises".*

Thus, frequent power cuts are blamed as the major cause of inadequate supply of electricity for the operations of all the firms interviewed. Additionally, 27 entrepreneurs disclosed that frequent disconnections of power metres by ECG officials even after they have provided evidence that they have paid their tariffs leads to interrupted power supply. Out of the 27 entrepreneurs who had experienced interrupted power supply due to disconnections of power, 33 per cent, 22 per cent, 19 per cent and 15 per cent are grinding millers, straighters and welders, dressmakers and sprayers respectively as indicated in Figure 6.3. The other 7 per cent and 4 per cent are sachet water producers and cold store operators respectively.

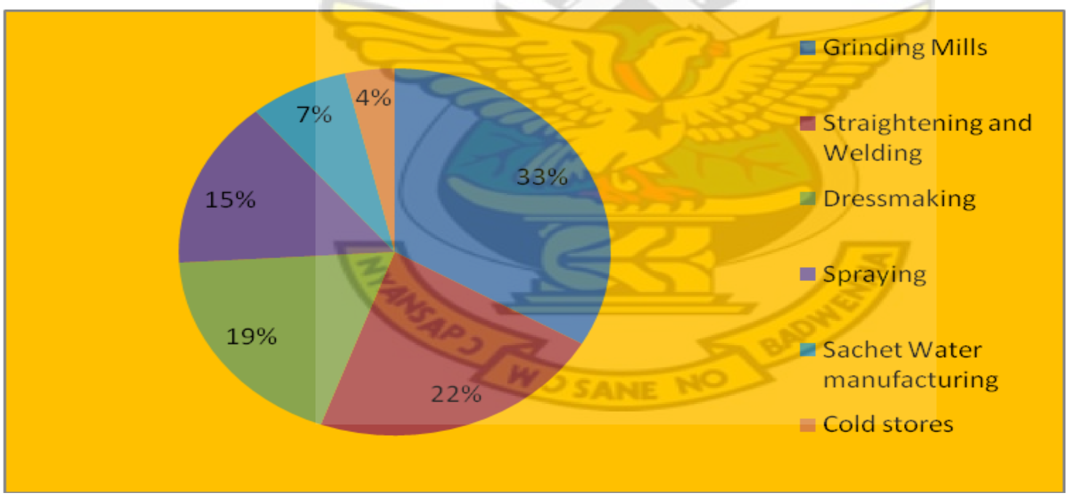

Figure 6.3: Composition of the Firms that experience disconnections of Power metres

6.4.2. Effects of Interrupted Power Supply on the Operations of the MSIs

Premising on the finding that the entrepreneurs' operations are engulfed by interrupted power supply, the study examined the effects it (the interrupted power supply) has on their operations. Three effects of the interrupted power supply on the operations of the enterprises were identified.

Firstly, all the entrepreneurs indicated that interrupted power supplies leads to the destruction of their equipment. All the cold store operators and grinding millers complained that interrupted power supply destroys the 'motors' of their refrigerators and mills. Similarly, wood processors, straighters and welders, sprayers, printing presses and dressmakers intimated that interrupted power supply destroys their equipment. The cold store operators in particular disclosed that interrupted power supply causes harm to their products (meat, fish and refrigerators). Due to improper records keeping on the part of the industrialists, none of the entrepreneurs could provide an account of the extent of destruction on their operations caused by interrupted power supply. Thus, the study could not probe further to examine the extent of the effects of the interrupted power supply on the operations of MSIs.

Secondly, due to the effects the interrupted power supply has on the equipment of the enterprises, cold stores and printing presses have incurred extra costs ranging between GH¢120 and GH¢250 to acquire stabilisers and uninterrupted power supplies (UPS) to stabilise the flow of electrical currents through their equipment. Additionally, all the cold stores, sachet water producers and printing presses have acquired generators at an average cost of GH¢1,000, GH¢500 and GH¢1,500 respectively to ensure continuous supply of electricity. Similarly, straighters and welders have procured welding machines that use LPG to ensure continuous operations even in times of power cuts.

Thirdly, whilst maintaining the same fixed capital and factors of production particularly labour, grinding millers, wood processors, dressmakers and sprayers are left with no other option than to wait for the restoration of power for production to continue. The grinding millers, wood processors, dressmakers and sprayers disclosed that the interrupted power supply increases their cost of production. For example, with low level of production, labour costs (measured in terms of wages) remain constant which subsequently affect the total profits of the entrepreneurs (grinding millers, wood processors, dressmakers and sprayers). Furthermore, the wood processors, dressmakers and sprayers complained that they are unable to meet contract deadlines during periods of excessive interruptions in the power supply.

6.4.3. Options available to the Entrepreneurs during Interruptions in Power Supply

Due to the adverse effects interrupted power supply has on the operations of the enterprises, the study investigated the options used by them during periods of interrupted power supply. As indicated in Table 6.7, all the wood processors and grinding millers depend solely on electricity supplied by ECG. Similarly, 44.4 per cent, 29.8 per cent and 77.6 per cent of straighters and welders, sachet water producers and dressmakers have no other alternative sources of electricity in times of failure from the national electricity grid. Thus, the affected straighters and welders, sachet water producers and dressmakers wait for power to be restored when there are power cuts.

On the other hand, about 66.7 per cent of the sachet water producers, all the cold store operators, all the printing press operators and 22.4 per cent of the dressmakers used an average of 3.3, 3.7, 2.7 and 2.1 gallons of petrol/diesel respectively per month in their generators to ensure the continuous supply of electricity. Thus, the average amounts spent on fuel per month by the affected sachet water producers, cold store operators, printing press operators and dressmakers were GH¢16.5, GH¢18.5, GH¢13.5 and GH¢10.5 respectively (see Appendix 11).

Table 6.7: Alternatives used by the Entrepreneurs during Power Cuts

Firms	**Alternatives used**							
	None		**LPG**		**Diesel/petrol powered generators**		**Total**	
	Freq	**Percent**	**Freq**	**Percent**	**Freq**	**Percent**	**Freq**	**Percent**
Straightening & Welding	8	44.4	10	55.6	-	-	18	100.0
Spraying	18	-	-	-	-	-	18	100.0
Sachet Water manufacturing	17	29.8	-	-	40	71.2	57	100.0
Cold stores	-	-	-	-	58	100.0	58	100.0
Wood Processors	66	100.0	-	-	-	-	66	100.0
Grinding Mills	35	100.0	-	-	-	-	35	100.0
Printing Presses	-	-	-	-	30	100.0	30	100.0
Dressmaking	45	77.6	-	-	13	22.4	58	100.0

Source: Field Survey, 2010

6.5. The Entrepreneurs' Willingness and Ability to Adopt ASEs

Following from the interrupted nature of the power supplied by ECG coupled with the extra costs incurred in ensuring continuous supply of electricity, the study examined the entrepreneurs' readiness (willingness and ability) to adopt ASEs for the supply of their electricity needs.

6.5.1. Willingness to Adopt the ASEs

The study identified that there were entrepreneurs in each category of the industries that were willing to wean themselves from the over-dependence on electricity supplied by ECG. An average of 82.5 per cent of all the entrepreneurs wished they had an alternative to the electricity supplied by ECG. As indicated in Figure 6.4, 77.8 per cent, 72.2 per cent, 82.5 per cent and 87.9 per cent of straighters and welders, sprayers, sachet water producers and cold store operators respectively hoped they had a cost effective and reliable alternative source of electricity. Additionally, 92.4 per cent, 77.1 per cent, 80 per cent and 89.7 per cent of the wood processors, grinding millers, printing presses and dressmakers respectively hoped for an alternative source of electricity.

Recounting their frustrations through the interrupted nature of electricity supplied by ECG with the perceived high tariffs, the entrepreneurs wished they had alternatives that could provide adequate supply of electricity without interruptions. The entrepreneurs also expressed their desire for an alternative that neither depends on the rainfall pattern for survival nor fossil fuels for operation. These were based on VRA/ECGs claim that power rationings in Ghana are caused by low amount of rainfall. Lastly, the entrepreneurs expressed their desire for safe alternatives they can own, manage and control themselves.

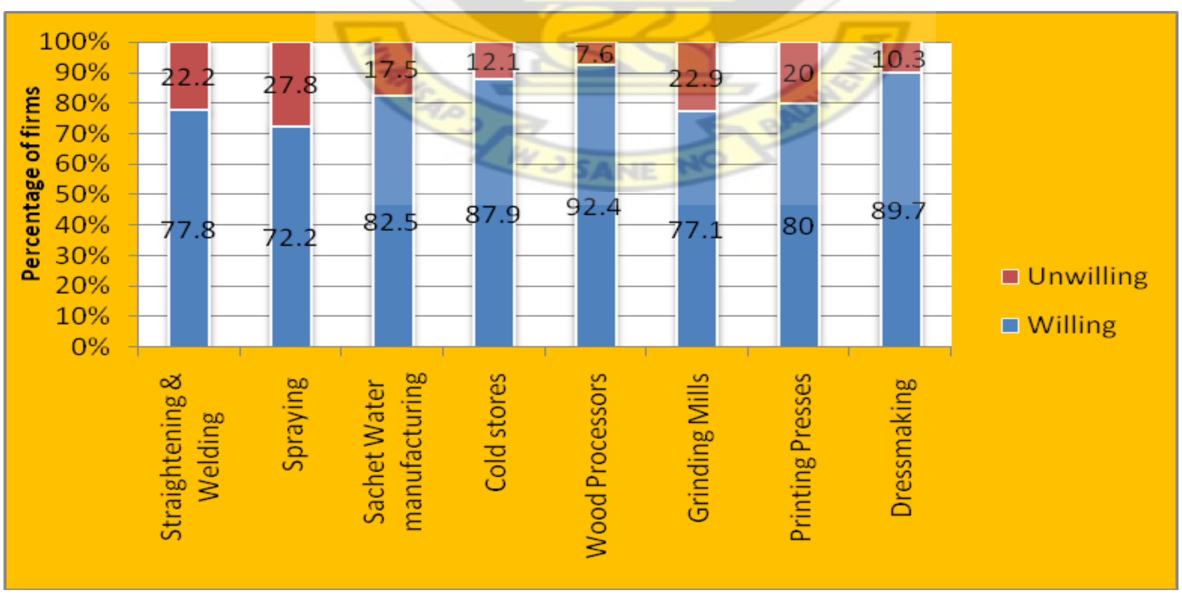

Figure 6.4: Proportion of Firms willing to use ASEs for electricity generation

In view of the fact that majority (82.5 per cent) of industrialists were willing to use ASEs to supply their electricity needs, the study investigated to know the category of firms that were willing to use ASEs.

Cross tabulating willingness to use ASEs with the amount of tariffs paid to ECG for electricity consumption, the study identified that firms that were in the third and fourth categories of the electricity tariffs structure wanted the service delivery to commensurate the perceived high tariffs they paid as indicated in Appendix 12. Thus, due to the perception that the entrepreneurs paid high tariffs (not less than GH¢30.2 in Table 5.5) for electricity consumption, they sought a more reliable source of electricity devoid of interruptions, hence their willingness to use ASEs.

6.5.2. Appraisal of the ASEs in the SNEP (2006 – 2020) and NEP (2010 - 2015)

The recommended ASEs to supply the electricity needs of the micro and small scale entrepreneurs' depend on the availability of the technology and policy directions. These factors are based on the UN-Energy (2008: p.4) and World Bank Group (2009: p.2) claim that ASEs can be exploited to meet the energy needs of consumers if investments are made by national government for research and development. All the ASEs can be developed in their fullness with the guidance of national policies.

The study identified wind energy, solar energy, wood fuels power, small and mini-hydros power and landfills energy as the ASEs that have been provided for in SNEP (2006 – 2020) and NEP (2010 – 2015). Thus, wind energy, solar energy, wood fuels power, small and mini-hydros power and landfills energy are the ASEs with national support.

As an opportunity for the exploitation of the identified ASEs, the world has the technology for their development. For instance, the US Department of Energy (2001, p. 1) revealed that the most commonly used energy is the hydropower. Ghana and Democratic Republic of Congo obtain a chunk of their electricity from HEP. Similarly, Germany and Denmark generates 50 per cent and 8 per cent respectively of its total electricity needs from wind turbines. Lastly, the wood fuels and landfills have been developed in India to provide consumers' electricity demands. Thus, there exists the technology to exploit all the five ASEs in Ghana's energy policy.

6.5.3. The Options Required to be Developed

In terms of reliability, particularly in the face of climate change, small and mini hydro electric power dams are not very reliable as exemplified by the 1983, 1998 and 2007 energy crises. Consequently, the AGI in 2006 and 2009 considered electricity problems as the highest ranked challenge to their operations (NDPC, 2008:p.64; AGI, 2009:p.22). Small and mini hydro electric power dams' unreliability is further explained in DFID's claim that any electricity source that depends on the rainfall regimes for operation is unsustainable due to the effects of climate change (DFID 2009, p.11). Additionally, Smith (2005: p.10) points out that small and medium hydro electric power dams pose environmental challenges through flooding and displacement of communities. The Bui dam under construction is expected to flood an area of approximately 444 square kilometres requiring resettlement programmes which go with huge expenditures (GTV Regional Diary, 30/06/2010). Landfills also emit methane gas that is environmentally harmful. In this vein, harnessing the energy potentials from landfills requires that serious and effective arrangements are made to capture the methane gas to prevent environmental degradation known to cause climate change. Akuffo (2008:p.21) explains that research is ongoing to identify and value all the potential biomass generation sites for development.Thus, the development of small and medium HEP dams and landfills require detailed feasibility studies and comprehensive master plans by Central Governments only possible within the medium to long terms.

Similarly, wind energy can only be efficiently harnessed in offshore and high altitude areas that are characterised by strong and constant speed of the wind. This explains why Ghana hopes to generate wind energy from the Ghana-Togo border with favourable wind velocities of between 6-7 m/s. The moderate winds along the eastern coastline with speeds of 6 m/s at 40m height are to be harnessed for the generation of electricity (Akuffo 2008, p.20). Thus, the development of wind technologies in Ghana are intended to feed the national grid. The technology, just like the mini and medium HEP, is to be developed within the medium to long term. This argument is based on the lack of policy milestones on the development of the technologies (small and mini hydro electric power dams and wind turbines).

