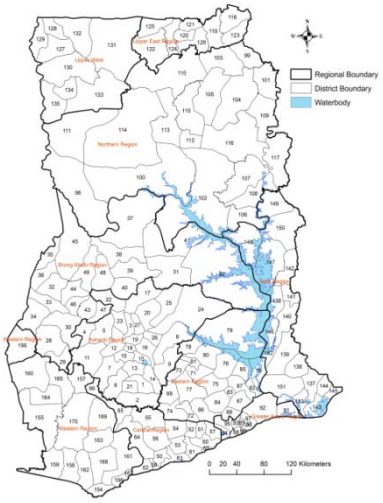
Ministry Of Energy

NATIONAL ELECTRIFICATION SCHEME (NES)

Master Plan Review (2011-2020)



DRAFT REPORT

Volume 1 of 12

Main Report

Arthur Energy Advisors

JULY 2010

EXECUTIVE SUMMARY

- ***Executive Summary is to be provided in Final Report*** -

NATIONAL ELECTRIFICATION SCHEME (NES)

Master Plan Review (2011-2020)

TABLE OF CONTENTS

1. BACKGROUND TO THE ASSIGNMENT

1.1. Introduction

The Government of Ghana initiated the preparation of a National Electrification Scheme (NES) in 1989 as its principal policy to extend the reach of reliable electricity supply to all parts of the country over a 30-year period from 1990 to 2020.

The objectives of the NES were as follows:

- Increasing the overall socio-economic development of the nation and creating wealth thereby alleviating poverty, especially in the rural areas.
- Increasing people's standard of living, especially those in the rural areas.
- Creating small-to-medium scale industries in rural areas.
- Enhancing activities in other sectors of the economy, such as agriculture, health, education, tourism etc.
- Creating jobs in the rural areas and thereby reducing the rate of rural to urban migration.

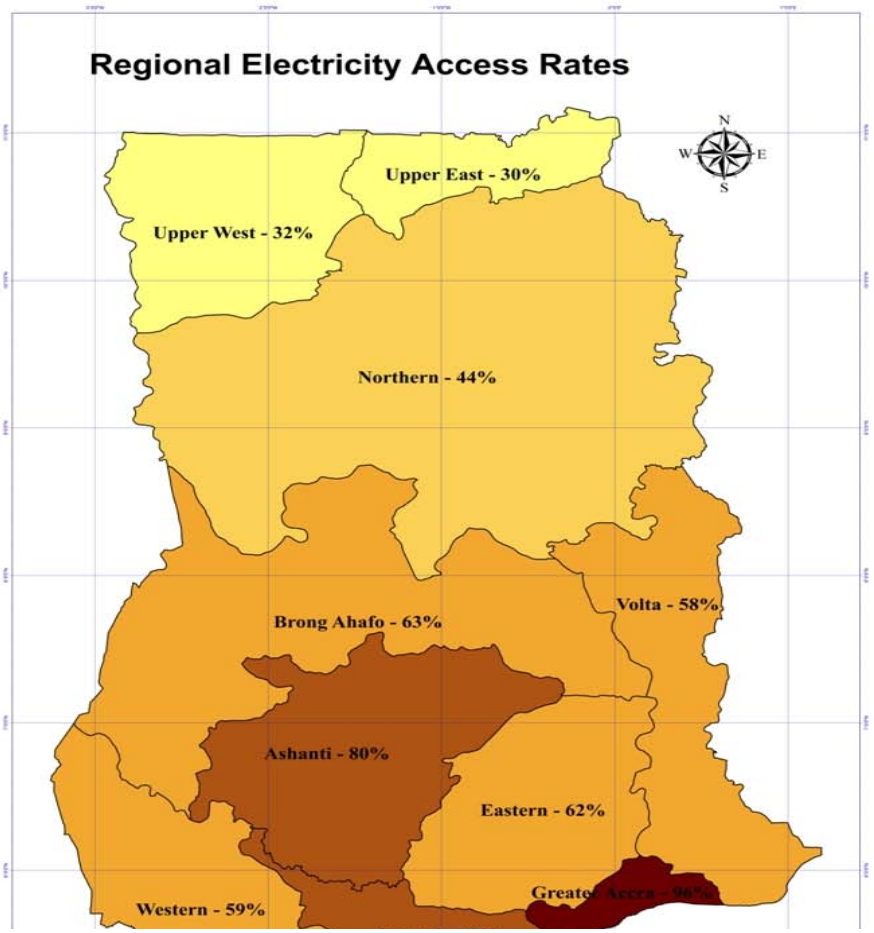
At the commencement of NES in 1990, about 4,200 communities were identified as communities having population of more than 500, and therefore qualified for connection to the national grid under the NES. Preceding the implementation of the NES, the national grid was extended and reinforced to cover the northern parts of the country under the Northern Electrification and System Reinforcement Project (NESRP)

The first phase of the NES was the electrification between 1990 and 1995 of district capitals towns and villages en-route to the district capitals. The subsequent phases of the NES Master Plan prioritized the electrification of communities in notional five-year blocks according to the economic viability of the projects. These were NES Phase 2 from 1996 to2000, Phase 3 from 2001 to 2005 and Phase 4 from 2006 to 2010.

Government as an integral and complimentary part to the phased national electrification scheme instituted the Self-Help Electrification Programme (SHEP). Under SHEP, communities within a distance of 20km from an existing medium voltage (MV) network (ie. 11kV and 34.5kV) and which took the initiative to provide the Low Voltage (LV) poles required for their communities, were assisted by the Government to advance their connection to the national electricity grid ahead of their scheduled connection time under the National Electrification Master Plan. The implementation of SHEP was also in phases and matched to those of the NES.

1.2. Context and Objectives for the Assignment

Implementation of the NES was due to enter its twentieth year as 2009 came to an end. The fourth phase of the NES and the Self–Help Electrification Programme (SHEP 4) were in progress but the fifth phase was yet to commence. The NES program had been pursued under various projects with funding support from donor agencies and institutions such as the International Development Association (IDA) of the World Bank, Danish International Development Agency (DANIDA) and the Japanese International Cooperation Agency (JICA). The total number of communities that had been connected to the national electricity grid was estimated to be four thousand one hundred and thirty two (4,132). From the population records of these communities, it was estimated that 66.7% of the citizens of the country had access to electricity supply from the national grid. The NES program had therefore made great progress and this progress could be depicted by the chart below of regional access rates.



The Ministry of Energy (MOE) recognized however that having passed the mid-point of the 30-year NES programme, the national circumstances may have changed and hence it needed to undertake an in-depth review of the NES implementation to-date in order to re-optimize the strategy to ensure the efficient and accelerated completion of the remaining phases of the program.. Accordingly, the MOE invited prospective consultants to submit proposals and subsequently employed Arthur Energy Advisors (AEA), an energy advisory and consultancy firm to undertake the NES Master Plan Review (2011 – 2020)

The goal of the Ministry of Energy for this assignment is to develop a revised NES Master Plan (2011 - 2020) that focuses on the achievement of Universal Access by year 2020. The specific objectives of the consultancy assignment are:

- To review work done so far under NES; electrified communities.
- To establish outstanding work; un-electrified communities.
- To review and evaluate the strategy and approach adopted for the NES so far and make recommendations for the effective pursuit and achievement of the NES goals
- Prepare a revised Master Plan for achieving 100% access by 2020 including suggestions for enhancing the Productive Use of Energy.

1.3. Commencement and Execution of the Assignment

The review of the National Electrification Scheme (NES Master Plan Review 2011-2020) commenced in January 2010 and was concluded in July 2010, a period of seven months.

1.3 (a) Methodology Used

The tasks required for effective execution of the assignment were identified under eight (8) captions as listed and described in detail below:

- Background information gathering and literature review
- Evaluation of NES Strategies and Incorporation of Productive Uses
- Field Visits and Surveys
- Identification of Prospective Electrification Projects
- Preparation of Project Estimates
- Creation of Database Structure & Interfaces and Data Input
- Preparation of GIS-based Electrification Maps
- Preparation of NES Master Plan (2011 – 2020).

<u>Background information gathering and literature review</u>

The consultant made enquiries at the Ministry of Energy (MOE), the Utilities and other energy-related agencies for existing documents relevant to Ghana's

National Electrification Scheme. The consultant also obtained from the Ghana Statistical Services Department, the 2000 Population and Housing Census for study and review. The Ministry of Local Government and the National Development Planning Commission were contacted to facilitate collaboration with all district assemblies and also to obtain district development plans; the collaboration with these agencies is on-going.

The documents identified for review are listed below.

Item	Reference Document	Source
(i)	National Electrification Master Plan (1990-2020)	Ministry of Energy (MOE)
(ii)	National Electrification Project Feasibility Study – Acres Int. & Asare Tsibu and Partners	Ministry of Energy (MOE)
(iii)	Strategic National Energy Plan, 2006	Energy Commission
(iv)	National Electrification Project (NEP) Completion Report	MOE, VRA, ECG
(v)	Danida Project Completion Report	MOE, VRA
(vi)	Japanese Project Completion Report	MOE, VRA
(vii)	Swedish Project Completion Report	MOE, VRA
(viii)	World Bank (IDA) Project Completion Report	MOE, VRA
(ix)	Self-Help Electrification (SHEP) Implementation Strategy Document	MOE
(x)	Self-Help Electrification (SHEP) Completion Report	MOE, VRA, ECG
(xi)	Electrification Data – National Coverage	MOE
(xii)	2000 Population & Housing Census documents	Ghana Statistical Service

Evaluation of NES Strategies and incorporation of Productive Uses

The evaluation of the NES strategies will be undertaken under the following five headings:

Technologies Employed: Technologies employed so far under the National Electrification Scheme will be thoroughly analyzed and recommendations made to optimize the benefits of the scheme to the beneficiary communities. Some of the parameters that will be examined include:

- Technical Standards
- Design specifications
- Construction Standards

- Equipment sizing
- Safety and maintainability
- Shieldwire Schemes
- Alternate supply to isolated communities

Contracting and packaging: The following issues will be examined in detail and recommendations made for improvement:

- Financing Arrangements
- Organization and Approach to Implementation
- Role of Consultants and Contractors
- Overall Schedules and Project Schedules
- Project Packaging
- Resources, namely Staff levels, Vehicles, etc.

Implementation and Monitoring: Some of the issues to be considered are:

- Work Plan and Methodology
- Quality Assurance Measures
- Warranty Management & Administration of Defects
- Environmental Impacts

Lessons Learnt About Effectiveness: Useful lessons would be drawn from Donor Completion and Evaluation Reports as well as feedback from participating agencies and project beneficiary communities in order to make recommendations for the improvement of prospective electrification projects. The following will be analyzed and recommendations made for improvement:

- Project Benefits & Costs
- Multiplier Impacts of Induced Development
- Socioeconomic Impacts

Incorporation of Productive Uses of Energy: Poverty reduction has been a central focus of the National Electrification Scheme and this was supposed to have been achieved by the implementation of an aggressive Productive Uses of Energy (PUE) programme. The PUE programme arm of the NES however was never implemented as planned. The consultant will make specific recommendations for explicit attention and aggressive implementation of the PUE programme to ensure significant contribution to the achievement of poverty reduction through the NES as originally planned.

Field Visits and Surveys

In order to effectively plan the implementation of the electrification projects for all communities with population of 500 and above taking into consideration relevant and prevailing field conditions, the consultant carried out extensive visits/survey of un-electrified communities between February and July 2010.

The consultant undertook initial field visits for the Greater Accra Region as a pilot or trial of the methodology. The initial methodology was then revised based on findings to ensure increased effectiveness in the other regions. Input datasheets used for the pilot field visit and survey were also revised for use in the remaining nine (9) regions.

The consultant visited all District Assemblies to collect the following technical and socio-economic data:

- Service status of electrified communities: Quality and reliability of supply
- Verify and list all un-electrified communities by district and region and obtain relevant documentation or basic information, namely geographic location, population, number of households and number of houses, etc.
- Natural resources of the communities and districts; Forests, Minerals, etc
- Commercial activities of the communities and the districts.
- Economic context, activities and prospects of the communities and the districts.
- Productive uses of energy in the communities and the districts.

The collected data was used to create a database of the electrified and un-electrified communities by district and region to facilitate the planning, monitoring, reporting and evaluation of implementation of the NES. The collected data was also be used to develop programmes that incorporate the productive uses of energy into the electrification programme.

Identification of Prospective Electrification Projects and Packages

The consultant undertook the following activities towards indentifying the electrification projects needed to meet the objectives of the assignment:

- Embarked on reconnaissance survey of all un- electrified communities
- Selected provisional line route, voltage of MV line, substation location/terminal points.
- Collected sufficient information that would permit provisional quantity estimate of the MV lines, Substations and LV network including service connections for all un-electrified beneficiary communities by district and region.
- Defined project components and packages by district and region for cost effectiveness, technical efficiency and expeditious execution.

Preparation of Project Estimates

The task of estimating the cost of prospective electrification projects was broken into two; material and cost estimation.

Material Estimates. The consultant prepared material estimates for the electrification of un-electrified communities that meet the criteria to be beneficiaries. The material estimates were driven by the expected scope of work for each community regarding four(4) key cost elements; ie Medium voltage (MV) lines, Pole-mounted transformer substations, Low voltage (LV) networks and Customer service connections. The material estimates for each of the cost elements were in turn based on the following indicators:

MV lines	-	Length of MV line
PM Substations	-	Demand per household and number of households
LV networks	-	Size/Population of community
Customer services	-	Number of houses

Afterwards the material requirements of any collection of communities considered as one logical implementation package was computed for ease of collation. The material estimates obtained were then also grouped by district.

To enable the project meet load growth during the initial 10-year period after implementation, some new substations as well as upgrades of existing substations and sub-transmission lines were required. The consultant has estimated and included these requirements for substation and sub-transmission line capacity upgrade.

It is also noted that the material estimates above have been based on conceptual design of the relevant distribution system. These estimates will therefore require revision upon completion of detailed design. The Materials Estimate datasheets for all the communities have been grouped according to district and are presented according to region as Volume 3 to Volume 12 of this report.

Cost Estimates. In order to prepare provisional cost estimate for the works relating to beneficiary un-electrified communities by district and region, the consultant obtained and adopted unit costs estimates for all items of work from similar works recently procured

An estimate of Engineering Construction and Supervision cost as well as a Contingency provision has been derived as a percentage of the works cost and added to the estimated direct works cost to obtain the overall project cost estimate.

The Project Cost Estimates for all the communities have been grouped according to district and are also presented according to region as part of Volume 3 to Volume 12 of this report.

Creation of Database Structure & Interfaces and Data Input

The consultant created an electrification database for all communities with population of 500 or more between the year 2010 and 2020. This database is expected to be extensively used by Policy Makers, Planners, Ministry of Energy and Contractors, Investors and Project Developers, Consultants and Researchers among others.

The database contains the following information:

- Socio-economic data:
- Community names
- Community population (gender disaggregated)
- District population (gender disaggregated)
- Regional population (gender disaggregated)
- Electrification status
- Distance from district capital
- Social amenities (schools, clinics, etc.)
- Economic profile (income levels, economic activities)
- Technical data:
- supply take-off town/point
- supply voltage level in the District and community
- MV distance from supply source town to un-electrified community
- technical challenges to supply the un-electrified community
- line voltage and type
- transformer capacities and quantities
- project/package composition/sponsors
- expected timeframe for supply connection
- Projected period to next supply capacity upgrade)/excess capacity
- line routing options
- natural resources profile
- usage intensity (expected energy demand)

Preparation of GIS-based Electrification Maps (e-maps)

The consultant carried out a GIS mapping exercise using the MapWindows software to map out all electrified and un-electrified communities in layers by district and region. This included communities with population of 500 or more inhabitants in 2010 based on projections from the 2000 Population Census and those communities estimated to have a population of 500 or more inhabitants in 2020.

The consultant sought from the Ghana Survey Department base maps (in digital format) at the National, Regional, District and Community levels. Such comprehensive base maps showing the geo-referenced locations of small communities were needed to form the base layers upon which the other layers were to be mounted and the e-maps built. Regrettably however, such base maps could not be obtained from the Survey Department of Ghana. In the absence of the base maps, the consultant obtained other maps for on-screen digitizing of the communities. This compromise was not as accurate and comprehensive as desired but was nevertheless necessary otherwise most communities would not appear on the e-maps to be produced.

To ensure the accuracy of relevant aspects of the e-maps however, the consultant dispatched personnel to all eligible un-electrified communities (ie those towns with population greater than 500) in order to record their specific geographic locations using a GPS device. This was so that the location of each un-electrified community included in the NES plans for Phase 5 and Phase 6 could be accurately plotted on the base map and processed using GIS software.

The consultant's personnel were able to visit and obtain GPS data for two thousand seven hundred and eleven (2,711) communities out of the total number of two thousand eight hundred and forty two (2,842). There were two main reasons why some of the communities were not visited; either the community was not accessible because the field visits were conducted in the rainy season or the consultant was unable to find the community. The breakdown of the GPS coverage by region is shown on the table below.

Region	GPS Data Obtained	No GPS data	Total	% Mapped
Ashanti	224	5	229	98%
Brong Ahafo	201	14	215	93%
Central	170	0	170	100%
Eastern	248	0	248	100%
Greater Accra	11	3	14	79%
Northern	653	68	721	91%
Upper East	300	1	301	100%
Upper West	298	7	305	98%
Volta	179	6	185	97%
Western	427	27	454	94%
Total	2,711	131	2,842	95%

The consultant, as shown by the table above, was able to achieve 95% GPS coverage of the eligible un-electrified communities being considered under this assignment.