In the case of wood fuels, at least 95 megawatt capacity providing about 600 gigawatt-hours annually is expected to be tapped from farm-wastes, sawmill and logging residues by 2010. This technology would be possible especially for the Sokoban Wood Village that generates biomass (sawmill wastes) which are managed by burning. However, it requires technical, financial and economic analyses to be carried out before resources could be committed by the state and corporate bodies. Thus, the technology is possible within the medium to long terms.

On the other hand, solar energy can be generated everywhere in Ghana and at the micro levels. This explains why there is a promotional programme dubbed "solar power for every home" aimed at providing electricity to homes. Additionally, PV electric systems installed in the country are well over 5,000 with installed capacity of about one megawatt generating between 1.2-1.5 gigawatt-hours every year. From the foregoing analysis, solar energy has already been started in Ghana and can be harnessed to provide the electricity needs of MSIs within the short term.

6.5.4. Advantages of the Solar Energy

According to Ishengoma (2002, p. 14), there are several advantages of photovoltaic solar power that makes it one of the most promising alternative energy sources in the world. Ardayfio-Schandorf (2009, p. 39) affirmed Ishengoma's claim by stating that "solar energy has a greater potential in tropical countries. If solar energy could be developed on a substantial scale, it would have many advantages over any other". Among its advantages are reliability, low operating costs, non-polluting and availability. Ardayfio-Schandorf (2009, p. 40) added that solar is available to all without reliance on some central system which political, mechanical or other troubles may interrupt. Aligned to this, the Alternative Energy Institute (n.d.) also maintained that solar power is non-polluting and has no moving parts that could break down. Additionally, it requires little maintenance, no supervision and has a lifespan of 20-30 years with low running costs. Ardayfio-Schandorf (ibid) revealed that solar energy seems to be more suitable to meet the needs of Ghana not least because it would be usable without the necessity of constantly tied to any other country (OPEC in the case of fossil fuel and neighbouring countries in the case of HEP). The adverse environmental consequences will seem likely to be less than the adoption of any other source. These advantages of the solar energy coupled with the fact that the technology is already being used by individuals explain why the study settled on the solar energy.

6.5.5. Barriers against the Exploitation of Solar Energy Technologies

Despite opting for solar energy technology ahead of the other ASEs, Akuffo (2008, p. 29) revealed that there were barriers to the widespread exploitation of solar energy technologies in Ghana that need attention. In order to fully utilise Ghana's solar energy potentials for the supply of electricity needs of MSEs, the barriers ought to be identified and managed. It is against this background that this section of the chapter identifies challenges with their policy implications.

i) High Costs due to Storage Problems

Akuffo (2008, p. 21) revealed that Ghana receives between 4-6kWh per square metre of solar radiation per day and an annual duration of sunshine ranging between 18,000 to 30,000 hours. Despite this huge potential for the generation of solar energy, the problem of intermittency which requires the addition of storage systems in order to maximise its reliability increases the capital costs. This is especially because users are required to change the battery in every 3 to 5 years. The need for storage systems is further elucidated by the fact that solar energy is available during the day but users may need it during the night. This problem will seriously affect the cold store operators who use electricity continuously for 24 hours. The other firms that will be unable to use solar energy without the storage system are the grinding mills and wood processing firms which required 10 hours of constant supply of electricity.

Due to the high cost of the solar panel, sustainability has been very difficult. Lack of sustainability in the use of solar energy has been a major issue. In citing Obeng (n.d), Akuffo (2008, p.29) revealed that the high cost of utilising solar energy has let users to abandon their solar panels when they were required to replace the storage systems after two to five years. Thus many users are unable to pay for the operation and maintenance of the solar system let alone contribute to full cost recovery.

Cost of the Solar Technology and Entrepreneurs' Ability to Adopt it

Following from the claims that solar energy technologies are expensive and beyond the reach of many, the study assessed the amount required to install and run the required solar panels. The study identified that the amount required to install and run the solar panels ranged from US$4,543 to US$13,598 for the dressmakers and cold store operators respectively as indicated in Table 6.8.

Table 6.8: Estimated Cost to be incurred by Firms for using Solar Energy

Firms	Units (kilowatt hour) of Electricity Consumed per month	Category of Solar Panel Required (in Watts	Cost of solar energy (in US Dollars)
Cold Store	936.5	3,547	17,205
Printing Presses	740.2	2,804	13,598
Wood Processing	650.2	2,463	11,945
Straightening & Welding	555.9	2,106	10,213
Sachet Water	545.5	2,066	10,021
Grinding Mills	337.6	1,279	6,202
Spraying	283.8	1,075	5,214
Dressmaking	247.3	937	4,543

Source: Wilkin Engineering Limited, 2010

In assessing the industrialists' ability to afford the solar systems the study used six scenarios in the analysis as indicated in Appendix 14. The generation of the scenarios was aimed at identifying the option that can be used by industrialists without committing extra resources to defray the total cost of the solar panels. The general assumption that underpinned the scenarios was that any cost that emerges due to defects of the system within the lifespan of the system would be borne by the manufacturers.

a) Scenario One:

In scenario one, the study considered the number of years the entrepreneurs will need to recover the full cost of their investments with the current tariffs as the mode of payment. Scenario one assumed 40 per cent interest rate (informed by HFC's mortgage interest rate) on the loan to use to procure the solar systems. Additionally, scenario one considered 40 per cent government subsidy informed by the 40 per cent government subsidy for consumers of more than 50 units of electricity. The study identified that if the firms used only their current electricity tariffs to defray the cost of the solar panels, it will take them an average of 12.3 years to defray the entire cost of the solar systems. The highest and least number of years was 18.2 years and 11.9 years for the dressmakers and cold store operators respectively as indicated in Appendix 14. The scenario assumed that the current tariffs may remain constant throughout the economic life of the facility and that the industrialists would have interest-free loans to purchase the facility.

b) Scenario Two:

In scenario two, the study assumed that, the industrialists would be provided a mortgage loan with 40 per cent interest rate. Again the monthly tariffs they paid to ECG would remain unchanged throughout the facility's lifespan. The analysis also revealed that an average of 20.4 years is required to defray the full cost of the solar panels as indicated in Appendix 14. However, the dressmakers would be expected to use 25.5 years to pay the full cost whilst cold store operators would use 16.6 years to pay the full cost.

c) Scenario Three:

Scenario three assumed that the government will provide 40 per cent subsidy on the total cost of the solar systems. The subsidy is informed by the current rate of subsidy paid for consumers that consume more than 50 units of electricity on their first 300 units consumed. Similarly, scenario three assumed that the tariffs would remain unchanged throughout the economic life of the solar systems.

The study identified that with the 40 per cent subsidy, the industrialists would need an average of 8.7 years to defray the full cost of the solar systems assuming that they are able to access interest-free loans. Appendix 14 also shows that the maximum number of years to recover the full costs of the solar system would be 10.9 years for the dressmakers whilst the cold store operators would use a maximum of 7.1 years to fully pay back the loan.

Other Scenarios

Scenarios four, five and six were based on the fact that the higher the solar systems' kilowatts supplied, the more cost effective it is to use. For example, a one kilowatt system cost, US$10,620, a two kilowatt system cost US$16,689.6 and a five kilowatt system cost US$37931. Mathematically, a five-kilowatt system would cost US$53,103, if one-kilowatt system costs US$10,620. Based on this cost effectiveness, the study examined the number of years groups of five industrialists (assuming that each industrialist requires one Kilowatt system) would use to defray the total cost of the solar systems.

d) Scenario Four:

Scenario four assumed 40 per cent government subsidy and 40 per cent interest on loans. Using the current tariffs paid by the industrialists, the study identified that the group of five industrialists would use an average of 14.5 years to defray the full cost of the solar systems. However, the period ranged between 30.4 years and 5.2 years for the groups of five dressmakers and five cold store operators respectively as indicated in Appendix 14. Thus, Appendix 14 has revealed that it is inappropriate to consider providing dressmakers with a higher capacity solar system since the group of dressmakers would be unable to pay the full cost of the systems within its economic life.

Having identified that the groups of dressmakers, grinding millers and sprayers with five members each would use a considerable number of years to defray the full costs of the five kilowatt solar system (even the group of five dressmakers will still be paying after its economic life), the study considered the actual number of the industrialists that can be served by the five kilowatt solar systems as indicated in Appendix 15.

It was identified that an average of 6.7 years would be used to defray the entire cost of the five kilowatt solar system. This was based on scenario four's assumption that there would be 40 per cent government subsidy and 40 per cent interest on loans. Additionally, the current tariffs paid by the industrialists would be used to defray the cost of the solar system. A group of 18 dressmakers would use 8.4 years whilst a group of five cold store operators would use 5.2 years to defray the entire cost of the solar system.

e) Scenario Five:

Under the fifth scenario, the study assumed 40 percent interest rate on loan without government subsidy. Using the current tariffs paid by the industrialists, the study identified that the groups of five industrialists would use an average of 20.3 years to defray the full costs of the solar systems. However, Appendix 14 shows that the periods that the industrialists would use to defray the costs of the solar system ranged from 42.6 years for the group of five dressmakers and 7.3 years for the group of five cold store operators.

Similar to scenario five, the groups of industrialists would use an average of 9.4 years to defray the entire costs of the five kilowatt solar system if the membership sizes reflect the actual membership sizes of the groups as revealed by Appendix 15. A group of 18 dressmakers would use 11.8 years whilst a group of five cold store operators would use 7.3 years to defray the entire cost of the solar system.

f) Scenario Six:

Scenario six assumed a government 40 per cent subsidy and an interest-free loan. Using the current tariffs paid, the groups of five industrialists could have used an average of 8.7 years to defray the full cost of the five kilowatts solar systems. The group of five dressmakers would use 18.2 years whilst the group of 5 cold store operators would use 3.1 year to defray the full cost of the solar systems.

On the other hand, assuming that there would be 40-percent subsidy on the cost of the solar system and an interest-free loan, the groups of the industrialists (groups that reflect the actual membership size) would use an average of 2.7 years to recover the amount invested in the five kilowatt solar system. The group of 18 dressmakers will use 5.1 years whilst the group of 5 cold store operators will use 3.1 years to defray the entire cost of the five kilowatt solar system.

In sum, though the costs of the solar panels are expensive, with a long term loan facility, the industrialists can pay the full cost of the solar system within its 30 year economic life. Additionally, the chances of paying the full cost of the solar systems within a short period would be enhanced if the industrialists could be put together in groups. The grouping is possible with the industrialists/artisans located within the industrial enclaves. However, the grouping may not be possible for the sachet water producers and dressmakers who are scattered across the Metropolis.

ii) Lack of Legislative Environment

The lack of enabling environment in Ghana is seen by Akuffo (2008:p.30) as one of the barriers to the development of Ghana's solar energy potentials. Though SNEP 2006 – 2020 and NEP 2010-2015 contain several policy statements and strategies to develop ASEs and more specifically, solar energy, there is no regulatory framework existing in the form of renewable energy legislation. The legislations available in the energy sector are the ones establishing the institutions such as the PURC, GEF, VRA/ECG, GEC, TOR, MOE, etc and not specifically on the ASEs. This has thus affected investor confidence in the renewable energy sector of Ghana despite a provision made for private sector involvement.

iii) Human Actions

Solar panels are mounted on surfaces exposed to the direct radiation from the sun in order to be efficient. Rooftops are the commonest surfaces most users mount their panels on. In some instances, the solar panels are used as roofs as a substitute to roofing sheets with evidence from the Ghana Ministry of Energy. This elucidates the claim that solar panels are efficient when exposed to the direct rays from the sun. The challenge however is that, in recent times the solar panels have been the targets of thieves. With the exposed nature of the industrial enclaves studied, mounting the solar panels on the roofs will be difficult.

iv) Lack of Local Manufacturing Capacity

Solar energy technologies in Ghana are imported technologies that come with the costs constrains in the form of import duties. Additionally, problems that develop with the system before the economic lives of the panels expire would be difficult to fix due to the few available experts. Replacement of the panels is near impossible due to the fact that they will have to be exported to the manufacturers abroad with a bearing on time and costs. Thus the lack of local manufacturing capacity has constrained the development of solar energy in Ghana.

6.6 Areas of Further Research

In view of the fact that Ghana has provided for five ASEs out of which solar was chosen for the study, the researcher recommends that the other four **(**wind energy, wood fuels power, small and mini-hydros power and landfills energy**)** should be examined on the extent to which they can be harnessed to supply electricity needs of industrialists. However, since wind and small and mini hydro power are to be provided to feed the national grid, the search for decentralised systems should focus on biomass and landfills.

First, researchers should examine the extent to which cogeneration plants which use sawdust can be installed at the Sokoban Wood Village to supply electricity from the sawdust that is wasted.

Further, there should be a comprehensive financial analysis to determine the benefit/cost ratio before resources can be committed.

Additionally, future research should examine the extent to which industrialists, especially those within the selected clusters, can come together to acquire solar and other systems at relatively lower prices to supply their electricity needs.

CHAPTER SEVEN

SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

7.1. Introduction

Following from the analysis and discussion of the survey data in chapter six, this chapter summarises the major findings from the study. Based on the identified challenges affecting the utilisation of solar power in Ghana, the chapter also recommends possible actions to manage them (the challenges). For easy appreciation, the major findings have been grouped under the six objectives the study sought to achieve.

7.2 Findings of the Study

The general objective of the study is to identify the effects Ghana's electricity structure poses on the operations of MSIs and make recommendations for the provision of reliable and sustainable electricity for the MSI sub-sector. The findings are summarised in this section.

7.2.1. Effects of Ghana's electricity supply and tariff structure on MSIs

The study identified that Ghana's electricity tariffs structure is a four-tier structure where the higher the quantity (measured in kilowatt hours) of electricity consumed by a firm the higher the tariffs paid. Consumers within the lifeline and residential consumption categories paid 9.5Gp and 12Gp respectively per unit of electricity consumed. Similarly, consumers within the 301 – 600 units consumption category and 601 units and above category paid 16Gp and 19Gp per unit of electricity used. In view of this, the study identified that the lowest consumers of electricity were dressmakers who used an average of 247.3 units/kilowatts hour of electricity per month and paid an average of GH¢30.2. On the other hand, the highest consumers of electricity per month, the cold store operators, used an average of 936.5 units/kilowatts of electricity and paid an average of GH¢174.8 per month.