The objective and focus of the e-maps produced was to present information about un-electrified communities. The maps therefore had the following features:

- Natural and geographical features commonly shown on maps
- Important landmarks
- Electricity supply source towns
- electrified communities with one symbol,
- un-electrified community with 500+ population by 2010 one symbol
- un-electrified community with 500+ population by 2020 another symbol
- community names on maps

Preparation of NES Master Plan (2011-2020)

The consultant will prepare a Master Plan which outlines the road map and will include project packaging, costing, scheduling and recommendations for accelerated implementation for the achievement of Universal Access to electricity to all communities with a population exceeding 500 by year 2020.

1.3 (b) Work Organization

The approach for the provision of required services for the review of NES Master Plan was to assign professionals who have extensive knowledge of the power system in Ghana, GIS-based Mapping officers and Distribution Survey Technicians. The Consultant trained and deployed four (4) teams of two persons each to travel the country and visit each of the eligible un-connected communities to gather the data needed and to record their GPS coordinates.

After some of the background documents, maps and data were assembled, significant efforts were invested in the analysis of the data available to create sample e-maps and electrification database. Other planned tasks followed sequentially culminating in the writing of the NES Master Plan Review (2011-2020).

Total Man-months used for the review of the NES (2011-2020) was sixty-five (65).

1.3 (c) Resources Employed

The consultants, Arthur Energy Advisors (AEA), undertook this NES Master Plan Review (2011-2020) assignment in collaboration with the Energy Centre of the Kwame Nkrumah University of Science and Technology (KNUST) to leverage and enable the building of capacity in GIS mapping. The AEA team included twelve (12) persons and the Energy Centre team comprised three (3) members.

The consultant used the following tools & equipment in performing the Master Plan Review (2011-2020):

- Garmin etrex GPS for collecting GPS coordinates of the communities.
- GPS TrackMaker for downloading and transferring GPS coordinates.
- Microsoft Excel 2007 for data entry and preliminary information processing.
- Microsoft Access as the Database Engine
- Arc Maps & MapWindows for creation of electrification maps
- Digitized base maps of the communities

1.4. Completion of Delivery

In broad accordance with the provisional Gantt Chart, the consultant has successfully undertaken all the necessary tasks and has prepared this Draft Report within seven months after the commencement of the assignment. It is anticipated that the final report would be submitted in less than a month after written comments on the draft report are received from the client.

The survey and verification of data from un-electrified communities as basic input for the definition of electrification projects and the development of GIS-based electrification maps and electrification database by District and Region was successfully undertaken in virtually all the ten (10) regions of Ghana. The exception was the Bawku district of the Upper East region where the consultant's personnel were unable to visit all communities because of the ongoing conflict. Unfortunately, the field survey activity had to be carried out during the rainy season. This affected the progress of work because of the poor state of roads during the season. As a result, the duration for field survey exercise had to be extended by about seven weeks because of the slow progress in these areas. The field visits were therefore not completed until the last week of July 2010.

The review and evaluation of NES strategies, incorporation of productive uses of energy programme into a phased electrification connection programme was undertaken in the home office of the consultant.

The development of GIS-based electrification maps and electrification database as well as the preparation of material and cost estimates & packaging of prospective electrification projects were held up by the delay in completing the field surveys. These tasks therefore had to be done simultaneously from the first week of April 2010 till the end of July 2010.

The preparation of the Draft Report NES Master Plan Study had to be done concurrently with the other task in order to save time and ensure completion by July 2010.

1.5. Report Structure and Terminology

The study report on the NES Master Plan Review (2011 – 2020) is in twelve volumes with contents as indicated on the report outline shown below.

NATIONAL ELECTRIFICATION SCHEME (NES)

Master Plan Review (2011-2020)

Report Outline

Volume 1.....Main Report

Volume 2..... Electrification Information

Volume 3.....Ashanti Region

Volume 4.....Brong-Ahafo Region

Volume 5..... Central Region

Volume 6.....Eastern Region

Volume 7.....Greater Accra Region

Volume 8..... Northern Region

Volume 9..... Upper East Region

Volume 10 .....Upper West Region

Volume 11 ..... Volta Region

Volume 12 ..... Western Region

This is the first volume of the twelve (ie Volume 1 of 12) and contains the Main Report. This volume is made up of eight (8) sections. It starts with a recollection in this section of the background and objectives of the assignment. It then recounts the commencement and stages of execution of the assignment. This first section then ends with an outline of the structure of the report.

Section 2 describes NES context and history. It describes the past organization and roles played by various agencies as well as past approaches to the implementation of the National Electrification Scheme (NES). The section offers recommendations for future roles and responsibilities and specifies the administrative functions of various agencies and stakeholders in the implementation of the next ten-year phase of NES.

Sections 3 contains an assessment of the effectiveness of the strategies and approaches employed under the NES in the past and makes specific recommendations for improvement of the NES. It also includes suggestions for the incorporation of a program for Productive Uses of Energy as an integral part of the phased NES Master Plan (2011 – 2020) and to ensure significant contribution to the achievement of poverty reduction through the NES as originally planned.

Section 5 describes the preparation of detailed provisional quantity and cost estimates of line, substation and customer services materials by communities, districts, regions in packages for technical efficiency and cost-effective implementation of electrification projects.

Section 6 covers the creation of an electrification database of the economic status and investment cost needed for all un-electrified communities with population of 500 or more by 2020. It is anticipated that this database will subsequently be used by Policy Makers/Planners, Investors and Project Developers.

Section 7 provides GIS-based electrification maps of all electrified and un-electrified communities by district and region as well as electrification coverage data by district and regions of Ghana.

Finally Section 8 recommends a revised NES Master Plan (2011-2020) which outlines a project implementation road map including project management considerations, project packaging, costing, scheduling and recommendations for accelerated implementation for the achievement of Universal Access to electricity for all communities with a population exceeding 500 by year 2020.

The medium voltage facilities that interconnect communities to the main grid system are referred to as the sub-transmission network. With regard to the transmission and distribution system, the following terminology has been adopted for this report.

1.6. Voltage System Terminology

Nominal Operating Voltage	System Terminology	Abbreviation	Application
>35kV	High voltage	HV	Transmission Level
11, 11.5, 20, 30, 33 or 34.5kV	Medium voltage	MV	Sub-transmission /Distribution Level
400/230 V	Low Voltage	LV	Utilization Level

2. NES CONTEXT AND HISTORY

2.1. Overview of the Power Sub-sector

The electricity supply sector in Ghana has an unbundled structure with the functions of power generation, transmission and distribution being performed by separate entities. The objective of the sector structure is to encourage private participation and market competition in the generation business. The transmission function is however performed by a designated transmission utility as an Independent System Operator (ISO) to provide non-discriminatory access to all market participants. The distribution function is performed by licensed entities which have been granted concession areas.

Whereas the arrangements between the operating entities are in general governed by contract and electricity regulations, the provision of electricity services to the public by these utilities are in addition subject to an independent regulator. The principal actors in the sector are:

- The **Ministry of Energy (MOE)** is responsible for formulating, monitoring and evaluating policies, programmes and projects for the power sub-sector and the energy sector in general. MOE is also the institution charged with the implementation of the National Electrification Scheme (NES) which seeks to extend the reach of electricity to all communities in the long term.
- The state-owned **Volta River Authority (VRA)** which undertakes power generation at the Akosombo and Kpong Hydro Power stations and the Takoradi Thermal Power Plant (TAPCO), situated at Aboadze. VRA is also a minority joint-venture partner with TAQA, a private sector company, to own the Takoradi international Power Company (TICO) which operates a thermal plant, also located at Aboadze.
- **Bui Power Authority (BPA**) another state-owned agency which is charged with implementation of the Bui Hydroelectric Power Project, while a number of private Independent Power producers (IPPs) have been licensed to build, own and operate power plants. The IPP projects are at various stages of development.
- The **Ghana Grid Company (GRIDCo)** a state-owned entity which has the exclusive mandate to operate the National Interconnected Transmission System (NITS) as an Independent System Operator (ISO) and to also be the Market Administrator for the Electricity Market. The NITS is defined to comprise "**all electricity plant and equipment within the borders of Ghana that function or are operated at any voltage higher than 36 kV as well as any associated feeder or supply equipment that are for shared or**

common use".

Accordingly GRIDCo exists to provide non-discriminatory open-access to transmission services for all market participants.

- The **Electricity Company of Ghana Limited (ECG),** a state-owned company distributes electricity in the southern part of the country, while the Northern Electricity Department, a subsidiary of VRA distributes electricity in the northern parts of Ghana.
- Regulatory oversight is provided by the **Public Utilities Regulatory Commission (PURC),** an independent body set up for the commercial regulation and oversight of the provision of electricity and water services to consumers.
- The **Energy Commission (EC)** also exits with functions relating to the regulation, management, development and utilization of energy resources in Ghana and to grant licenses for the transmission, wholesale supply, distribution and sale of electricity and natural gas and enforcing performance standards of the utilities.

Ghana has an installed capacity of 1,960 MW made up of hydro and thermal facilities. Electricity demand which is currently 1,400MW is growing at about 10% per annum. It also has extensive transmission and distribution infrastructure which covers all the regions of the country, providing electricity access to about 66% of the population.

2.2. Past Organization of NES

The National Electrification Master Plan (1990-2020) outlined an implementation plan made up of six five-year phases spanning the 30-year period. Before the commencement of the NES in 1989, 4175 communities were identified as having a population of 500 or more. Of this number, only 478 communities were supplied with electricity at the inception of the NES.

The Ministry of Energy (MOE) had responsibility for long range planning of electrification in accordance with Government policy and also monitoring progress against plans. It also had the responsibility of identifying and organizing financing for implementing electrification projects especially since these projects were not always financially attractive to the operating utilities.

2.2 (a) Role of Funding Agencies

The World Bank and other Bi-lateral funding agencies have supported the implementation of the National Electrification Scheme (NES) from its inception in 1989. The National Electrification Project (NEP), which was executed between 1995 and 2000 comprised the electrification of the first two phases of the NES as outlined in the National Electrification Master Plan (1990-2020). The project

covered the electrification of 23 un-electrified District Capitals and four hundred (400) other towns/villages en-route to the District Capitals.

Other electrification project concessions have been supported through Grant Aid financing by various foreign Governments and Development Partners to-date.

2.2 (b) Role of Utilities

The utilities, Electricity Company of Ghana (ECG) and Volta River Authority (VRA) & Northern Electricity Department (NED) have responsibility for NES project Implementation. They act as Engineers and are responsible for all utilities' involvement with planning, designing, constructing and commissioning of the NES projects.

2.2 (c) Role of Consultants and Contractors

Consultants and contractors have played significant roles in NES project implementation. Consultants have been engaged in the design layout of electrification facilities, preparation of bill of materials and detail cost estimates as well as the development of project budget and schedules. Consultants have also acted as the utility's agents for the procurement of materials and installation of electrification facilities. Contractors on the other hand have been employed to undertake field survey and the preparation of electrification maps as well as the erection and installation of electrification facilities and equipment.

2.2 (d) Role of District Assemblies, Environmental Agencies, National Evaluation Board (NEB) Traditional Authorities and Beneficiary communities.

The District Assemblies, traditional authorities and beneficiary communities have supported the NES project identification process, field survey and acquisition of right of way (ROW) as well as identification and payment of compensation for property affected by electrification projects. The District Assemblies and Self-help Communities have provided funds for the purchase of LV poles and provided communal labour and the Government has provided materials such as conductors and distribution transformers to help the communities realize their community electrification aims.

The Ministry of Energy (MOE) has defined three criteria that must be satisfied before a town or village is considered for the Self Help Electrification Project (SHEP):

- Distance to an existing 33kV or 11kV supply must be within 20km
- The community must be prepared to purchase all LV poles
- A minimum number of houses are wired up and ready to receive electricity

Environmental Protection Agencies have provided environmental and social impact assessment (ESIA) study reports as well as environmental management plan (EMP) for electrification projects while the National Evaluation Board has identified and evaluated the required compensation for property affected by electrification projects.

2.3. Past Approach to Implementation

At the commencement of the NES in 1990, national access to electricity was said to be about 23%. Assuming, in accordance with adopted national policy, that all un-electrified communities with population of 500 and above were connected national access would be 66.50%.

At the end of year 2009 the total number of electrified communities was four thousand one hundred and thirty two (4,132) while eighty-four thousand eight hundred and thirteen (84,813) communities were un-electrified. Based on population, National Access to electricity was estimated at 66.70%.

The Ministry of Energy (MOE) which was charged with the implementation of the NES, steered individual electrification projects through the following steps:

(i) Project identification

(ii) Project scope and Cost

(iii) Economic Analysis

Depending on the financing arrangement secured by MOE/Government, the Utilities which are project implementing agencies would go through the remaining steps to complete an electrification project, namely:.

(i) Field Survey to compile maps

(ii) Design layout of MV and LV lines

(iii) Preparation of bill of materials

(iv) Detail Cost Estimate

(v) Development of Budget and Schedule

(vi) Procurement of materials

(vii) Erection and Installation of facilities

(viii) Commission and Energization of Electrical Networks

Where a turnkey arrangements were used, the entire implementation works were awarded to a single contractor, otherwise the utilities would retain management

responsibility and arrange separate contracts for field survey and preparation of maps, design, detail cost estimates, materials procurement and construction.

The goals of the NES were pursued through the implementation of several otherwise discrete projects but linked by the ultimate objective. The notable projects amongst these are described in the following sub-sections.

2.3 (a) National Electrification Project (NEP)

The first phase of the NES was the electrification between 1990-1995 of district capital towns and villages en-route to the district capitals. The National Electrification Project (NEP) which was conceived and executed between 1990-2000 was one of the earliest projects under NES Phases 1 and 2.

The scope of the NEP comprised the electrification of twenty-three (23) un-electrified district capitals and 400 towns/villages en-route to the district capitals. The NEP was financed by the World Bank and other Bi—lateral funding agencies as follows:

Component of NEP	Funding Agency	Amount
Brong Ahafo, Northern, & Upper East Regions.	World Bank	US$35.3million
Eastern, Ashanti (Rural & urban), Greater Accra, Volta (Urban) Central, Western (Urban)	World Bank	US$42.5million
Volta Region (Rural)	Nordic Dev. Fund(NDF)	US$6.88million
Western Region (Rural)	Dutch Govt. (ORET)	US$31.0million
Central Region (Rural) & Upper West Region	Danish Govt.(DANIDA)	US$24.35million

(i) Brong Ahafo, Northern, and Upper East Components of the NEP

This component of the NEP was executed under the jurisdiction of the Volta River Authority (VRA) and covered the electrification of 13 district capitals and 129 towns/villages along the supply route. The project was funded by the World Bank at a cost of US$35.5million and was executed by Norelec of France and KEC International of India.

(ii) Eastern, Ashanti, Greater Accra, Central, Western, Volta Components of NEP

This NEP electrification component was executed under the jurisdiction of the Electricity Company of Ghana (ECG) and covered 42 rural communities in the Eastern Region and 15 rural communities in the Ashanti Region. The project also covered urban communities in the six regions under the NEP Urban Project. The World Bank funded the project at a cost of US$42.5million.

(iii) Volta Region (Rural) Component of NEP

The Nordic Development Fund (NDF) provided the US$6.9million funding for this component of NEP which was executed under the jurisdiction of ECG by KL Contractors of Denmark. The project covered the electrification of 2 district capitals in the Volta Region and 33 towns/villages en-route to the district capitals.

(iv) Western Region (Rural) Component of NEP

This component of NEP was financed by the Dutch Government (ORET) to the tune of US$31.0million and was executed by Holec Projects of Holland. The project covered the electrification of 3 district capitals, namely, Asankragua, Enchi and Half-Assini and 96 other towns/villages en-route to the district capitals. By the end of 1997 when funds provided by ORET got exhausted, all the 3 district capitals and 60 towns/villages had been connected to the national grid. The Government of Ghana provided the additional funds required for the electrification of the remaining 33 towns/villages.

(v) Central (Rural) and Upper West Regions Component of NEP

The Central (Rural) and Upper West Regions component of the NEP was funded by the Danish International Development Agency (DANIDA) at a cost of US$24.35million and was executed by Semco/Skanska Jensen of Denmark. The project covered the electrification of 2 district capitals, namely, Ajumako and Twifo Praso and 64 other towns/villages in the Central Region and 3 district capitals, namely, Lawra, Jirapa, Nadawli and 10 other towns/villages in the Upper West Region.

2.3 (b) Other Bi-Lateral Funded Electrification Projects

(i) Electrification of Bekwai, Kuntenase and Other Communities – JICA 1

This project was a Japanese Government Grant Aid for electrification which covered 2 district capitals, namely, Bekwai and Kuntenase and 29 other communities in the Ashanti and Central regions. The project commenced in 1989 and was completed in 1990. The cost involved was US47.8million.

(ii) Electrification of Ada-Foah, Sogakope, Adidome and Other Communities – JICA 3

This Japanese Government Grant Aid electrification project involved the connection of 3 district capitals, namely, Ada-Foah, Sogakope and Adidome and 19 other communities in the Greater Accra and Volta regions. The project commenced in 1993 and was completed in 1995. The cost involved was US$17.1million.

(iii) Electrification of Asesewa and Yeji Areas – JICA 3

This project was funded under the Government of Japan Grant Aid of US$10.2 million to cover Asesewa and Yeji areas and executed by Japanese contractors, Nishizawa Limited and Tochs Corporation.

The first phase of the project was the electrification of Asesewa and 20 other communities in its surroundings areas. The project was commenced in March 1997 and completed in December 1999.