With the high cost imposed on MSIs for electricity consumption, the Government of Ghana provided 40 per cent subsidy for the first 300 units of electricity for consumers who consumed more than 50 units. The study observed that the subsidy has reduced electricity tariffs by an average of 30.8 per cent. The highest and lowest effects were felt by sachet water producers and cold store operators respectively. Despite the effects the subsidy has had on the MSI's tariffs, an average of 54.3 percent of the entrepreneurs considered the tariffs as expensive.

The study further identified that electricity supply to the industrialists interviewed has been intermittent compelling 55.6 per cent of the straighters and welders, 71.2 per cent of the sachet water producers, 22.4 per cent of the dressmakers and all the cold store and printing press operators to use alternatives such as LPG (in the case of straighters and welders) and generators (in the case of the others). Subsequently, additional costs of GH¢16.5, GH¢18.5, GH¢13.5 and GH¢10.5 are incurred every month for the affected sachet water producers, cold store operators, printing press operators and dressmakers respectively. These extra cost coupled with the perceived high tariffs underpinned the MSI's choice for ASEs.

The study again identified that an average of 82.5 per cent of all the entrepreneurs wished they had an alternative to the electricity supplied by ECG with the highest and lowest proportions being wood processors (92.4 per cent) and sachet water producers (72.2 per cent) respectively. Based on the frequent interruptions experienced with electricity supply in Kumasi, the entrepreneurs wished they had decentralised alternatives that could provide adequate electricity without interruptions. As identified by the study, the entrepreneurs expressed their desire for an alternative that neither depends on the rainfall pattern for survival nor fossil fuels for operation but affordable. Thus, the entrepreneurs want an affordable source which provides reliable and sustainable electricity.

7.2.6. Ghana's Readiness to Exploit ASEs

Through a review of SNEP (2006 – 2020) and NEP (2010 – 2015), the study identified that Ghana has made provisions for the development of ASEs. The ASEs provided for in the energy policies were wind energy, solar energy, wood fuels power, small and mini-hydros power and landfills energy. Ghana's keen interest in the development of the five ASEs (wind energy, solar energy, wood fuels power, small and mini-hydros power and landfills energy) were informed by the technologies' cleanness, reliability and sustainability. Thus, the technologies will help reduce Ghana's contribution to climate change whilst at the same time having sustainable and reliable access to energy resources for its poverty reduction agenda. Despite this, the policies did not spell out clearly institutions required to develop the ASEs except VRA in the areas of HEP.

Similarly, the study could not identify a single legislation particularly to guide the private sector in the development of ASEs. Subsequently, the lack of ASE legislation has affected investor confidence in the development of ASEs.

7.2.3 The Technology to supply the electricity needs of the MSIs

The review of the five ASEs contained in Ghana's energy policies revealed that not all the ASEs are to be developed in the short term. For instance, research is ongoing to identify and quantify all the potential sources from which biomass energy could be generated. Available data indicates that 95MW can be generated from the already known sources. Similarly, small and mini hydro dams, and Wind energy are to be developed at suitable locations in the medium to long terms after detailed feasibility studies have been undertaken. Due to the methane gas associated with Landfills energy, methane gas captures are required to generate clean energy from landfills. This is possible within the medium to long term. On the other hand, solar energy programmes have already been started in both the rural and urban communities. Underpinned on the programmes that have already started, the study examined the extent to which it can provide the electricity needs of MSIs.

7.2.4. The MSI's ability to adopt ASEs

The study identified that the highest consumers of electricity were the cold store operators who used about 936.5 units of electricity per month. This implied the need for solar systems that can supply the electricity needs of the MSIs. Through six scenarios, the study revealed that the industrialists could afford the solar systems only when there are flexible terms of payment. Preferably, with government subsidies and interest-free loans, industrialists can afford the costs of the solar panels within a maximum of 10.9 years to pay the full cost and will have 19.1 years of electricity supply without paying any tariffs.

The industrialists' chances of paying the full costs of the solar systems are enhanced if they are put in groups even without government assistance and 40 per cent interest rate. The study identified that an average of 9.4 years would be used to defray the total cost of the five kilowatts solar systems. Their chances become brighter if there is a government subsidy and interest-free loans. The average years of recovery reduces from 9.4 years to 2.7 years.

7.2.5. The Challenges that need to be overcome in order to fully Exploit the Solar System

Despite the significant role that solar systems can play in the supply of the electricity needs of the MSEs, the lack of appropriate legislative environment and human actions would need to be managed. The lack of a legislative instrument has affected investor confidence in the development of solar and other renewable energy technologies in Ghana. Hence, solar panels are always imported from the developed countries for installation. This has subsequently, increased the systems' costs.

High cost of the solar panels is another challenge affecting the full utilisation of the solar systems. This problem has further been compounded by thefts of the movable parts such as the panels by unscrupulous people.

Emanating from the challenges that inhibit the exploitation of the solar energy for the supply of MSEs' electricity requirements, the study recommends the following actions to manage them:

7.3. Recommendations

7.3.1. Establishment of an Enabling Environment through Regulatory Framework

The establishment of an enabling environment should first see the passing of the renewable energy bill into law. The law should clearly establish the regulatory framework that is required to build investor confidence in the economy. The regulatory framework should spell out clearly the technical standards for installation and operation. Secondly, the enabling environment should focus on measures such as tax rebates/incentives and infrastructural development for the investors to enjoy economies of scale.

The interest of consumers should also be protected by the regulatory framework. In view of the fact that the solar technologies' economic lives are 30 years and over, consumers should be assured of enjoying the services for this length of time if they follow user instructions provided by manufacturers. Manufacturers should also be ready to fix any technical problems that develop with the facilities before their economic lives. This will encourage consumers to easily switch over to the use of the solar energy technologies.

7.3.2. Measures to Mitigate the Cost Constraints

The challenge against the exploitation of solar energy emanating from the cost of the technology can be mitigated by direct interventions from government and corporate bodies. The study identified that with flexible terms of payment particularly extending the payment period, all the MSEs can afford the solar energy within the economic life of the facilities.

The surest way of mitigating the cost constraint is to put the industrialists, particularly, the printing presses clustered together at Asafo, the wood workers in the Sokoban Wood Village, the grinding millers in the Central and Race Course markets and the cold store operators at Asafo into groups of five industrialists. Without government subsidy, they would be able to afford the solar energy technologies.

On the other hand, industrialists that are scattered across the metropolis require flexible terms of payment. The flexible terms of payment should be the responsibility of the Government of Ghana collaborating with other stakeholders. It must focus on an extension of the loan repayment period to cover the 30-year lifespan of the facility. In this case, dressmakers that pay the least amount of tariffs could afford the costs of the solar panels within the facilities' economic lives if they use only their current tariffs to defray the cost. Industrialists could also be provided with a government subsidy similar to what is paid on the consumption of the electricity from the conventional sources. By the government subsidy, industrialists could afford the solar systems before their economic lives expire. Thus there should be a level playing field for both conventional and non conventional sources of electricity. This will avert the cost constraint and will lead to the development of solar energy.

7.3.3. Security of the Facilities

Consumers should endeavour to protect the solar panels from thieves. This requires sealing the solar panels which are mostly fixed to the roofs with metallic cages. With this, it will take a thief several hours to break into it. Additionally, consumers should fix their panels at points that are not easily reachable by strangers.

7.3.4. Support for Research and Development of Solar Systems

In view of the fact that solar energy systems are said to be costly beyond the reach of many, government should support research institutions to carry out researches into improved ways of storing solar energy for use at night. The research institutions should focus on the development of solar batteries which are within the means of many whilst at the same time, can lasts for a long time before replacement.

7.4. Conclusion

Ghana's unreliable and intermittent electricity supply is caused by growing demand through the increasing population and increasing global temperatures. The intermittent and unreliable nature of the electricity supply has affected the operations of micro and small scale light industries which depend on electricity for their operations. There is thus the need for reliable and sustainable alternative.

Ghana has significant solar energy resources in the form of direct solar radiation which could be developed to support national development priorities and aspirations. The solar energy resources are characterised by reliability and sustainability due to its indifferences from the rainfall regime. However, there are several barriers to the development and utilisation of the solar energy. They include lack of an enabling environment for private sector investments, high initial cost, lack of a level playing field between renewable and conventional sources and lack of local manufacturing capacity.

Interventions are thus required to create an enabling environment in order to attract investors that can help develop local capacity. Additionally, with the creation of a level playing field for conventional and nonconventional sources of electricity specifically for the solar energy, micro and small scale industrialists can switch over to the use of solar energy for their electricity needs.

Research and development should also focus on the development of cost effective storage systems for solar energy resources.

References

Aboh I.J.K. (2009). *Power Generation in Ghana- The Nuclear Option*, a presentation delivered at the KITE Energy Seminar, 19th September, 2009.

Abor, J. & Adjasi, C. (2007). '*Corporate Governance and the Small and Medium Enterprise Sector: Theory and Implication's*, Journal of Corporate Governance Vol.7 No.2, pg. 111-122.

Adeya, N. (2006). *Knowledge, Technology and Growth: The Case Study of Suame Manufacturing Enterprise Cluster in Ghana*, Knowledge for Development (K4D) Programme.

Adomako, A.K. (2007). *Energy Crisis, Half Truths and the Blame Game*, http://allafrica.com/stories/200706280680.html, date accessed 18/08/09.

Association of Ghana Industries (2009). *AGI Policy Perspectives*, Accra, Midland Press Limited.

Akuffo, F.O. (2008). *"Ghana's Energy Resources Options: Issues for the Development and Utilisation of Renewable Energy Resources in Ghana"*, in Energy and Ghana's Socio-economic Development, Development and Policy Dialogue Report One, George Benneh Foundation, Accra, Pg 18 – 31.

Albaladejo, M. (2002). *Promoting SMEs in Africa: Key Areas for Policy Intervention*, United Nations Development Organisation, Vienna.

Alternative Energy Institute (n.d.). *Alternative Energy, Alternative energy news and information resources about renewable energy technologies* http://www.altenergy.org/renewables/hydroelectric.html date accessed 12/01/2010.

Anitei, S. (2008). *What's Light Industry? http://news.softpedia.com/news/What-039-s-Light-Industry-77218.shtml*, date accessed 18/02/2010.

Ardayfio-Schandorf, E. (2009). *Energy and the Development Nexus, the Realities, Challenges and Opportunities for the Future*, An Inaugural Lecture Delivered at the University of Ghana on 16th September, 2004, Accra, Ghana University Press.

AusAID (2001). *Power for the People: Renewable Energy in Developing Countries*, A Summary of Discussion at the Renewable Energy Forum, Canberra, 18 October 2000 Hosted by the Australian Agency for International Development (AusAID).

Bailey, W. (1982). *Methods of Social Research*, New York, the Free Press.

Bala Subrahmanya, M.H. (2008). *SME Financing in Canada, 2003, http://www.sme-fdi.gc.ca/eic/site/sme_fdi-prf_pme.nsf/eng/h_01565.html* date accessed 03/02/2010.

Banks, D. & Schäffler, J. (2006). *The potential contribution of renewable energy in South Africa*, a draft update report prepared for Sustainable Energy & Climate Change Project (SECCP). Johannesburg, South Africa.

Bartlett, W. & Bukvi, V. (2004). *'Barriers to SME Growth in Slovenia',* in the Journal of MOCT-MOST: Economic Policy in Transitional Economies, Volume 11, Number 2, June, 2001 Springer Netherlands. Pg 177 – 195.

Bell, J. (2004). *Doing Your Research Project, A Guide for First-time Researchers in Education and Social Science,* 3rd edn. Berkshire, UK, Open University Press.

Cassin, M. & Zolin, B (2009). '*Can Wind Energy Make a Real Contribution to Improve the Quality of Life of Rural/Remote Areas? The European Union and India Compared'* in Transition Service Review, Volume 16, Number 3, October, 2009. Pg 735-754.

CEPA 2007, The Current State of the Ghanaian Economy, Ghana Economic Review and Outlook 2007, GSEI No. 15.

Cohen, B.L. (1983). *'Breeder reactors: A renewable energy source'* in the American Journal of Physics. Pg. 75–76. http://sustainablenuclear.org/PADs/pad11983cohen.pdf, date accessed 02/01/2010.

Contreras, R. (n.d.). "Competing Theories of Economic Development" The University of IOWA Center for International Finance and development, http://www.uiowa.edu/ifdebook/ebook2/contents/part1-III.shtml, date accessed 24/04/2010.

CRA International (2007). *SME Trends and Achievements*, Final Report prepared for Telstra Business,http://www.archive.dcita.gov.au/2008/january/ict_production_in_australian_smes/ict_production_by_australian_smes/ict_production_in_australian_smes/industry_profile_of_ict_producing_smes date accessed 03/02/2010.

Cross, S. (2007). *The Role of Electricity: New Path to Secure, Competitive Energy in a Carbon-constrained World,* at the Union of the Electricity Industry, www.eurelectric.org, date accessed 08/02/2010.

Daily Graphic, Wednesday April 22, 2009. *Energy Sector Needs $10bn to finance initiatives in next 5 years,* Accra, No. 17896, Graphic Communications Group.

Daily Graphic, Thursday, 04 Feb 2010. *Energy Crisis looms as VRA crawls on dwindling income,* Accra, No. 17896, Graphic Communications Group.

Deichmann, U., Meisner, C., Murray, S. & Wheeler, D. (2009). *The Economics of Renewable Energy Expansion in Rural Sub-Saharan Africa*, The World Bank Development Research Group Environment and Energy Team, Policy Research Working Paper 5193.

DFID (2008). "*What's Stopping us Building a Global Society",* how to bring international organisations into the 21st century, in the Developments Journal, Issue No. 42. London, Engage Group, Pg 14 - 17 http://www.developments.org.uk/downloads/developments_issue42.pdf 12/12/2009.

DFID (2009)."*All Change, How fighting Climate change and poverty is the same battle"*, in the Developments Journal, Issue No. 46. London, Engage Group, Pg 1 - 20 http://www.developments.org.uk/downloads/developments_issue42.pdf 12/12/2009.

Edjekumhene, I.; Amadu, M.B & Brew-Hammond, A. (2001). Power *Sector Reform in Ghana: The Untold Story,* Kumasi Institute of Technology and Environment, Kumasi.

e Meirelles, D.S.; Ulrich Pace, E.S. & Cruz Basso, L.F. (2006). *The Contributions of Firm's Productive Assets to its Competitive Performance: A Resource-Based View Approach in the Software Sector,* www.brazillink.org/tiki-download_file.php?field=124, date accessed12/05/2010.

Energy Commission (2006). *Strategic National Energy Plan -206-2020,* Main Report, July 2006.

Energy Commission. *Ghana Energy Statistics 2000-2008, http://www.energycom.gov.gh/pages/docs/Ghana%20Statistics%202000_2008.pdf*, date accessed 08/02/2010.

Frondel, M., Christoph M.S. & Colin V. (2008). *"A Regression on Climate Policy - The European Commission's Proposal to Reduce CO2 Emissions from Transport"* pages Ruhr Economic Papers 0044, pg. 1 – 23, Rheinisch-Westfälisches Institut für Wirtschaftsforschung, Ruhr-Universität Bochum, Universität Dortmund, Universität Duisburg-Essen. http://repec.rwi-essen.de/files/REP_08_044.pdf date accessed 24/04/2010.

Frankfort-Nachmias, C. and Nachmias, D. (1996). *Research Methods in Social Science*, 5th Edition, New York, St Martins Press Inc.

Gand, E.K (2009). *Country Profile for Ghana*, Sustainable Energy Technology at Work www.SETatWork.eu, date accessed 02/20/2010.

Gantenbein, M. (2010). *A Brief Overview of Renewable Energy Sources, http://energy-conservation.suite101.com/article.cfm/a-brief-overview-of-renewable-energy-sources* date accessed 08/02/2010.

Ghana Statistical Service (2006). *2003 National Industrial Census Background and Results*, Phases 1 and 2 Report, Main Report. http://www.statsghana.gov.gh/docfiles/1Contents.pdf date accessed 27/04/2010.

Gibson, T. & van der Vaart, H. J. (2008). *Defining SMEs: A Less Imperfect Way of Defining Small and Medium Enterprises in Developing Countries,* Brookings.

Government of Romania (2010). *Export Strategy for the Romanian Light Industry*, http://www.dce.gov.ro/sne/Textile_cloting_and_leather.htm, accessed on 02/02/2010.

Granovskii, M., Ibrahim, D. & Rosen, M.A (2007). "*Greenhouse gas emissions reduction by use of wind and solar energies for hydrogen and electricity production: Economic factors"* in the International Journal of Hydrogen Energy, Volume 32, pg 927-931.

Gritsevskyi, A. (2008). *Renewable vs. Non-Renewable Energy*, International Atomic Energy Agency, http://www.docstoc.com/docs/528036/Renewable-vs-Non-renewable-energy date accessed 21/01/2010.

Gyasi, E.A. (2008). *"Hydropower, Land Degradation, and Sedimentation in the Volta Basin in Ghana"* in Energy and Ghana's Socio-economic Development, Development and Policy Dialogue Report One, George Benneh Foundation, Accra. Pg. 66 – 79.

Gyau-Boakye, P. (2001). *"Environmental Impacts of the Akosombo Dam and Effects of Climate Change on the Lake Levels",* in the Journal of Environment, Development and Sustainability. Netherlands, Kluwer Academic Publishers, Volume 3 Number 1. Pg 17 – 29.

Harrison, G. P.; Whittington, H. W. & Wallace, A. R. (2006). *"Sensitivity of hydropower performance to climate change",* in International Journal of Power and Energy Systems. Volume 26, pg 1 – 20.

IEA (2002). *Renewable Energy into the Mainstream,* The Novem Sittard, The Netherlands.

Institute of Statistical, Social and Economic Research (2005). *The Guide to Electric Power,* 1st edition, 2005, by the Resource Centre for Energy Economics and Regulation**,** University of Ghana, Legon - Accra.

Ishengoma, F.M. (2002). *"Modelling, Simulation and Digital Control of Photovoltaic power supply"* in a Summary of Dr.Ingeniør (PhD) Projects, at the Norwegian University of Science and Technology, NTNU, Faculty of Electrical Engineering and Telecommunications, Department of Electrical Power Engineering in 2001.

Kahane, A. and Squitieri (1987). "*Electricity Use in Manufacturing",* in the Annual Review of Energy, Volume 12. Pg 223 – 251 http://arjournals.annualreviews.org/doi/pdf/10.1146/annurev.eg.12.110187.001255?cookieSet=1 date accessed 02/02/2010.

Karve, A.D. (2005). *"Biomass as Energy Source"* in Alternative Energy Sources, a Two- day National Seminar, the Vpm's Polytechnic, from August 27-28, 2005.

Kayanula, D. & Quartey, P. (2000). "*The Policy Environment for Promoting Small and Medium-sized Enterprises in Ghana and Malawi"*, an article published in Finance and Development Research Programme working paper series 15, IDPM, University of Manchester.

Kemfert, C. (2006). *An integrated assessment of economy, energy and climate: the model WIAGEM* – A reply to Comment by Roson and Tol. Integrated Assessment Journal, 6, pg. 45-49.

KMA (2006). *Medium Term Development Plan 2006-2009*, Kumasi Metropolitan Assembly, unpublished report.

Koffi, I.K. (2009). *Towards an Optimal Generational Mix for Ghana,* presentation at the KNUST Energy conference, VRA October 30, 2009.

Kufuor, A.A. (2008). "*Employment Generation and Small Medium Enterprise (SME) Development – the Garment and Textile Manufacturing Industry in Ghana",* paper presented at the International Forum on Sustainable Private Sector Development on Growing Inclusive Markets Forum in Halifax, Nova Scotia, Canada, at Dalhousie University's Faculty of Management: 19th – 21st June, 2008.

Kumekpor, T.K.B. (2002). *Research Methods and Techniques of Social Research,* Accra, SunLife Publications.

Liqa-Sally, R.; Koranteng, R.T. and Akoto-Danso, E. K (2006). *Research, Development and Capacity Building for the Sustainability of Dam Development with Special Reference to the Bui Dam Project*, http://www.iwmi.cgiar. org/Africa, date accessed 7/05/2009.

MacKay, D.J.C. (2009). *Sustainable Energy- without the hot air,* England, UIT Cambridge Limited.

Malerba, F. & Orsenigo, L. (1994). *The Dynamic and Evolution of Industries,* Working paper WP-94-120 in the International Institute for Applied System Analysis, Luxemberg – Austria.

Mensah, S. (2004). *A Review of SME Financing Schemes in Ghana*, a paper presented at the UNIDO Regional Workshop of Financing Small and Medium Scale Enterprises, Accra, Ghana, 15-16 March 2004.

Ministry of Energy (2009). *National Energy Policy,* Final Draft Report, November 2009.

Ministry of Finance and Economic Planning (MoFEP) (2008). *The Budget Statement and Economic Policy of the Government of Ghana for the 2008 financial year*, Republic of Ghana.

Ministry of Strategy and Finance (MSF), Republic of Korea and Korea Development Institute (KDI) (2009). *Building the Foundation for the Development of SMEs in Ghana*, a publication by the Ministry of Strategy and Finance, Republic of Korea under the Knowledge Sharing Programme, September, 2008.

NDPC (2003). *Ghana Poverty Reduction Strategy (2003 –2005), An Agenda for Growth and Prosperity* – Vol. 1, Analysis and Policy Statement 2003.

NDPC (2008). *Draft Long Term Development Plan, Vol. 1,* Towards a Development Policy Framework, Unpublished.

Niasse, M. (2005). *Climate-Induced Water Conflict Risks in West Africa: Recognising and Coping with Increasing Climate Impacts on Shared Watercourses*, a presentation made at an International Workshop on the theme Human Security and Climate Change, Holmen Fjord Hotel, Asker, near Oslo, 21–23 June 2005.

Obeng, G.Y. and Hans-Dieter, E. (2009). *Solar PV rural electrification and energy-poverty: A review and conceptual framework with reference to Ghana,* MPRA Paper No. 17136, posted 06. September 2009, http://mpra.ub.uni-muenchen.de/17136/, date accessed 10/07/2009.

Ofosu-Ahenkorah, A.K. (1995). *The Results of the Energy Conservation Programme, its Impact on the Industrial Sector in Ghana and Strategies for the Future*, Paper presented at the Sixth Session of the Africa Regional Conference on Mineral & Energy Resources Development and Utilisation, Accra, Ghana.

Ofosu-Ahenkorah, A.K. (2008). "*Ghana's Energy Resource Options: Energy Conservation"* in Energy and Ghana's Socio-economic Development, Development and Policy Dialogue Report One, George Benneh Foundation, Accra. Pg 51 – 65.

Ogunlade, D. & Youba, S. (2001). "*Energy and Sustainable Development: Key issues for Africa",* in UJEP (2001). Proceedings of the African High-level Regional Meeting on Energy and Sustainable Development, for the ninth session of the commission for Sustainable Development in Nairobi, Kenya 10-13 January, 2001, organised by UNEP in collaboration with the Government of Kenya and the UN Department for Economic and Social affairs. Oregon.

Otchere, J.N.K. (2006). *Akosombo Dam and Electricity Load Shedding: A Challenge of our Time,* Featured Article of Monday, 23 October 2006 on http://ghanaweb.com/GhanaHomePage//features/artikel.php?ID=112576, date accessed 12/02/2010.

Oteng-Adjei, J. (2008). "*Politics and Ghana's Energy Supplies:* in Energy and Ghana's Socio-economic Development, Development and Policy Dialogue Report One, George Benneh Foundation, Accra. Pg 103 – 115.

Oviemuno, A.O. (2006). *Impact of Energy on the Manufacturing Sector in Nigeria,* http://searchwarp.com/swa70577.htm, date accessed 03/02/2010.

Owusu, G. & Lund, R. (2004). "*Markets and Women's Trade: Exploring their Role in District Development in Ghana",* Norwegian Journal of Geography, Volume 58, Issue 3 Pg 113 - 124.

Parvaiz, A. (2010). *South Asia: 'Harness Untapped Renewable Energy Sources' – Experts* an article published by Inter Press Service Agency, Columbia http://ipsnews.net/news.asp?idnews=49906, date accessed 11/02/2010.

Perlman, H. (2009). *Hydroelectric power water use,* http://ga.water.usgs.gov/edu/wuhy.html, date accessed 11/02/2010.

POEMS (2005). *Practical ocean energy management systems*, http://www.poemsinc.org/FAQcurrent.html, date accessed 12/11/2009.

Quansah, C. (2009). '*Assessment of the Impact of Some Selected Pro-Poor Programmes on Poverty Reduction in Ghana; The Cases of the Rural Enterprises Project in the Asante Akim North Municipality and the Social Investment Fund in Bosomtwe District, Ashanti',* A thesis submitted to the Department of Planning, KNUST, Kumasi, June, 2009.

Sambo, A. S. (2005). '*Renewable Energy for Rural Development: The Nigerian Perspective',* in ISSESCO Science and Technology Vision, Volume 1, pg 12 - 22.
Smith, C.L. (2005). *Fusion and the World Energy Scene,* http://fire.pppl.gov/fpa05_llewellyn_smith.ppt, date access 01/02/2010.

South Facing (2010). *Clean, silent and maintenance electricity for sustainable future,* http://www.south-facing.co.uk/solar-electricity-prices.aspx, date accessed 09/07/2010

Spiegel, M. R & Stephens, L.J. (2008). Schaum's Outline Series, theory and problem of statistics, SI (metric) edition, New York McGraw Hill Company Limited

Storey, D.J (1994). *Understanding the Small Business Sector*, Routledge, London.

Sullivan, A, & M.S Steven (2003). *Economics: principles in Action*. Upper Saddle River, New Jersey**,** Pearson Prentice Hall.

Todaro, M.P. & Smith, S.C. (2009). *Economic Development,* 10 edn, Essex, England, Pearson Educational Limited.

Tuebal, M. (1973). *"Heavy and Light Industry in Economic Development" an article published in the* American Economic Review Vol. 63, No. 4 . by American Economic Association Pg 588-596.

Turkson, J. K. & Amadu, M. B. (1999). *Environmental Protection Implications of Electric Power Restructuring in Ghana,* Riso National Laboratory, Rocklide, Denmark.

UN (2006). *The Least Developed Countries Report, 2006,* a report presented during the United Nations Conference on Trade and Development- Geneva, http://www.unctad.org/en/docs/ldc2006p2ch6_en.pdf date accessed 18/02/2010.

UN-ENERGY (2008). *Energy, Development and Security: Energy issues in the current macroeconomic context, http://www.unido.org/fileadmin/user_media/Publications/documents/energy_development_and_security.pdf*, date accessed 08/02/2010.

UNEP (2001). The Proceedings of the African High-level Regional Meeting on Energy and Sustainable Development for the Ninth Session of the Commission on Sustainable Development. The African High-level Regional Meeting on Energy and Sustainable Development, was held in

Nairabi, Kenya from 10 – 13 January and was organised by UNEP in collaboration with Government of Kenya anf UN Department of Econmic and Social Affairs.

UNESCO (n.d). *Development of Handicrafts & Light Industries,* UNESCO Technical Assistance Mission in Iraq, project–*tfWtl,* http://unesdoc.unesco.org/images/0015/001582/158214eb.pdf date accessed 02/02/2010.

UNESCO (1995). *Meeting of Experts on Women in the Informal Sector*, United Nations Centre, Gigiri, Kenya, 25-27 September 1995.

United States Department of Energy (2001). *Energy Efficiency and Renewable Energy; Small Hydro systems*, http://www.nrel.gov/docs/fy01osti/29065.pdf date accessed 11/02/2010.

University of California (2009). Non-renewable Energy Sources, Connexions module: m16730, University of California College Prep, http://cnx.org/content/m16730/latest/ date accessed 18/02/2010.

Van Kooten, G. C. and Timilsina, G.R. (2009). *Wind Power Development: Economics and Policies*, the World Bank Development Research Group, Policy Research Working Paper 4868.
Velázquez, N. (2006). *Impact of Rising Energy Costs on Small Business*, Report by the House Small Business Committee, Congress of the United States, House of Representatives.