The second phase of the project was the electrification of Yeji and twelve other communities in its surrounding areas. It was commenced in March 1997 and completed in September 1999.

(iv) Electrification of Nyinahin & Other Towns – JICA 4

The electrification of Nyinahin and 23 other communities in the Atwima District of Ashanti region was funded with the Government of Japan Grant Aid of US$6.3million and Government of Ghana fund of GHC7.5million. The project was executed in 2003.

(v) Electrification of Communities in the Amansie West District – JICA 4

This project involved the electrification of 10 communities in the Amansie West District under the Government of Japan Grant Aid of US$2.6million. The project was executed in 2004.

(vi) Electrification of Juabeso-Bia District – GOG

This project was funded by the Government of Ghana (GOG) and covered the electrification of Juabeso, the district capital of the Juabeso-Bia district and 33 other communities in the Juabeso-Bia and Sefwi-Wiawso districts. The project commenced in 1992 and was completed in 1994.

(vii) Electrification of Greater Accra and Volta Regions – Sida

This electrification project initially covered 63 towns/villages in the Volta region and 13 towns/villages in the Greater Accra region. The project was funded by the Swedish Government through the Swedish International Development Agency (Sida) with an initial amount of US$8.3million and was executed by the Swedish contractor, Transelectric AB. Works under the main contract commenced in

October 1997 and was completed in October 1999. A supplementary amount of US$2.47million from Sida was used for the electrification of additional 34 towns/villages in the project areas, which commenced in May 2000 and completed in July 2001.

(viii) Upper East Region Electrification Project

The Government of Ghana (GOG) secured a concessionary loan of US$10million from the Spanish Government to undertake this project to cover the electrification of 51 communities in the Upper East region. The project commenced in June 1999 and was completed in December 2000. The project was executed by the Spanish contractor Elecnor.

(ix) Western Region Electrification Project

This project connected 108 communities in eleven districts in the Western region to the National Electricity Grid. The project was financed with European Union Grant Aid of €10million. The project which was executed by Norelec of France commenced in July 2001 and was completed in July 2004.

(x) Electrification of Volta Lake Resettlement Townships

The electrification of 144 Volta Lake Resettlement Townships was funded under Chinese EXIM Bank Loan of US$32.8million. The project which was executed by China International Water & Electric Corporation was completed in 2003.

2.3 (c) Self-Help Electrification Programme (SHEP)

Government of Ghana (GOG), as a complimentary programme to the National Electrification Scheme (NES) instituted the Self-Help Electrification Programme (SHEP). Under SHEP, communities within a distance of 20km from an existing medium voltage (MV) (ie. 11kV and 34.5kVnetworks) and which had taken the initiative to provide the Low Voltage (LV) poles required for their communities, were assisted by the Government for connection to the national electricity grid ahead of their scheduled connection time under the National Electrification Master Plan.

(i) Self-Help Electrification Package – SHEP 1

The SHEP 1 project was implemented between 1990 and 1991. 50 communities were connected to the National Electricity Grid.

(ii) Self-Help Electrification Package – SHEP 2

The SHEP 2 project was implemented between 1992 & 1994. Under this project, 250 communities were connected to the National Electricity Grid.

(iii) Self-Help Electrification Package – SHEP 3

Studies undertaken throughout the ten regions of Ghana by local consultants between 1993-1994 identified 1400 towns/villages which were eligible for inclusion in the SHEP 3 package. Off-shore electrical materials and equipment valued at about US$130million were procured for the package. In view of the large number of towns/villages under the SHEP 3, the project was divided into three phases, SHEP 3-phase 1, SHEP 3-phase 2 and SHEP 3-phase 3. The implementation of the phase 1 project which benefitted 170 communities was commenced in October 1996 and was completed in December 1998. The phase 2 of this project which benefitted 480 communities commenced in 1998 and was completed in 2000. 700 communities benefitted under the SHEP 3-phase 3 package.

The fourth phase of the Self–Help Electrification Programme (SHEP 4) has commenced and the initial projects are in progress.

2.4. Critique of what worked and what didn't work well

The role of the MOE in identifying and organizing financing for NES implementation in accordance with Government policy and the utilities acting as project implementation agencies worked well. In respect of support from the World Bank and other Multi and Bi-lateral funding agencies, the Government of Ghana; as the recipient of Government to Government funding support; on-lent the funds made available for these projects to the utilities through subsidiary loan agreement. These utilities then had responsibility for implementation while the MOE had oversight responsibility for the projects.

The funding agencies were allowed to have direct dealings with the utilities in respect of the projects. This worked extremely well because there was adequate understanding of the challenges facing the project as well as full accountability of the implementer in respect of the scope and performance of the project.

On the other hand, in respect of the Self-Help Electrification Project (SHEP) which was a complimentary programme under the NES, MOE played both the policy making and project implementation roles. The SHEP projects although fairly successful had a number of challenges, namely:

(i) Insufficient network coverage of the communities as a result of the communities' inability to procure all the required number of low voltage poles. This resulted in lower than expected access to electricity by prospective consumers.

(ii) Substandard network extensions by communities to serve prospective customers was another challenge. For example the inclusion of non-

standard low voltage poles in the built network meant these had to be replaced by the utilities at high cost within very short periods.

(iii) In order to take advantage of the presence of contractors within area prior to their demobilization, some medium voltage lines and transformers were installed in some communities in advance of the community fully meeting the pre-conditions for inclusion in the SHEP programme. The inability of some of these communities to procure low voltage poles and wire 30% of houses in the communities has caused delays to project completion.

2.5. Recommended Future Roles and Rationale

The Ministry of Energy (MOE) should have both policy making and executive responsibility for NES implementation for continuity. It should continue its critical role of keeping long range planning of electrification and monitoring progress against plans in accordance with Government policy. It should have overall responsibility for organizing the NES programme, dealing with funding agencies, the District Assemblies and the beneficiary communities.

The utilities should continue in their role as Engineers to NES project implementation to ensure that their technical specifications are fully applied at all times.. This is in order to develop a distribution system that is unified and consistent throughout the country, even when it is constructed in stages and by different organizations. The utilities should provide guidance to SHEP communities for electrification implementation to assure quality workmanship. They should commission and energize the built network facilities.

The District Assemblies and Beneficiary communities must continue to play the roles they have played in the past. There should however be strict implementation of the guidelines for community participation in the SHEP programme to ensure improved access to electricity connection by prospective customers and early completion of the SHEP projects.

The Ministry of Energy/Government should continue to seek both Interest-free loans and Grant-Aid financing for the next 5-year phases of NES because rural electrification is not profitable. Rural electrification levy and/or margins on electricity tariff could be used to supplement interest-free loans and Grant-Aid financing. The MOE/Government should shape the local content policy in future agreement with Bi-lateral financing agencies to produce some of the materials for electrification locally in order to boost the manufacturing industry and create employment.

3. EVALUATION OF NES STRATEGIES AND INCORPORATION OF PRODUCTIVE USES OF ENERGY

3.1. Increasing Access to Electricity Supply

The primary focus of the Government of Ghana (GOG) towards achieving strategic objective of universal access to electricity was to extend the reach of electricity to all communities with population of 500 and above by 2020.

In concert with Government policy, the first five year phase of the NES was planned to supply all district capitals that did not have electricity. Sub-transmission networks were developed from the nearest existing grid networks to connect these large population centers as well as smaller centers located along the routes. In addition communities that were officially a part of the self-help electrification programme were supplied.

The National Electrification Master Plan (1990-2020) outlined for implementation a National Electrification Scheme (NES). At the commencement of the NES in 1990, 4175 communities were identified as having a population of 500 or more. Of this number, only 478 communities were supplied with electricity at the inception of the NES.

The transmission network extensions to all regional capitals which were carried out from 1987 had provided the infrastructural backbone for subsequent supply to smaller, more remote population centers. These centers were supplied by radial networks from the existing networks or from initial NES networks.

The implementation of the remaining phases of the electrification projects under NES Master Plan (1990-2020) were developed by making the most economic use of available resources in a priority order based on unit cost of electricity.

In the remainder of this Section we have evaluated the electrification strategies to-date in order to re-optimize NES project implementation to ensure the effectiveness and accelerated completion of the remaining Phase 5 (ie 2011-2015) and Phase 6 (ie 2016-2020) of the NES.

3.2. Technologies Employed

Technology is an important aspect in the design and implementation of rural electrification projects that seek to minimize project requirements in general while at the same time promoting the productive use of energy in particular.

In the development of NES Master Plan (1990-2020) electrification projects, distribution networks were generally designed to satisfy the requirements for a low-

cost system that integrates operationally with the existing systems in both ECG and VRA/NED.

Some serious challenges have however emerged due to long medium voltage (MV) lines and single phase MV radial extensions in some districts in the country which cannot support small and medium scale industry. Inadequate investment in the past has also led to the deterioration of the electricity distribution system. This has resulted in high system losses and the widespread complaints in the country about the poor reliability and quality of electricity supply.