VRA (2006a). *Takoradi Thermal Power Station*, http://www.vra.com/Power/thermal.html date accessed 18/02/2010.

VRA (2006b). *Akosombo Hydro Power Plant* http://www.vra.com/Power/akohydro.html, accessed, August, 2009.

Wikipedia, the free encyclopaedia (2010). *Alternative Energy*, http://en.wikipedia.org/wiki/Alternative_energy, date accessed, 17/01/2010.

WNA (2009). *Sustainable Energy, Promoting the peaceful worldwide use of nuclear power as a sustainable energy resource*, http://www.world-nuclear.org/info/inf09.html, date accessed 12/11/2009.

Wohlgemuth, N. & Monga, P. (2007). *Renewable Energy for Industrial Application in developing Countries, http://springerlink.com/content/jg111j27r5128975/* date accessed 04/02/2010.

World Bank (2010). *COP 15 or Copenhagen Climate Change Summit*, MENA Climate Change Newsletter, January 10, Number 1.

World Bank Group (2009). *Beyond Bonn: World Bank Group Progress on Renewable Energy and Energy Efficiency in Fiscal 2005–2009,* Washington, D.C. World Bank Institute, World Bank.

Wuddah-Martey, M. (2009). *Utilisation of Wind Energy Resources in Ghana*, a presentation made by Kpone/Prampram Wind Park Project, NEK Ghana Limited at KNUST on the theme Power Generation Options in Ghana.

Youngquist W. (2000). *Alternative Energy Sources*, http://www.oilcrisis.com/Youngquist/altenergy.htm date accessed 02/02/2010.

Appendix 1

Formula for the determination of the sample size

$$n = \frac{NZ^2 * 0.25}{d^2 * (N-1) + (Z^2 * 0.25)}$$

n= sample size, N= sample frame, d= precision level (92 per cent), Z= no. of standard deviation units corresponding to confidence level, 1 = mathematical constant.

Appendix 2: Confidence level with their corresponding Z factors

Confidence level	Z factor
99.9	3.29
99.7	3.0
99.5	2.8
99.0	2.57
98.0	2.32
95.5	2.0
95.0	1.96
92.0	1.75
90.0	1.64
85.0	1.43
80.0	1.28

Source: Computed from Spiegel, 1972 and tallied with Air University, 1996:

Appendix 3: Number of Workers employed by the Firms

Number of Employees	Frequency	Valid Percent	Cumulative Percent
	Straightening and Welding		
6	2	11.1	11.1
7	2	11.1	22.2
8	6	33.3	55.6
10	2	11.1	66.7
11	3	16.7	83.3
12	3	16.7	100.0
Total	**18**	**100.0**	
Mean = 9, Range =2-12			
	Spraying Firms		
3	1	5.6	5.6
4	3	16.7	22.3
5	5	27.8	50.1
6	2	11.1	61.2
7	2	11.1	72.3
10	5	27.7	100.0
Total	**18**	**100.0**	
Mean = 6, Range =3-10, Median = 5.5,			
	Sachet Water Producing Firms		
3	7	12.3	12.3
4	18	31.6	43.9
5	8	14.0	57.9
6	9	15.8	73.7
12	6	10.5	84.2
50	9	15.8	100.0
Total	**57**	**100.0**	
Mean = 12, Range = 3-50			
	Cold Stores		
1	6	10.3	10.3
2	31	53.4	63.8
3	15	25.9	89.7
4	2	3.4	93.1
5	1	1.7	94.8
6	2	3.4	98.3
7	1	1.7	100.0
Total	**58**	**100.0**	
Mean = 3, Range = 1-7			
	Wood Processors		
1	7	10.6	10.6
2	1	1.5	12.1

3	18	27.3	39.4
4	14	21.2	60.6
8	8	12.1	72.7
10	18	27.3	100.0
Total	**66**	**100.0**	
Mean =6 , Range = 1-10			
	Grinding Mills		
1	11	31.4	31.4
2	7	20.0	51.4
4	7	20.0	71.4
6	7	20.0	91.4
15	3	8.6	100.0
Total	**35**	**100.0**	
Mean = 4, Range = 1-15			
	Printing Presses		
1	2	6.7	6.7
2	3	10.0	16.7
3	7	23.3	40.0
4	3	10.0	50.0
6	3	10.0	60.0
10	5	16.7	76.7
15	3	10.0	86.7
32	4	13.3	100.0
Total	**30**	**100.0**	
Mean = 9, Range = 1-32			
	Dressmakers		
1	7	17.9	19.0
2	21	53.8	72.4
3	10	25.6	98.3
7	1	2.6	100.0
Total	**39**	**100.0**	
Mean 3, Range 1-7			

Source; Field Survey, May, 2010

Appendix 4: Value of the Firms' Assets (in Ghana Cedis)

Value of Assets (GH¢)	Frequency	Valid Percent	Cumulative Percent
Straightening and Welding			
Below 5,000	10	55.6	55.6
5,000 - 10,000	8	44.4	100
Total	**18**	**100**	
Mean = 4,722; approximately 5,000			
Spraying Firms			
Below 5,000	12	66.7	66.7
5,000 – 10,000	6	33.3	100
Total	**18**	**100.0**	
Mean = 4,167; approximately 4,000			
Sachet Water Producing Firms			
15001 – 20,000	1	1.8	1.8
20,001 – 25,000	4	7.0	8.8
25,001 – 30,000	6	10.5	19.3
30,001 – 35,000	8	14.0	33.3
35,001 – 40,000	6	10.5	43.8
40,001 – 45,000	10	17.5	61.3
45,001 – 50,000	15	26.3	87.6
50,000 - 100,000	4	7.0	94.6

Above 100,000	3	5.3	100.0
Total	**57**	**100.0**	
Mean = 92,456; ; approximately 90,000			
Cold Stores			
5,000 – 9,999	11	19.0	19.0
10,000 – 14,999	9	15.5	34.5
15000 – 19,999	8	13.8	48.3
20,000 – 24,999	7	12.1	60.4
25,000 – 29,999	6	10.3	70.7
30,000 – 34,999	5	8.6	79.3
35,000 – 39,999	6	10.3	89.6
40,000 – 44,999	3	5.2	94.8
45,000 – 49,999	2	3.4	98.2
50,000 and above	1	1.7	100.0
Total	**58**	**100.0**	
Mean = 22,759; approximately 23,000			
Wood Processors			
Below 5,000	3	4.5	4.5
5,000 – 9,999	7	10.6	15.1
10,000 – 14,999	12	18.2	33.3
15000 – 19,999	11	16.7	50.0
20,000 – 24,999	9	13.6	63.6
25,000 – 29,999	14	21.2	84.8
30,000 – 34,999	10	15.1	100.0
Total	**66**	**100.0**	
Mean = 19,924; approximately 20,000			
Grinding Mills			
Below 5,000	32	91.4	91.4
5,000 – 9,999	2	5.7	97.1
10,000 – 14,999	1	2.9	100.0
Total	**35**	**100.0**	
Mean = 3,071; approximately 3,000			
Printing Presses			
Below 5,000	2	6.7	6.7
5,000 – 9,999	6	20.0	26.7
10,000 – 14,999	5	16.7	43.4
15000 – 19,999	7	23.3	66.7
20,000 – 24,999	5	16.7	83.4
25,000 – 29,999	2	6.7	90.1
30,000 – 34,999	3	10.0	100.0
Total	**30**	**100.0**	
Mean = 16,667; approximately 17,000			
Dressmakers			
Below 5,000	29	74.4	71.1
5,000 – 9,999	9	23.1	98.2
10,000 – 14,999	1	2.6	100.0
Total	**39**	**100.0**	
Mean = 3,879; approximately 4,000			

Source; Field Survey, May, 2010

Appendix 5: Cross tabulation between Firms' Fixed Assets Value and Number of Workers Employed

Firms' Fixed Assets Value (GH¢)	**Number of workers employed by the firms**				
	Below 6	**6-12**	**13-18**	**31+**	**Total**

	Count	%	Count	%	Count	%	Count	%	Count	%
Straightening and Welding										
Below 5,000	-	0	10	55.6	-	0	-	0	10	55.6
5,000 – 9,999	-	0	8	44.4	-	0	-	0	8	44.4
Total	**0**	**0**	**18**	**100**	**0**	**0**	**0**	**0**	**18**	100.0
Spraying Firms										
Below 5,000	9	50	3	16.7	-	0	-	0	12	66.7
5,000 – 9,999	-	0	6	33.3	-	0	-	0	6	33.3
Total	**9**	**50**	**9**	**50**	**0**	**0**	**0**	**0**	**18**	**100.0**
Sachet Water Producing Firms										
15000 – 19,999	1	1.7	-	0	-	0	-	0	1	1.8
20,000 – 24,999	3	5.3	1	1.8	-	0	-	0	4	7.0
25,000 – 29,999	3	5.3	3	5.3	-	0	-	0	6	10.5
30,000 – 34,999	4	7.0	4	7.0	-	0	-	0	8	14.0
35,000 – 39,999	3	5.3	3	5.3	-	0	-	0	6	10.5
40,000 – 44,499	7	12.3	3	5.3	-	0	-	0	10	17.5
45,000 – 49,999	9	15.8	1	1.8	-	0	5	8.8	15	26.3
50,000 – 100,000	3	5.3	-	0	-	0	1	1.8	4	7.0
Above 100,000	-	0	-	0	-	0	3	5.3	3	5.3
Total	**33**	**57.9**	**15**	**26.3**	**0**	**0**	**9**	**15.8**	**57**	**100.0**
Cold Stores										
5,000 – 9,999	11	19.0	-	0	-	0	-	0	11	19.0
10,000 – 14,999	9	15.5	-	0	-	0	-	0	9	15.5
15,000 – 19,999	8	13.8	-	0	-	0	-	0	8	13.8
20,000 – 24,999	7	12.1	-	0	-	0	-	0	7	12.1
25,000 – 29,999	6	10.3	-	0	-	0	-	0	6	10.3
30,000 – 34,999	5	8.6	-	0	-	0	-	0	5	8.6
35,000 – 39,999	6	10.3	-	0	-	0	-	0	6	10.3
40,000 – 44,499	3	5.2	0	0	-	0	-	0	3	5.2
45,000 – 49,999	-	0	2	3.4	-	0	-	0	2	3.4
50,000 and above	0	0	1	1.7	-	0	-	0	1	1.7
Total	**55**	**94.8**	**3**	**5.2**	**0**	**0**	**0**	**0**	**58**	**100.0**
Wood Processors										
Below 5,000	3	4.5	-	0	-	0	-	0	3	4.5
10,000 – 14,999	6	9.1	1	1.5	-	0	-	0	7	10.6
15,000 – 19,999	9	13.6	3	4.5	-	0	-	0	12	18.2
20,000 – 24,999	8	12.1	3	4.5	-	0	-	0	11	16.7
25,000 – 29,999	7	10.6	2	3.0	-	0	-	0	9	13.6
30,000 – 34,999	5	7.6	9	13.6	-	0	-	0	14	21.2
10,000 – 14,999	2	3.0	8	12.1	-	0	-	0	10	15.2
Total	**40**	**60.6**	**26**	**39.4**	**0**	**0**	**0**	**0**	**66**	100.0
Grinding Mills										
Below 5,000	23	65.7	7	20.0	2	5.7	-	0	32	91.4
5,000 – 9,999	1	2.9	-	0	1	2.9	-	0	2	5.7
10,000 – 14,999	-	0.0	-	0	1	2.9	-	0	1	2.9
Total	**25**	**71.4**	**7**	**20**	**3**	**11.4**	**0**	**0**	**35**	100.0
Printing Presses										
Below 5,000	2	6.7	-	0	-	0	-	0	2	6.7
5,000 – 9,999	6	20.0	-	0	-	0	-	0	6	20.0
10,000 – 14,999	4	13.3	1	3.3	-	0	-	0	5	16.7
15000 – 19,999	3	10.0	4	13.3	-	0	-	0	7	23.3
20,000 – 24,999	-	0.0	3	10.0	1	3.3	1	3.3	5	16.7
25,000 – 29,999	-	0.0	-	0.0	1	3.3	1	3.3	2	6.7
30,000 – 34,999	-	0.0	-	0.0	1	3.3	2	6.7	3	10.0
Total	**15**	**50.0**	**8**	**26.7**	**3**	**10.0**	**4**	**13.3**	**30**	100.0
Dressmaking firms										

Below 5,000	43	74.1	-	0	-	0	-	0	43	74.1
5,000 – 9,999	14	24.1	-	0	-	0	-	0	14	24.1
10,000 – 14,999	-	0	1	1.7	-	0	-	**0**	1	1.7
Total	**57**		**1**	**1.7**	**0**	**0**	-	**0**	**58**	100.0

Source; Field Survey, May, 2010

Appendix 6: Total Monthly Expenditure and Revenue

Amount (GH¢)	**Total Monthly Expenditure**		**Total Monthly Revenue**	
	Frequency	**Percent**	**Frequency**	**Percent**
Straightening and Welding				
1,000 – 1,999	2	11.1	-	0.0
2,000 – 2,999	13	72.2	2	11.1
3000 – 3,999	2	11.1	7	38.9
4,000 – 4,999	1	5.6	5	27.8
5000 – 5,999	-	0.0	4	22.2
6000 – 6,999	-	0.0	-	0.0
Total	**18**	**100.0**	**18**	**100.0**
Mean = 2,610.6			**Mean = 3,277.3**	
Spraying firms				
1,000 – 1,999	4	22.2	2	11.1
2,000 – 2,999	11	61.1	10	55.6
3000 – 3,999	2	11.1	5	27.8
4,000 – 4,999	1	5.6	1	5.6
5000 – 5,999	-	0.0	-	0.0
6000 – 6,999	-	0.0	-	0.0
Total	**18**	**100.0**	**18**	**100.0**
Mean = 2,499.5			**Mean = 2,777.3**	
Sachet water manufacturing firms				
5000 – 6,999	9	15.8	0	0.0
7,000 – 8,999	18	31.6	6	10.5
9,000 – 10,999	3	5.3	13	22.8
11,000 – 12,999	9	15.8	21	36.8
13,000 – 14,999	18	31.6	14	24.6
15,000 and above	-	0.0	3	5.3
Total	**57**	**100**	**57**	**100.0**
Mean = 10,315.3			**Mean = 11,824.1**	
Cold stores				
5000 – 6,999	1	1.7	-	0.0
7,000 – 8,999	46	79.3	29	50.0
9,000 – 10,999	10	17.2	11	19.0
11,000 – 12,999	1	1.7	4	6.9
13,000 – 14,999	-	0.0	5	8.6
15,000 and above	-	0.0	9	15.5
Total	**58**	**100.0**	**58**	**100.0**
Mean = 9,344.3			**Mean = 10,413.3**	