In the remaining ten-year period of NES implementation, adequate level of capital should be invested in the provision of appropriate technologies and equipment such as automatic voltage regulators, auto-re-closers and shunt capacitors within the sub-transmission and distribution systems, based on analytic studies of the power system requirements, to reduce voltage drops and losses and also enhance the reliability and quality of electricity services.

3.2 (a) Technical Standards

Design and construction standards were included in the NES Master Plan Study (1990-2020) to serve as guidelines during detail design of the distribution system. Adoption of the two standards was intended to minimize overall programme costs while achieving the established goals for power quality and systems reliability.

In recognition of continuing technological changes in the power industry and rapid growth of customer demand in the country, it will be beneficial for the power utilities to establish a forum for regular review of their technical standards that brings to bear their experiences and best practices elsewhere and aimed at moving towards ultimately adopting a common national technical standard in all their work.

3.2 (b) Design Specifications

In the distribution network layout, the existing 33kV sub-transmission voltage was used for primary distribution as well. Thus it was not necessary to provide intermediate 33/11kV transformation. Sub-transmission and distribution at 11kV was therefore only used in areas where it was already established.

Single phase 33kV and 11kV radial extensions were implemented in some districts in the country. Single-phase and two-phase LV distribution was extensively used to minimize cost. Further cost savings were achieved by the use of pole mounted distribution transformers and pole mounted auto-reclosers where applicable.

The market for single phase motors for the small scale industries, agriculture and irrigation is non-existent in Ghana in view of their comparative price and by extension small scale industrial process equipment for rural enterprises.

While the consideration of 33kV sub-transmission voltage for primary distribution for extension of electrification to rural communities is excellent for the elimination of intermediate 33/11kV transformation cost, single phase 33kV and 11kV radial extensions are a limitation to providing motive power for rural industries required for rural development and are therefore not recommended.

3.2 (c) Construction Standards

The NES construction standards were in essence, an extension of the design standards, and they were to ensure that the individual pieces of equipment adequately met the capabilities in the system design.

The distribution construction standards employed by ECG and VRA/NED were reviewed and adopted where appropriate.

Construction standards of ECG and VRA/NED should be updated on a continual basis during the implementation of NES (2011-2020) to take advantage of technological advancement in material, equipment and construction techniques as well as experience gained by the utilities. Construction standards should continue to be applied diligently to NES implementation in order to develop a distribution system that is unified and consistent throughout the country, even when it is constructed by different organizations.

3.2 (d) Equipment Sizing

Within the communities serviced, 3-phase supply was restricted to areas that had customers with demonstrated need. Residential areas were served with single phase power. Consistent with the above, the distribution system had small secondary service areas, supplied by small transformers in the 25kVA – 100kVA range.

A decentralized distribution system with small secondary service areas serviced by small transformers is ideal for rural community settlements of 500 and above inhabitants as will be encountered in the next phases of NES. This is because equipment outages will be localized and distribution losses will be minimized. However the design and installation of the distribution system in the communities should be sized so that upgrading will not be required for at least ten years. In the NES Mater Plan Review (2011-2020) the standard sizes of distribution transformers used are either 50kVA or 100kVA.

3.2 (e) Safety and Maintainability

Medium Voltage (MV) networks were developed from the nearest existing grid supply networks and were routed along existing roads to supply the communities. In general this method resulted in MV network routes along acceptable terrain and with good access for construction and maintenance. Adherence to the technical standards for design and construction was sufficient to limit outage frequency and duration through the use of standard protection design methodology. The reliability criteria specified in the NES electrification project development were achieved through the recommended protection devices for isolation of the faulted sections of the network manually and automatically.

3.2 (f) Shieldwire Schemes

The VRA/NED operates a single phase 161kV shieldwire distribution system in parts of Ashanti, Brong Ahafo and Northern regions of Ghana. For this scheme, one of the MV conductors is grounded, however the output for the low voltage (LV) networks is the same as the conventional scheme. The shieldwire scheme can supply single phase loads and a limited amount of three-phase loads with typical limitations of 1.1MW at 20km and 0.8 MW at 40km (lumped loads at 0.9 power factor). A criticism of the Shieldwire supply scheme has been its inability to supply significant amounts of motive power for the communities.

While bearing in mind he above criticism, the single phase 161kV shieldwire distribution system should be extended where appropriate to supply communities in the Brong Ahafo, Northern and parts of Ashanti regions.

3.2 (g) Alternate supply to isolated communities

A solar-photo-voltaic project was started in 1998 as a component of NES to provide rural energy services using fee-for service model and other strategies in one hundred and thirteen (113) communities in twenty-four districts in Ghana. Over 80% of the communities where the PV systems were installed have however been connected to the national electricity grid under NES. Plans to relocate and re-install the PV systems in off-grid communities elsewhere have not materialized.

3.3. Contracting and Packaging

Electrification development in the next NES phases as proposed under this NES Master Plan Review (2011-2020) involve 2563 projects spread over 147 districts in the ten regions of Ghana, which means there is a considerable technical independence between many of the projects and sub-projects. This creates a natural flexibility in implementation which allows the participation of several financing agencies, consultants and contractors without the necessity of a rigid overall

approach. The possibility of involving several agencies in a relatively simple manner means a high degree of confidence can be placed in the project's implementation.

3.3 (a) Financing Arrangements

The NES has been implemented over the years with support from donor communities and institutions such as the International Development Association (IDA) of the World Bank, European Union, Danish International Development Agency (DANIDA), the Japanese International Cooperation Agency (JICA), other Bi-lateral Funding Agencies and the Government of Ghana. The financing arrangements came in the form of concessionary loans and Grant-Aid. Some Bi-lateral funding arrangements required that project work was undertaken on turnkey basis instead of the conventional design-supply-install approach with international competitive bidding (ICB).

3.3 (b) Organization and Approach to Implementation

The Ministry of Energy (MOE) was responsible for long-range plans for electrification and ensuring that the general direction of activities in progress was consistent with these plans and national policy. The MOE also had the critical role of identifying and organizing financing for implementing electrification. The two utilities- Electricity Company of Ghana (ECG) and the Volta River Authority/Northern Electricity Department (VRA/NED) were designated as the implementing agencies, with each responsible for those projects falling in its respective existing geographic service area.

In the case of the Self-Help Electrification Project (SHEP) however, the MOE was responsible for both policy planning and project implementation.

3.3 (c) Role of Consultants and Contractors

Expatriate engineering consulting organizations, local consulting organizations, individual consultants, (both local and expatriate), as well as expatriate and local contractors did play major roles in NES electrification project implementation over the years.

Implementation of the NES required major increases in the workload of the three implementing agencies, namely; MOE, ECG and VRA/NED and was not possible without significant increases in staffing levels. Consultants and contractors were assigned all or some of the critical steps in electrification project implementation, namely; project feasibility studies, field survey to compile maps, design layout of MV and LV lines, preparation of bill of materials and detail cost estimate, development of budget and schedule, procurement of materials, erection and installation of facilities, commission and energization of facilities.

3.3 (d) Overall Schedules and Single Project Schedules

An overall schedule duration of 5 years was selected as a realistic target in tandem with the five year phases of the 30 year NES. Since the overall project involved a large number of relatively independent projects much work could proceed in parallel. Three types of schedules were developed; overall project schedule, single project schedule and group of three projects schedule.

It was assumed that international competitive bidding (ICB) would be required to recruit consultants, procure materials and engage contractors which required considerable schedule allowance for the several approval agencies and steps involved. It was also assumed that the materials procurement tender be organized to establish an initial inventory and also to replenish it as work proceeded.

For the single or individual project schedule, it was assumed that all materials were available and the construction contractor and staff resources were available as and when needed. Construction was expected to take about 25 weeks, so that the entire project was completed in 29 weeks.

The schedule for a group of three projects was indicative of the situation when a group of projects stood alone as perhaps might be the case if financing were provided on a bilateral basis and all ICB procedures were followed. Overall duration was approximately 17 months.

3.3 (e) Project Packaging

The National Electrification Planning Study (NEPS) defined 69 projects distributed in all the 10 regions of Ghana. Project packaging followed deliberate Government policy to electrify district capital that did not have electricity first, hence the District Capital Electrification Project. This was followed by the electrification of towns with 1990 population exceeding 2000 inhabitants. Sixty-nine (69) electric networks were developed to connect these large population centers, and also supply smaller towns en-route. Other electrification packages were designed to connect large population centers with commercial potential and strategic towns through the extension of the initial networks. There were also electrification packaging that were driven by the financing arrangements available.

The following criteria guided project packaging under the NES Master Plan (1990-2020):

- District capitals as the administrative centers of local government.
- Centers with 1990 population of 2000 and above.
- The most economic use of available resources to develop projects in a priority order based on unit cost of electricity, with population centers close to initial networks supplied first.