Wood Processors				
1,000 – 1,999	7	10.6	0	0.0

2,000 – 2,999	36	54.5	32	48.5
3000 – 3,999	12	18.2	15	22.7
4,000 – 4,999	11	16.7	5	7.6
5000 – 5,999	-	0.0	11	16.7
6000 – 6,999	-	0.0	3	4.5
Total	**66**	**100.0**	**66**	**100.0**
Mean = 2,908.6			**Mean = 3,560.1**	
Grinding mills				
100 – 199	11	31.4	0	0.0
200 – 299	17	48.6	2	5.7
300 – 399	4	11.4	10	28.6
400 – 499	3	8.6	9	25.7
500 – 599	0	0.0	5	14.3
600 – 699	0	0.0	3	8.6
700 - 799	0	0.0	6	17.1
Total	**35**	**100.0**	**35**	**100.0**
Mean = 246.6			**Mean = 492.4**	
Printing Presses				
5000 – 6,999	6	20.0	3	10.0
7,000 – 8,999	9	30.0	10	33.3
9,000 – 10,999	11	36.7	13	43.3
11,000 – 12,999	4	13.3	3	10.0
13,000 – 14,999	-	0.0	1	3.3
Total	**30**	**100.0**	30	100.0
Mean = 8,866.2			**Mean = 9,266.2**	
Dressmaking firms				
1,000 – 1,999	32	82.1	24	61.5
2,000 – 2,999	7	17.9	11	28.2
3000 – 3,999	-	0.0	3	7.7
4,000 – 4,999	-	0.0	1	2.6
Total	**39**	**100.0**	**39**	**100.0**
Mean = 1,679.0			**Mean = 2,012.3**	

Source; Field Survey, May, 2010

Appendix 7: Determination of the Relationship between firms' assets value and Profit margins

Firms	**Value of Fixed Assets (GH¢) X**	**Profit Level (GH¢) Y**
Straightening and Welding	4,722	666.7
Spraying	4,162	277.8
Sachet Water manufacturing	92,456	1,508.80
Cold stores	22,759	1,069
Wood Workers	19,924	651.5
Grinding Mills	3,071	245
Printing Presses	16,667	400
Dressmaking	3,879	333.3

Source; Author's construct, 2010 with data from field survey, May, 2010

Formula:

Product Moment Correlation Coefficient

$$\frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{\quad}}$$

Definition of the variables:

Y = Dependent Variable

X = Independent Variable

Source: Adopted from Spiegel and Stephens, 2008

$r= \quad (N\sum X^{2} - (\sum X)^{2} * N\sum Y^{2} - (\sum Y)^{2})$

Appendix 8: Electricity Consumption and their associated Tariffs

Units	Frequency	Percent	Tariff (GH¢)	Frequency	Percent
Cold Store					
0-50	0	0.0	0 – 4.75	0	0.0
51 - 300	0	0.0	3.7 – 21.6	0	0.0
301 - 600	0	0.0	28.96 – 76.8	0	0.0
601 - 900	22	37.9	86.0 – 142.8	22	37.9
901 and above	36	62.1	143.0 and above	36	62.1
Total	**58**	**100.0**	**Total**	**58**	**100.0**
Mean = 936.5			**Mean = 149.8**		
Dressmakers					
0-50	0	0.0	0 – 4.75	0	0.0
51 - 300	31	79.5	3.7 – 21.6	31	79.5
301 - 600	6	15.4	28.96 – 76.8	6	15.4
601 - 900	2	5.1	86.0 – 142.8	2	5.1
901 and above	0	0.0	143.0 and above	0	0.0
Total	**39**	**100.0**	**Total**	**39**	**100.0**
Mean = 247.3			**Mean = 24.1**		
Grinding Mills					
0-50	0	0.0	0 – 4.75	0	0.0
51 - 300	22	62.9	3.7 – 21.6	22	62.9
301 - 600	7	20.0	28.96 – 76.8	7	20.0
601 - 900	5	14.3	86.0 – 142.8	5	14.3
901 and above	1	2.9	143.0 and above	1	2.9
Total	**35**	**100.0**	**Total**	**35**	**100.0**
Mean = 337.6			**Mean = 39.8**		
Printing Presses					
0-50	0	0.0	0 – 4.75	0	0.0
51 - 300	0	0.0	3.7 – 21.6	0	0.0
301 - 600	7	23.3	28.96 – 76.8	7	23.3
601 - 900	17	56.7	86.0 – 142.8	17	56.7
901 and above	6	20.0	143.0 and above	6	20.0
Total	**30**	**100.0**	**Total**	**30**	**100.0**
Mean = 740.2			**Mean = 111.4**		
Sachet water					
0-50	0	0.0	0 – 4.75	0	0.0
51 - 300	0	0.0	3.7 – 21.6	0	0.0
301 - 600	41	71.9	28.96 – 76.8	41	71.9
601 - 900	14	24.6	86.0 – 142.8	14	24.6
901 and above	2	3.5	143.0 and above	2	3.5
Total	**57**	**100.0**	**Total**	**57**	**100.0**
Mean = 545.1			**Mean = 72.1**		
Straightening and Welding					
0-50	0	0.0	0 – 4.75	0	0.0

51 - 300	4	22.2	3.7 – 21.6	4	22.2
301 - 600	7	38.9	28.96 – 76.8	7	38.9
601 - 900	4	22.2	86.0 – 142.8	4	22.2
901 and above	3	16.7	143.0 and above	3	16.7
Total	**18**	**100.0**	**Total**	**18**	**100.0**
Mean = 555.9			**Mean = 77.4**		
Sprayers					
0-50	0	0.0	0 – 4.75	0	0.0
51 - 300	12	66.7	3.7 – 21.6	12	66.7
301 - 600	5	27.8	28.96 – 76.8	5	27.8
601 - 900	1	5.6	86.0 – 142.8	1	5.6
901 and above	0	0.0	143.0 and above	0	0.0
Total	**18**	**100.0**	**Total**	**18**	**100.0**
Mean = 283.8			**Mean = 29.5**		
Wood Processors					
0-50	0	0.0	0 – 4.75	0	0.0
51 - 300	0	0.0	3.7 – 21.6	0	0.0
301 - 600	26	39.4	28.96 – 76.8	26	39.4
601 - 900	36	54.5	86.0 – 142.8	36	54.5
901 and above	4	6.1	143.0 and above	4	6.1
Total	**66**	**100.0**	**Total**	**66**	**100.0**
Mean = 650.2			**Mean = 93.6**		

Source; Field Survey, May, 2010

Ghana's Electricity Tariff Structure

<u>Non-subsidised:</u> Category 1= 9.5Gp per unit Category 2 = 12Gp per unit
Category 3 = 16Gp per unit Category 4 = 19Gp per unit

<u>Subsidised for the first 300 units:</u> Category 1= 9.5Gp per unit Category 2 = 7.2Gp per unit
Category 3=9.6Gp per unit Category 4 = 11.4Gp per unit

Appendix 9: Cross tabulation between Perception about the Electricity Tariffs and the Actual Tariffs paid by the Enterprises

Perceptions	**Amount (measured in units) of Electricity Consumed**										**Total**	
	0 - 50		**51 - 300**		**301 - 600**		**601 - 900**		**901+**			
Straightening and Welding	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Expensive	0	0	0	0.0	7	38.9	4	22.2	3	16.7	14	77.8
Moderate	0	0	4	22.2	0	0.0	0	0.0	0	0.0	4	22.2
Cheap	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	**0**	**0**	**4**	**22.2**	**7**	**38.9**	**4**	**22.2**	**3**	**16.7**	**18**	**100.0**
Spraying Firms												
Expensive	0	0	0	0.0	5	27.8	1	5.6	0	0	6	33.3
Moderate	0	0	12	66.7	0	0.0	0	0	0	0	12	66.7
Cheap	0	0	0	0.0	0	0.0	0	0	0	0	0	0.0
Total	**0**	**0**	**12**	**66.7**	**5**	**27.8**	**1**	**5.6**	**0**	**0**	**18**	**100.0**
Sachet Water Producing Firms												
Expensive	0	0	0	0	11	19.3	14	24.6	2	3.5	27	47.4
Moderate	0	0	0	0	30	52.6	0	0.0	0	0.0	30	52.6

Cheap	0	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0
Total	**0**	**0**	**0**	**0**	**41**	**71.9**	**14**	**24.6**	**2**	**3.5**	**57**	**100.0**
Cold Stores												
Expensive	0	0	0	0	0	0	11	19.0	47	81.0	58	100.0
Moderate	0	0	0	0	0	0	0	0.0	0	0	0	0.0
Cheap	0	0	0	0	0	0	0	0.0	0	0.0	0	0.0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**11**	**19.0**	**47**	**81.0**	**58**	**100.0**
Wood Processors												
Expensive	0	0	0	0	0	0.0	30	45.5	4	6.1	34	51.5
Moderate	0	0	0	0	26	39.4	6	9.1	0	0.0	32	48.5
Cheap	0	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0
Total	**0**	**0**	**0**	**0**	**26**	**39.4**	**36**	**54.5**	**4**	**6.1**	**66**	**100.0**
Grinding Mills												
Expensive	0	0	0	0.0	13	37.1	0	0	0	0	13	37.1
Moderate	0	0	22	62.9	0	0.0	0	0	0	0	22	62.9
Cheap	0	0	0	0.0	0	0.0	0	0	0	0	0	0.0
Total	**0**	**0**	**22**	**62.9**	**13**	**37.1**	**0**	**0**	**0**	**0**	**35**	**100.0**
Printing Presses												
Expensive	0	0	0	0	1	3.3	15	50.0	4	13.3	20	66.7
Moderate	0	0	0	0	6	20.0	2	6.7	2	6.7	10	33.3
Cheap	0	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0
Total	**0**	**0**	**0**	**0**	**7**	**23.3**	**17**	**56.7**	**6**	**20**	**30**	**100.0**
Dressmaking firms												
Expensive	0	0	0	0.0	8	20.5	0	0	0	0	8	20.5
Moderate	0	0	28	71.8	0	0	0	0	0	0	28	71.8
Cheap	0	0	3	7.7	0	0	0	0	0	0	3	7.7
Total	**0**	**0**	**31**	**79.5**	**8**	**20.5**	**0**	**0**	**0**	**0**	**39**	**100.0**

Source; Field Survey, May, 2010

Appendix 10: Duration required for Constant Supply of Electricity by the Enterprises

Duration (in hours)	**Frequency**	**Percentage**
Straightening and Welding		
4 - 8	18	100
Total	**18**	**100**
Mean = 6		
Spraying Firms		
Below 4	4	22.2
4 - 8	12	66.7
8 – 12	2	11.1
Total	**18**	**100.0**
Mean = 5.5		
Sachet Water Producing Firms		
4 - 8	54	94.7
8 – 12	3	5.3
Total	**57**	**100.0**
Mean = 6.2		

Cold Stores		
20 – 24	58	100
Total	**58**	**100.0**
Mean = 24		
Wood Processors		
8 – 12	66	100
Total	**66**	**100.0**
Mean = 10		
Grinding Mills		
8 – 12	35	100
Total	**35**	**100.0**
Mean = 10		
Printing Presses		
4 - 8	17	56.7
8 – 12	13	43.3
Total	**30**	**100.0**
Mean = 7.7		
Dressmakers		
Below 4	9	15.5
4 – 8	49	84.5
Total	**58**	**100.0**
Mean = 5.4		

Source; Field Survey, May, 2010

Appendix 11: Costs of Alternatives Sources of Electricity per month

No. of Gallons of fuels used by the Firms	**Frequency**	**Percentage**
Sachet Water manufacturing		
1 – 2	7	17.5
3 – 4	30	75
5 – 6	3	7.5
7 and above	0	0
Total	**40**	**100**
Mean = 3.3		
Cold stores		
1 – 2	0	0.0
3 – 4	51	87.9
5 – 6	7	12.1
7 and above	0	0.0
Total	**58**	**100.0**
Mean = 3.7		
Printing presses		
1 – 2	11	37.9
3 – 4	18	62.1
5 – 6	0	0.0
7 and above	0	0.0
Total	**29**	**100.0**
Mean = 2.7		
Dressmaking		

1 – 2	9	69.2
3 – 4	4	30.8
5 – 6	0	0.0
7 and above	0	0.0
Total	**13**	**100.0**
Mean = 2.1		

Source; Field Survey, May, 2010

Appendix 12: Cross tabulation between willingness to use ASE and the Tariffs paid for electricity consumption

Units	Frequency	Willingness			
		Willing	Per cent	Unwilling	Per cent
Cold Store					
0-50	0	0	0.0	0	0.0
51 - 300	0	0	0.0	0	0.0
301 - 600	0	0	0.0	0	0.0
601 - 900	22	19	32.8	3	5.2
901 and above	36	34	58.6	2	3.4
Total	**58**				
Dressmakers					
0-50	0	0	0.0	0	0.0
51 - 300	31	27	77.1	4	10.3
301 - 600	6	6	15.4	0	0.0
601 - 900	2	2	5.1	0	0.0
901 and above	0	0	0.0	0	0.0
Total	**39**	**35**	**89.7**	**4**	**10.3**
Grinding Mills					
0-50	0	0.0		0	0.0
51 - 300	22	14	40.0	7	20.0
301 - 600	7	6	17.1	1	2.9
601 - 900	5	5	14.3	0	0.0
901 and above	1	1	2.9	0	0.0
Total	**35**	**27**	**77.1**	**8**	**22.9**
Printing Presses					
0-50	0	0	0.0	0	0.0
51 - 300	0	0	0.0	0	0.0
301 - 600	7	1	4.2	6	20.0
601 - 900	17	17	56.7	0	0.0
901 and above	6	6	20.0	0	0.0
Total	**30**	**24**	**80.0**	**6**	**20.0**
Sachet Water					
0-50	0	0	0.0	0	0.0
51 - 300	0	0	0.0	0	0.0
301 - 600	41	33	57.9	8	17.0
601 - 900	14	13	22.8	1	1.8
901 and above	2	1	1.8	1	1.8
Total	**57**	**47**	**82.5**	**10**	**17.5**
Straightening and Welding					
0-50	0	0	0.0	0	0.0
51 - 300	4	0	0.0	4	22.2
301 - 600	7	7	38.9	0	0.0
601 - 900	4	4	22.2	0	0.0
901 and above	3	3	16.7	0	0.0
Total	**18**	**14**	**77.8**	**4**	**22.2**

Sprayers					
0-50	0	0	0.0	0	0.0
51 - 300	12	8	44.4	4	22.2
301 - 600	5	4	22.2	1	5.6
601 - 900	1	1	5.6	0	0.0
901 and above	0	0	0.0	0	0.0
Total	**18**	**13**	**72.2**	**5**	**27.8**
Wood Processors					
0-50	0	0.0	0	0	0.0
51 - 300	0	0.0	0	0	0.0
301 - 600	26	22	33.3	4	6.1
601 – 900	36	35	53.0	1	1.5
901 and above	4	4	6.1	0	0.0
Total	**66**	**61**	**92.4**	**5**	**7.6**

Source; Field Survey, May, 2010

Appendix 13: Electricity Consumption and their associated Tariffs

- 1 Kilowatt system supplies 825 units (kilowatt hour) of electricity at a cost of £7,000.
- 2 Kilowatt system which consists of 12 modules can supply 1700 units (kilowatt hour) of electricity at a cost of £11,000.
- 5 kilowatts supplies 4,250 - 4500 units at a cost of £25,000

NB. The prices are inclusive of all equipment, materials, installation, scaffolding and electrical.

Appendix 14: Number of years needed to Defray the Total Cost of the Solar Panels

Firms	**Current Monthly Tariffs (US$)**	**Amount Expected to pay (US$) at 40 percent interest rate and 40 per cent subsidy**	**Years**
Scenario One paid the current tariffs (converted to US$) used a 40 per cent government subsidy and 40 per cent interest rate on loans.			
Printing Presses	90.1	13,598	12.6
Cold Store	120.6	17,205	11.9
Wood Processing	75.9	11,945	13.1
Sachet Water	58.9	10,021	14.2
Straightening & Welding	63.1	10,213	13.5
Grinding Mills	33.2	6,202	15.6
Spraying	25.1	5,214	17.3
Dressmaking	20.8	4,543	18.2

Scenario Two: Assumed a 40 percent interest on loan without government subsidy without government subsidy

Firms	**Current Monthly Tariffs (US$)**	**Amount Expected to pay (US$) at 40 percent interest rate with subsidy**	**Years**
Printing Presses	90.1	19,037	17.6
Cold Store	120.6	24,087	16.6
Wood Processing	75.9	16,723	18.4
Sachet Water	58.9	14,029	19.8
Straightening & Welding	63.1	14,298	18.9

Grinding Mills	33.2	8,683	21.8
Spraying	25.1	7,300	24.2
Dressmaking	20.8	6,360	25.5

Scenario Three: Government provided a 40 per cent subsidy on the solar systems and an interest-free loan.

Firms	**Current Monthly Tariffs (US$)**	**Amount Expected to pay (US$) with 40 per cent subsidy and interest free loan**	**Years**
Printing Presses	90.1	8,159	7.5
Cold Store	120.6	10,323	7.1
Wood Processing	75.9	7,167	7.9
Sachet Water	58.9	6,013	8.5
Straightening & Welding	63.1	6,128	8.1
Grinding Mills	33.2	3,721	9.3
Spraying	25.1	3,128	10.4
Dressmaking	20.8	2,726	10.9

Scenario Four: Government provided a 40 per cent subsidy on the solar systems

Firms	**Current Monthly Tariffs (US$) for a group of five industrialists**	**Amount Expected to pay (US$) with a-40 percent subsidy and a-40 percent interest**	**Years**
Printing Presses	450.5	37,931	7.0
Cold Store	603.0	37,931	5.2
Wood Processing	379.5	37,931	8.3
Sachet Water	294.5	37,931	10.7
Straightening & Welding	315.5	37,931	10.0
Grinding Mills	166.0	37,931	19.0
Spraying	125.5	37,931	25.2
Dressmaking	104.0	37,931	30.4

Scenario Five: Assumed a 40 percent interest on loan without government subsidy

Firms	**Current Monthly Tariffs (US$) for a group of five industrialists**	**Amount Expected to pay (US$) at 40 percent interest rate without subsidy**	**Years**
Printing Presses	450.5	53,103.4	9.8
Cold Store	603.0	53,103.4	7.3
Wood Processing	379.5	53,103.4	11.7
Sachet Water	294.5	53,103.4	15.0
Straightening & Welding	315.5	53,103.4	14.0
Grinding Mills	166.0	53,103.4	26.7
Spraying	125.5	53,103.4	35.3
Dressmaking	104.0	53,103.4	42.6

Scenario Six: Government provided a 40 per cent subsidy on the solar systems and an interest free loan

Firms	**Current Monthly Tariffs (US$) for a group of five industrialists**	**Amount Expected to pay (US$) with a 40 percent subsidy and interest free-loan**	**Years**
Printing Presses	450.5	22,758.5	4.2
Cold Store	603.0	22,758.5	3.1
Wood Processing	379.5	22,758.5	5.0
Sachet Water	294.5	22,758.5	6.4
Straightening & Welding	315.5	22,758.5	6.0
Grinding Mills	166.0	22,758.5	11.4
Spraying	125.5	22,758.5	15.1
Dressmaking	104.0	22,758.5	18.2

Source: Author's construct, 2010

Exchange Rate: US$ 1 = GH¢1.45

Appendix 15: Identifying the minimum number of industrialists to be put in a group

Firms	Units (kilowatt hour) of electricity consumed	Number of Industrialist the 5 kilowatt solar system can supply	Cost of solar energy (in Pounds Sterling)
Printing Presses	740.2	6	37,931
Cold Store	936.5	5	37,931
Wood Processing	650.2	7	37,931
Sachet Water	545.5	8	37,931
Straightening & Welding	555.9	8	37,931
Grinding Mills	337.6	13	37,931
Spraying	283.8	16	37,931
Dressmaking	247.3	18	37,931

Source: Author's construct, 2010

Appendix 16: Attachments to Scenarios Four, Five and Six

Scenario Four: Government provided a 40 per cent subsidy on the solar systems

Firms	Current Monthly Tariffs (US$) for a group of five industrialists	Amount Expected to pay (US$) with a-40 percent subsidy and a-40 percent interest	Years
Printing Presses	540.6	37,931	5.8
Cold Store	603.0	37,931	5.2
Wood Processing	531.3	37,931	5.9
Sachet Water	471.2	37,931	6.7
Straightening & Welding	504.8	37,931	6.3
Grinding Mills	431.6	37,931	7.3
Spraying	401.6	37,931	7.9
Dressmaking	374.4	37,931	8.4

Scenario Five: Assumed a 40 percent interest on loan without government subsidy

Firms	Current Monthly Tariffs (US$) for a group of five industrialists	Amount Expected to pay (US$) at 40 percent interest rate without subsidy	Years
Printing Presses	540.6	53,103.40	8.2
Cold Store	603.0	53,103.40	7.3
Wood Processing	531.3	53,103.40	8.3

Sachet Water	471.2	53,103.40	9.4
Straightening & Welding	504.8	53,103.40	8.8
Grinding Mills	431.6	53,103.40	10.3
Spraying	401.6	53,103.40	11.0
Dressmaking	374.4	53,103.40	11.8

Scenario Six: Government provided a 40 per cent subsidy on the solar systems and an interest free loan

Firms	Current Monthly Tariffs (US$) for a group of five industrialists	Amount Expected to pay (US$) with a 40 percent subsidy and interest free-loan	Years
Printing Presses	540.6	22,758.50	3.5
Cold Store	603.0	22,758.50	3.1
Wood Processing	531.3	22,758.50	3.6
Sachet Water	471.2	22,758.50	4.0
Straightening & Welding	504.8	22,758.50	3.8
Grinding Mills	431.6	22,758.50	4.4
Spraying	401.6	22,758.50	4.7
Dressmaking	374.4	22,758.50	5.1

Source; Author's Construct, 2010

APPENDIX 17

DEPARTMENT OF PLANNING
COLLEGE OF ARCHITECTURE AND PLANNING
KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI.

VOLTA RIVER AUTHORITY

Research Topic:

Towards an Alternative Supply of Electricity for Small and Medium Scale Light Industries in Ghana.

The information is required to enable the study identify the factors that influence the determination and regulation of electricity prices in Ghana. This information will enable the study examine the impact of electricity pricing on the operations of small and medium scale light industries.

Please, I assure you that any information provided would be treated with the deserving confidentiality and be used for purely academic purpose.

Name of enumerator:...
Date of interview:...
Start time:...End time:...

1. As an authority, what are your vision and mission?..
2. What roles do you perform towards achieving your vision and mission?
   ....
3. What is the legal framework for the above-mentioned roles?
   ....
4. What factors are considered in pricing electricity in Ghana?
   ....
5. Do the prices of electricity reflect the real cost of production? 1. Yes ☐ 2. No ☐
6. If no, what is the difference? What accounts for the difference?
   ....
7. Are there subsidies for electricity consumption in Ghana? 1. Yes ☐ 2. No ☐
8. If yes, why are the subsidies provided?
   ....
9. How are the subsidies determined?
   ....
10. Who provides the subsidies (or who pays for the subsidy?...
11. How much is paid as subsidy per annum?
    ....
12. How do the subsidies affect your roles as electricity producer/supplier?
    ....
13. Who are the beneficiaries of the subsidies provided?
    ....
14. Do the beneficiaries of the subsidy package include SMEs? 1. Yes ☐ 2. No ☐
15. If no to question 14, why?
    ....
16. Do you have any intentions of considering the SMEs for the subsidy package if they are not beneficiaries? 1. Yes ☐ 2. No ☐
17. What are your reasons for the answer in question 16 above?
    ....
18. What factors determine electricity consumption in Ghana?
    ....
19. With the increasing demand for electricity, have you considered the promotion of the use of renewable sources of electricity? 1. Yes ☐ 2. No ☐
20. If yes, what is the quantity of electricity produced from the renewable sources of energy?
    ....
21. If yes, what are your targets?
    ....
22. If yes, what types of renewable energy technologies have you invested in?
    ....

23. If no, why are the renewable energy sources not promoted?
    ....
24. Do you have any other useful information for the study that the questionnaire has not covered? ....

    Thank you very much for your time.

APPENDIX 18

DEPARTMENT OF PLANNING
COLLEGE OF ARCHITECTURE AND PLANNING
KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

Research Topic:

Towards an Alternative Supply of Electricity for Small and Medium Scale Light Industries in Ghana.

PUBLIC UTILITY REGULATORY COMMISSION (PURC)

The information is required to enable the study identify the factors that influence the determination and regulation of electricity prices in Ghana. This information will enable the study examine the impact of electricity pricing on the operations of small and medium scale light industries.

Please, I assure the Commission that any information provided would be treated with the deserving confidentiality and be used for purely academic purpose.

Date of interview:...

Start time:...

End time:...

1. As a Commission, what are your vision and mission?...
2. What activities do you perform towards achieving your vision and mission?

   ....
3. Within which legal framework do you perform your activities? ....
4. What factors are considered by the Commission in regulating electricity pricing in Ghana?

   ....
5. Which stakeholders are consulted in the determination of electricity charges?
   ....
6. Do the prices of electricity determined by the Commission reflect the true cost of production?

   1. Yes ☐ 2. No ☐
7. If no, what accounts for the difference? ....

8. If no, how does it affect the operations of the service providers? ....
9. What attempts are being made (if any) to ensure that electricity tariffs reflect the true cost production? ....
10. Are there subsidies for electricity consumption in Ghana? 1. Yes ☐ 2. No ☐
11. If yes, why are the subsidies provided? ....
12. How are the subsidies determined? ....
13. Who are the beneficiaries of the subsidies provided? ....
14. Do the beneficiaries of the subsidy package include SMEs? 1. Yes ☐ 2. No ☐
15. If no to question 14, why? ....
16. Do you have any intentions of considering the SMEs for the subsidy package if they are not beneficiaries? 1. Yes ☐ 2. No ☐
17. What are your reasons for the answer in question 16 above?

    ....
18. Do you regulate the prices of electricity produced by private producers?

    1. Yes ☐ 2. No ☐
19. If no, do you have any intentions of regulating the prices of electricity produced by private producers? 1. Yes ☐ 2. No ☐
20. How do you plan to execute these intentions?
21. Please, provide any other relevant information you consider relevant but have not been covered by the questionnaire?

....

Thank you very much for your time

APPENDIX 19

DEPARTMENT OF PLANNING, KNUST - KUMASI

QUESTIONNAIRE FOR FIRMS (SELECTED LIGHT INDUSTRIES)

Research Topic:

Towards an Alternative Supply of Electricity for Small and Medium Scale Light Industries in Ghana.

Introduction

Enumerator, please introduce yourself formally to your respondent. Give him/her the assurance that the information is required for academic purposes only. Though, you are required to assess the situation quickly and determine your own style of introducing yourself, the sample below may be relevant.

Good Morning/Afternoon/Evening Sir/Madam. I am a student from the Department of Planning, KNUST (show your student ID card) and as part of the requirements to be fulfilled for the award of a degree, a study has to be undertaken by each student in an area of importance. I had an approval for the above topic in view of the fact that reliable and affordable supply of energy influences the efficiency of firm for national development. I have therefore set out to gather information for the study. The required information will enable the study assess the readiness of small and medium scale light industries for alternative supply of energy. This has become imperative in view of the unreliability of the current supplies of electricity (cite power rationing and frequent power outages as typical examples). Please, be assured that any information provided would be treated with the deserving confidentiality and be used for purely academic purpose.

Name of enumerator:...
Enumerators ID number:...
Date of interview:...
Start time:..

End time:..