- Geographic location of various projects and the administrative boundaries of the two implementing utilities.
- Size of electrification projects.
- Availability and size of funding.

3.3 (f) Resources; namely Staff levels, Vehicles, etc.

The NES Master Plan (1990-2020) outlined the number and qualifications of staff that were required on the utility project teams for project implementation. Work schedule and resources were organized such that resource levels were essentially constant over the duration of each of their respective activities. Excluded from the staff numbers were the staff for surveying townships and compiling maps and construction work which were tasks to be undertaken by contractors.

Vehicles were assigned to all field staff as well as to the Project Directors and Project Engineers. Other physical resources included:

- Travel and accommodation for field staff
- Office supplies, communications and courier
- Advertizing, printing, shipping and meeting expenses for tendering
- Accommodation for expatriate staff

A budget was prepared indicating the resources and cost of implementation.

3.4. Implementation and Monitoring

Pre-conditions for the successful implementation of any rural electrification programme is the collection of sound statistical data to map out the electrification needs of the country. The shaping of the electrification policy (including the choice of technologies for electrification and deadlines) will greatly depend on the geographical distribution of the rural population and of the existing grid, the density of this population and its level of electrification.

3.4 (a) Work Plan and Methodology

In 1991 the National Electrification Planning Study (NEPS) estimated that out of 4221 urban population centers in Ghana, 478 had electricity leaving 3743 centers with a combined population of 5.4 million people without electricity supply. For these population centers, a procedure was set up and applied to define a number of electrification projects. Each of these projects was then evaluated economically in order to rank them. The ranking was used to determine the least cost plan for the 30-year (1990-2020) planning period.

NEPS also estimated that 590 centers that had population in excess of 2000 people had no electricity. The population of those centers was 2.2 million which represented 40% of the un-served urban population.

Sixty-nine (69) electric networks were developed to reach these large urban centers, and also supply smaller towns en-route to effectively supply 1620 centers with a combined population of 3.30 million. That represented 61% of the unsupplied urban population.

Development of the initial networks provided a backbone for subsequent supply to smaller, more remote centers. These centers would be supplied by radial extensions from the existing networks or from initial NES networks. The number of centers in this category was about 2120, with a combined population of 2.1 million, representing the remaining 39% of unsupplied urban population.

3.4 (b) Quality Assurance Measures

The NEPS recommended the following quality assurance measures:

- that during project design analytic studies was conducted to determine the necessary reactive power compensation requirements to ensure that end-user voltages were in the range of 400/230 V, +10%, -6%.
- distribution system was designed and installed within the communities so that upgrading will not be required for at least ten years.
- the source sub-transmission system voltages were used throughout the MV distribution network.

3.4 (c) Environmental Impacts

NES Master Plan (1990-2020) addressed two broad categories of environmental impacts: physical and social impacts.

Beneficial impacts of electrification on the physical environment relate to the displacement of petroleum-based fuels as an energy source. Emissions associated with kerosene lighting and with the use of diesel fuel for motive power or private generation should be substantially reduced as grid supply of electricity replaces these traditional alternatives. Environmental impacts which may be considered benign relate to the extension of MV and LV lines and the associated effects on land use, land ownership and vegetation. While transmission line construction is potentially a concern, particularly where it interferes with or requires relocation of farms or houses, no significant impacts are anticipated as a result of proposed projects.

Socio-economic impacts potentially include:

- Ability to deliver improved healthcare and education services to the electrified communities (through increased access to lower-cost lighting, refrigeration and electrical equipment)

- Improved nutrition and food supply through more efficient and cost-effective food processing and storage capabilities.
- Improved dissemination of information through electronic media.
- Social and cultural changes including increased opportunities for social interaction both within and outside the family.

3.5. Lessons Learnt About Effectiveness

3.5 (a) Access to Electrification

Under the NEP programme, the concessionary connection cost policy that resulted in community member paying on five thousand (5,000) cedis for a service connection, was to a large extent very effective in providing access to the broad masses of the population to connect to the grid. A number of poor households could not wire their homes during the concessionary connection fee period, which meant that they would be required to pay the full cost after they have managed to wire their homes in their own time.

Access to the benefits of electrification was not equal between men and women in the electrified households. Men own and use more electrical appliances than women. Often the areas where women needed electricity the most (kitchen and bathrooms) were not lighted, either for concern of running up high bills or limited budget for wiring.

3.5 (b) Knowledge on Productive Uses of Electricity

No sustained effort or programme was put in place by the utilities to educate consumers in the newly electrified towns on how to use electricity productively and efficiently. This accounts perhaps for the rather slow uptake of electricity for productive purposes and for those who have ventured on their own, led to inefficient operations, often leading to early collapse of their businesses.

The process of transformation of attitudes, productivity and living standards, is not sparked off automatically when electricity is provided in societies which depend on farming. Such transformation is only possible with a carefully worked out strategy on promoting productive uses of electricity, and this goes well beyond the traditional electric utility function of electricity distribution.

3.5 (c) Economic Enterprises

Even though electricity is a convenient form of energy for promoting entrepreneurial activity, there are more complexities than the provision of electricity. The more important issues are capital, knowledge and skills for productive activity and access to markets. Where other prerequisites for sustained development are absent, demand for electricity for productive uses did not grow.

3.6. Summary of Recommended Strategy Changes for 2011-2020

Electrification development under NES Master Plan Review in the next ten years (2011-2020) would involve 2563 urban centers with population between 500 and 2000 inhabitants each supplied by radial grid extensions from existing networks.

The following are recommended strategy changes for project implementation:

a) The Ministry of Energy (MOE) should have both policy making and executive responsibility for NES implementation for continuity. The Utilities should have the engineering design responsibility for project implementation.

b) The MOE should pursue firm electrification implementation policies and goals backed by adequate level of financial resources for the long-term maintenance and repair of electrification infrastructure.

c) The MOE/GOG could use rural electrification levy and/or margins on electricity tariff to supplement interest-free loans and Grant-Aid financing for electrification projects.

d) The MOE/GOG should shape the local content policy in future agreement with Bi-lateral financing agencies to produce some of the materials for electrification locally in order to boost the manufacturing industry in Ghana to create employment.

e) There should be strict implementation of the guidelines for community participation in the SHEP programme to ensure improved access to electricity connection by prospective customers and early completion of the SHEP projects.

f) In order to develop a distribution system that is unified and consistent throughout the country, even when it is constructed in different stages/programmes and by different organizations, it is imperative that common standards for design and construction be consistently applied during implementation of the electrification projects.

g) Each individual SHEP project under NES should necessarily pass through all the steps in electrification project implementation, namely; project identification, field survey & compilation of maps, design layout of MV and LV lines, detail cost estimate, etc. for successful early completion of the project.

h) Electrification projects should be developed in a priority order based on unit cost with larger urban communities supplied first. Small population centers located away from main MV lines should be supplied on a similar basis.

i) Distribution systems within the communities should be designed so that upgrading will not be required for at least 10 years.

j) During project design, analytic studies should be conducted to determine the reactive power compensation requirements to ensure that end-user voltages are in the range of 400/230 V, +10%, -6%.

k) Regular maintenance and upgrading of power lines and transformers will significantly reduce transmission and distribution losses. Long medium voltage (MV) lines (when extending the grid to rural areas) are at risk of high transmission and distribution losses. Line quality and the quality of transformers will also impact the efficiency of transmission and distribution.

l) In parallel to the electrification process, energy efficiency policies or measures should be implemented. Energy efficiency measures such as the use of energy-saving appliances, simple demand side management measures, or energy conservation in buildings significantly reduce electricity demand.

m) Productive Uses of Energy should be pursued vigorously as a complementary economic development programme alongside the provision of electricity to foster business. Joint efforts with other ministries or development agencies are therefore recommended to enhance the benefits of electrification.

n) Sustainable renewable energy schemes could be integrated into the NES with the right electrification implementation policies. The appropriate financing scheme and holistic approach to the education of the citizenry on renewable energy sources is key.

o) The highest environmental standards should be enforced during field implementation of the electrification projects in accordance with Environmental Protection Agency, EPA Act 1994, (Act 490), the lands (Statutory Way-leaves) Act, 1963 (Act 186) Forestry Department regulations and local/district assembly bye-laws.

3.7. Productive uses of energy in a phased National Electrification Scheme

Promoting the productive uses of energy is widely considered to be an important aspect in the design and implementation of rural energy projects. Projects with a "productive use" focus or component have been developed in recognition of the fact that the provision of energy in itself is not the end-goal but rather the economic and social development it is supposed to enable. Promoting "productive uses" in essence is an attempt to make the energy input work directly and effectively for rural economic development.

Poverty reduction/creation of wealth was the ultimate rationale for the National Electrification Scheme (NES) and it was implicitly assumed that this would occur

naturally upon the empowerment of citizens by the provision of electricity services. Even though Ghana's NES has made good progress in increasing electricity access rates from the estimated 23-28% in 1989 to the current estimated national coverage of 66%, the much anticipated economic activity that was expected to have resulted from electrification is yet to be realized to the extent assumed. Twenty (20) years after the Scheme commenced its economic impact is yet to be felt in any significant way in the electrified communities.