Background Information

1. Name of firm..
2. Location of firm..
3. Type of firm (what is produced by the firm)? ....
4. Year of establishment...
5. Name of owner..
6. Age of owner...
7. Educational level of Owner..

Size/turnover of firm

8. Number of employees...
9. Number of hours of work per day ....

10. Quantity of inputs used for production.

SN.	Inputs	Quantity	Unit Price	Total Price
1.				
2.				
3.				
4.				

Enumerator please be patient to take down all the inputs used by the firm for a period (daily, weekly, monthly, etc). Remind him of obvious inputs that he may leave out.

11. Quantity of output produced by the firm

SN.	Outputs	Quantity Produced	Unit Price	Total Price
1.				
2.				
3.				
4.				
5.				

***Note:** Enumerator please be patient to take down all the outputs that are produced from the inputs in question 10.*

12. What is the profit margin of the firm per cycle of production?*(Enumerator, please be patient not to undervalue or overvalue the profit. This information will enable the researcher assess the ability of the firm owners to afford alternative sources of electricity).*

Electricity use

13. What do you use electricity for in your production process?..

14. What quantity of electricity does your operations consume *(please, request for his/her electricity bills politely. Record the amount of electricity used and the tariff paid per month)*?

SN.	Month	Amount of electricity consumed	Tariff paid
1.			
2.			

*(**Note:** Enumerator, you could ask him to give an estimate if the electricity bill can not easily be located)*

15. How do you consider the tariffs? 1.Very Expensive ☐ 2.Expensive ☐ 3.Moderate ☐ 4. Cheap ☐ 5. Other, specify..
16. What is the source of electricity?...
17. How many hours of constant supply of electricity do you need a day? ....
18. Do you get the required amount of electricity everyday? 1. Yes ☐ 2. No ☐
19. If no, what accounts for that?
    i. ....
20. What measures do you take when there is power outage? *(Enumerator, consider citing examples such as load shedding and the frequent power outages as instances).*
21. What other problems do you encounter with the current supply of electricity?
    i. ....

Adoption of alternative sources of energy

22. Will you want to change the source of electricity for your production? 1. Yes ☐ 2. No ☐
23. If yes, how do you describe the type of electricity you need for production? ....
24. How much are you ready to pay for the alternative source of electricity? ....
    How do you want to pay for the cost of installation?
    1. Instant on my own ☐ 2. Instant from a loan ☐ 3. On instalments ☐
    4. other, specify............................
24. Do you have any other information that has not been captured by the questionnaire? ....

Thank you very much for your time.

APPENDIX 20
DEPARTMENT OF PLANNING
COLLEGE OF ARCHITECTURE AND PLANNING
KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

Research Topic:

Towards an Alternative Supply of Electricity for Small and Medium Scale Light Industries in Ghana.

RENEWABLE ENERGY PRODUCING COMPANIES

NAME OF COMPANY:

The information is required to enable the study examine the potential of renewable energy technologies (especially the off-grid technologies) in the provision of electricity for light industries. This has become necessary in view of the unreliability of the conventional sources of electricity coupled with the increasing demand for electricity for sustainable socioeconomic and environmental development.

Please, I assure you that any information provided would be treated with the deserving confidentiality and be used for purely academic purpose.

Date of interview:...
Start time:..
End time:..

1. As an entity, what are your vision and mission?
   ....

2. What activities do you perform in order to achieve your vision and mission?
   ....

3. What is the legal framework for the above-mentioned activities?
   ....

4. What are your reasons for the promotion of renewable energy technologies in Ghana?
   ....

5. Please, list the renewable energy technologies that you promote/produce.
   ....
   What are the various options (in terms of power generation capacities) under each of the technologies? (e.g. types of solar technologies, wind, biomass, etc, their capacities and total lifespan).

Option	**Capacity**	**Estimated lifespan**

6. Please, provide the cost details of using off-grid renewable energy sources in the table below? *(e.g. types of solar technologies, wind , biomass, etc., unit cost, total cost of electricity production and how much paid as tariffs per their capacities).*

List of Alternatives	**Total cost of power production (installation and running)**	**How much would consumers be expected to pay as tariffs?**	**How much are consumers currently paying (Unit cost)**

7. Please, provide the cost details of using off-grid renewable energy sources in the table below? *(e.g. types of solar technologies, wind, biomass, etc. and the capacities).*

List of Alternatives	**Total cost of power production (installation and running)**	**How much would consumers be expected to pay as tariffs?**	**How much are consumers currently paying (Unit cost)**

8. Please, what are the advantages and disadvantages of off-grid renewable energy technologies and the on-grid renewable energy technologies?
   ....
   ....
9. Which option (off-grid or on-grid) does your company promote and why?
   ....
10. How successful have you been in the promotion of the renewable energy technologies in Ghana?
   ....
11. What are your challenges in the promotion of renewable energy technologies in Ghana?
   ....
12. What in your opinion can be done to manage the challenges?
   ....
13. Do you have any other information you consider useful but has not been covered by the questionnaire that you wish to share?
   ....

Thank you very much for your time

APPENDIX 21
CHECKLIST FOR THE REVIEW OF GHANA'S ENERGY POLICIES

MINISTRY OF ENERGY

This checklist is to help the researcher examine the extent to which Ghana's energy policies make provisions for the exploitation of alternative sources of electricity to provide for the growing demands for electricity in Ghana.

1. Are there specific policies for the use of renewable energy sources? Yes ☐ 2. No ☐

(If yes to question 1 answer questions 2 – 21, if no answer question 22)

2. If yes, are the policies defined in policy documents? What are the documents' name and sources?
   ....
   ....
3. What is the name/title of the energy policy?
   ....
4. Which year was the policy promulgated?
   ....
5. Within which period is the policy to be implemented?
   ....
6. What are the goals and objectives (targets) of the energy policy?
   ....
7. What strategies have been outlined to achieve the goals and objectives?
   ....
8. Are there specific legislations to promote renewable energy technologies?
   1. Yes ☐ 2. No ☐
9. If yes, state the legislation.
   ....
10. If no, why?
    ....
11. Does the country participate in international organisations and treaties dealing with energy and environment? 1. Yes ☐ 2. No. ☐
12. If yes, which?
13. If no, why not?

....

14. What are the reasons for the promotion of renewable energy technologies in Ghana?
    ....
15. Who are the stakeholders for the implementation of the energy policy? What are their roles? (Please indicate the names of the stakeholders).
    ....
16. What sources of renewable energy does the policy consider?
    ....
17. What are the main characteristics of this policy?
    ....
18. What is the annual budget allocation for investment into renewable energy technologies?

Year	**Amount**

19. What are the challenges with the exploitation of renewable energy technologies in Ghana?
    ....
20. What measures do you have to arrest these challenges?
    ....
21. Is there any other information considered useful for the review of the policy?
    ....
22. Why is there no policy for the exploitation of renewable energy technologies in Ghana?
    ....

APPENDIX 22
DEPARTMENT OF PLANNING

COLLEGE OF ARCHITECTURE AND PLANNING

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI.

KUMASI INSTITUTE OF TECHNOLGY ENERGY AND ENVIRONMENT (KITE)

Research Topic:

Towards an Alternative Supply of Electricity for Small and Medium Scale Light Industries in Ghana.

The information is required to enable the study examine the potential of renewable energy technologies (especially the off-grid technology) in the provision of the electricity requirements for light industries. This has become necessary in view of the unreliability of the conventional sources of electricity coupled with the increasing demand for electricity for sustainable socioeconomic and environmental development.

Please, I assure you that any information provided would be treated with the deserving confidentiality and be used for purely academic purpose.

Date of interview:..

Start time:...

End time:..

1. As an institute, what are your vision and mission?
   ....
2. What roles do you perform towards achieving your vision and mission?
   ....
3. What is the legal framework for the above-mentioned activities?
   ....
4. What are your reasons for the promotion of renewable energy technologies in Ghana?
   ....
5. Please, list the renewable energy technologies that you promote.
   ....
6. What are the various options (in terms of power generation capacities) under each of the technologies? *(e.g. types of solar technologies, wind, biomass, etc. and the capacities)*

SN.	**Option**	**Capacity**	**Estimated lifespan**
1.			
2.			

7. Please, provide the cost details of using on-grid renewable energy sources in the table below? *(e.g. types of solar technologies, wind , biomass, etc., unit cost, total cost of electricity production and how much paid as tariffs per their capacities).*

List of Alternatives	**Total cost of power production (installation and running)**	**How much would consumers be expected to pay as tariffs?**	**How much are consumers currently paying (Unit cost)**

8. Please, provide the cost details of using off-grid renewable energy sources in the table below? *(e.g. types of solar technologies, wind , biomass, etc., unit cost, total cost of electricity production and how much paid as tariffs per their capacities).*

List of Alternatives	**Total cost of power production (installation and running)**	**How much would consumers be expected to pay as tariffs?**	**How much are consumers currently paying (Unit cost)**

9. Please, how do you arrange financing for businesses in the renewable energy industry?

....

10. Under what terms do you provide the financing arrangements?

    ....

11. How successful have you been in the financing arrangement *(categories of people assisted, recovery ate, etc)?*

    ....

12. Please, what are the advantages and disadvantages of off-grid renewable energy technologies and the on-grid renewable energy technologies?

    ....

13. Which option (off-grid or on-grid) does your company promote and why?

    ....

14. How successful have you been in the promotion of the renewable energy technologies in Ghana? ....

15. What are your challenges in the promotion of renewable energy technologies in Ghana?

    ....

16. What in your opinion can be done to arrest the challenges?

    ....

17. Do you have any other information you consider useful but has not been covered by the questionnaire that you wish to share?

    ....

Thank you very much for your time

APPENDIX 23
DEPARTMENT OF PLANNING
COLLEGE OF ARCHITECTURE AND PLANNING
KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

Research Topic:

Towards an Alternative Supply of Electricity for Small and Medium Scale Light Industries in Ghana.

ENERGY FOUNDATION

The information is required to enable the researcher examine the potential of renewable energy technologies (especially the off-grid technologies) in the provision of the electricity requirements for light industries. This has become imperative in view of the unreliability of the conventional sources of electricity coupled with the increasing demand for electricity which eventually threaten mankind's survival.

Please, I assure you that any information provided would be treated with the deserving confidentiality and be used for purely academic purpose.

Date of interview:...
Start time:..
End time:...

1. As an entity, what are your vision and mission?
   ....
2. What activities do you perform in order to achieve your vision and mission?
   ....
3. What is the legal framework for the above-mentioned activities?
   ....
4. What are your reasons for the promotion of renewable energy technologies in Ghana?
   ....
5. Please, list the renewable energy technologies that you promote.
   ....
6. What are the various options (in terms of power generation capacities) under each of the technologies?*(e.g. types of solar technologies, wind, biomass, etc. and the capacities)*

Option	**Capacity**	**Estimated lifespan**

7. Please, provide the cost details of using on-grid renewable energy sources in the table below?*(e.g. types of solar technologies, wind, biomass, etc. and the capacities).*

List of Alternatives	**Total cost of power production (installation and running)**	**How much would consumers be expected to pay as tariffs?**	**How much are consumers currently paying (Unit cost)**

8. Please, provide the cost details of using off-grid renewable energy sources in the table below? *(e.g. types of solar technologies, wind, biomass, etc. and the capacities).*

List of Alternatives	**Total cost of power production (installation and running)**	**How much would consumers be expected to pay as tariffs?**	**How much are consumers currently paying (Unit cost)**

9. Please, what are the advantages and disadvantages of off-grid renewable energy technologies and the on-grid renewable energy technologies?
   ....
10. Which option (off-grid or on-grid) does your organisation promote and why?
   ....
11. How successful have you been in the promotion of the renewable energy technologies in Ghana?
   ....

12. What are your challenges in the promotion of renewable energy technologies in Ghana?
    ....
13. What in your opinion can be done to manage the challenges?
    ....
14. Do you have any other information you consider useful but has not been covered by the questionnaire that you wish to share?
    ....

APPENDIX 24
DEPARTMENT OF PLANNING
COLLEGE OF ARCHITECTURE AND PLANNING
KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

Research Topic:

Towards an Alternative Supply of Electricity for Small and Medium Scale Light Industries in Ghana.

THE GHANA ENERGY COMMISSION

The information is required to enable the researcher examine the readiness of the Ghana Energy Commission to promote the exploitation of renewable energy technologies (especially off-grid technologies) in the provision of the electricity requirements for light industries. This has become necessary in view of the unreliability of the conventional sources of electricity coupled with the increasing demand for electricity which eventually threaten mankind's survival.

Please, I assure you that any information provided would be treated with the deserving confidentiality and be used for purely academic purpose.

Name of enumerator:...
Date of interview:...

Start time:..End time:..

1. As a Commission, what are your vision and mission?
   ....
2. What activities do you perform towards achieving your vision and mission?
   ....
3. What is the legal framework within which the Commission perform its activities?............
4. Do you have specific policies for the exploitation of renewable energy sources in Ghana?
   1. Yes *2. No*
   (If the answer to question 4 is yes, then please answer questions 5-15. If the answer is no, please skip to question 16).
5. In which documents can these policies be found?
   ....
6. What are your targets for renewable energy production in Ghana?
   ....
7. What is the rationale for the exploitation of renewable energy sources?
   ....
8. How does the Commission promote renewable energy in Ghana?
   ....
9. How successful has the Commission been in the promotion of renewable energy in Ghana?
   ....
10. Please, list the renewable energy technologies that have been promoted by the Commission in Ghana.
    i. ....
    ii. ....
11. How effective have the renewable energy initiatives been towards meeting the increasing demand for electricity in Ghana?
12. How much does the Commission spend per annum for the promotion of renewable energy? What does the spending cover?
13. Which companies have been licensed by the Commission to invest into renewable energy technologies and/or production?

SN.	**Name of company**	**Type of renewable technology being promoted (e.g. solar PV, etc)**
1.		
2.		

14. How does the commission monitor the operations of the licensed companies in the production of renewable energy?
    ....
15. Are the producers required to feed the national electricity grid or produce electricity off-grid?

....…
16. Why has the Commission not promoted the use of renewable energy technologies in Ghana?
....…
17. Is there any other information on renewable energy supplies in Ghana that you want to add?
....…...................

Thank you very much for your time