3.7 (a) Review of PUE program under NES

The NES was to be accompanied by an aggressive Productive Uses of Energy (PUE) programme. The nation's efforts under the PUE component of the NES over the past twenty (20) years can be summed up as follows:

- Organization of public forums on productive uses of electricity in newly electrified communities.
- Socio-economic study/Productive Uses of Electricity in some districts:
- Assessment of the feasibility of embarking on a scheme for the productive use of electricity in the districts
- Development of a strategy for implementing a pilot project(s) to demonstrate the practicality and sustainability of productive uses of electricity.

According to some researchers only 50-60% of households with electricity in their communities are actually connected and most of these customers consume less than 50kWh per month. The low consumption rates are due to the fact that the use of electricity in these communities is predominantly for domestic lighting purposes only. This is because the PUE programme component of the NES that was to have actively facilitated the generation of economic activity in the respective communities was not adequately pursued. The result is the seeming absence of a direct contribution from electrification to economic activity in communities that have benefited from the Scheme.

Due to the limited activity with respect to the Promotion of productive uses of energy by the Ministry of Energy there was not enough experience to derive lessons from. There have been however a number of small to medium scale attempts by a number of non-government institutions. Most of these initiatives were usually intended as pilot or demonstration projects which required policy leverage for expanded impact and private sector buy-in to ensure long-term sustainability. Because these projects were entirely outside the public sector, even the successful ones had very limited impact due to the absence of the necessary Government support.

3.7 (b) Strategy notes for the development of a national PUE programme

To enable this project distil some lessons from successful PUE programmes for the consideration of the Ministry of Energy a number of best practice PUE models outside of Ghana were reviewed. Furthermore, since a national PUE program cannot be developed without extensive consultation with the targeted communities and individuals, we have in this report provided strategy notes only for consideration in the development of a successful PUE program.

Sustained long-term government support

The proposed PUE program is expected to be for rural and peri-urban communities, areas that are usually not attractive to the private sector unless given special incentives. Government may have to seriously consider a national PUE program as part of its development agenda and economic strategy and develop a comprehensive long-term program with the commitment to provide the necessary budget and policy support.

This PUE program will be a long-term investment that prepares the rural areas for improved performance by the informal private sector in the medium-term and entry by the 'big' private sector in the long-term. If successfully as the NES has been, this programme will transform the economic landscape of this country in a significant way. The national PUE program must be long-term and must have the requisite budget and policy support for a sustained effort.

Need for strong Program leadership and stakeholder coordination

The PUE program must have strong champion and this may be the PUE unit at the Ministry of Energy (preferably connected to the government) to lead the development and periodic review to sustain relevance and leveraging of knowledge and skills for optimum results. This champion will have to coordinate with other sector agencies and stakeholders and work with them to explore cross-sector synergies between programs for improved results.

The proposed national PUE program should not be for un-electrified communities only as even already electrified rural and peri-urban communities are yet to translate their access to electricity into economic activity and improved livelihood. Serious attention needs to be paid to peri-urban communities since they seem to be growing at a much higher rate in many cases than the rural populations.

Even though electricity is a major determinant in the generation of entrepreneurial/economic activity, there are other important factors such as knowledge, skills and capital that need to be present for a successful outcome. Coordination with all stakeholders will therefore have to be actively pursued if the program is to be effective.

Involvement of rural communities and other stakeholders throughout the decision-making process

It is vitally important to adequately involve community members and rural development workers in establishing what their real needs and priorities are. It is important to ensure the full participation of women in this consultation process as they are major users and decision makers in the entire process. Rural community workers bring invaluable knowledge of the communities as well as skills required for training and communicating with community members and effective partnership with them can significantly enhance the success of the program. Some of the issues to consider in the consultation process as well as in the formation of the various partnerships are:

- Identification of major stakeholders within and outside the Energy Sector and indeed across all sectors, government and non-government institutions, major private sector players who may be already playing significant roles or have the potential to do so.
- Development of a strong, comprehensive, long-term, national program as well as plan that is seen and marketed more as part of a national economic development program/plan than a rural development effort.
- The constitution of a strong marketing and fundraising team for the program.
- In the short to medium term the program/plan should carry out the following tasks:
    - Identification of existing productive activities across all sectors
    - Careful analyses of the production processes involved and identification of possible improvements and limitations.
    - Consideration of the contribution of electricity to these expected improvements and resources required.
    - Analysis of the technical and economic feasibility and the social viability of the ideas put forward as well as solutions proposed.
    - Development of market for produce beyond local area as part of any effective and sustainable improvement effort.

Affordability

The affordability of the electricity being provided for rural communities continues to plaque efforts at getting households and businesses to use the commodity in ways that ensure the translation of access into improved livelihoods and economic development. The low consumption rates pose a big challenge for continued investments in these communities by way of maintenance and other supply improvements. Our suggestion is for the

proposed PUE program to look at the issue of affordability not just from the pricing angle as the provision of government subsidies is unsustainable. Government's subsidy budget can instead be invested in paying a one-time connection charge and the implementation of energy efficiency and economic development policies and measures/programmes. This will ensure effective consumption and therefore save consumers money and increase their income levels so that they can afford what they consume.

Community involvement in metering, billing and payment recovery

As common in other jurisdictions/successful models, community involvement should not be limited to consultation alone but rather through innovative schemes, community dwellers can actively participate in metering, billing and payment recovery as well as reducing losses due to theft.

Sufficient long-term financing for effective system maintenance

It is in the interest of long-term viability of any PUE program that funds are set aside for maintenance of the local electricity system to ensure that quality of service and reliability levels in the electrified communities are satisfactory and serve as encouragement to investors and users who switch to electricity. Proper maintenance of the local networks will impact the efficiency of transmission and distribution and reduce losses as well as reduce the utilities' burden whilst they wait for the communities to become financially viable.

4. PROPOSED ELECTRIFICATION PROJECTS AND PACKAGES

4.1. Identification of Proposed Electrification Projects

A reconnaissance survey of all the un-electrified communities was embarked upon to identify the possible medium voltage source or connection point from which to build a sub-transmission network to supply the target eligible community. The survey was also to select line route, assess the distance from the medium voltage (MV) line connection point to the substation location/terminal point of the target community. It was generally found to be technically feasible to extend the medium voltage (MV) networks from the closest substation to each of the eligible communities.

4.2. Proposed Electrification Projects by Region and District

The NES Master Plan Review (2011-2020) has proposed two thousand five hundred and sixty three (2,563) electrification projects. Each project is defined to serve an identified town or community. These projects which are estimated to cost about seven hundred and twenty two million United States dollars (US $ 722 million) will together serve an estimated 2010 population of about 2.1 million people and the population served by these systems is projected to grow to 2.6 million by year 2020. The key as summarized on the table below.

Region	No of Towns	Estimated Pop.2010	Estimated Pop.2020	Cost Estimate (US$)
Ashanti	216	169,478	216,782	76,039,367
Brong-Ahafo	192	183,728	232,805	73,209,774
Central	177	135,603	173,503	61,751,131
Eastern	247	152,313	194,845	65,507,001
Greater Accra	11	8,709	11,143	2,473,815
Northern	655	374,379	478,918	129,432,158
Upper East	301	257,716	329,756	54,765,364
Upper West	298	246,307	315,147	48,307,701
Volta	171	139,856	178,939	52,322,409
Western	295	398,558	510,046	157,959,177
Grand Total	**2,563**	**2,066,647**	**2,641,884**	**721,767,896**

The breakdown of the projects by district and region is shown on the tables that follow.

Region / District	No of Towns	Estimated Pop.2010	Estimated Pop.2020	Cost Estimate (US$)
Ashanti				
Adansi North	3	1,635	2,072	818,696
Adansi South	21	16,650	21,095	7,665,735
Afigya-Kwabre new	0	0	0	0
Ahafo Ano North	9	6,919	8,767	2,788,243
Ahafo Ano South	36	32,473	41,143	10,008,588
Amansie Central	18	13,730	17,395	5,993,225
Amansie West	18	16,652	21,101	6,034,441
Asante Akim North I	14	8,592	10,883	7,182,920
Asante Akim South	13	7,413	9,390	3,613,773
Atwima Kwanwoma	0	0	0	0
Atwima Mponua	12	6,698	8,483	3,940,459
Atwima Nwabiagya	3	2,498	3,165	849,875
Bekwai Municipal	2	1,034	1,310	272,468
Bosome Freho	9	7,056	8,941	2,277,518
Bosomtwe	0	0	0	0
Ejisu-Juaben Munici	1	533	675	193,423
Ejura/Sekyedumase	14	8,111	10,275	4,772,478
Kumasi Metropolita	0	0	0	0
Kwabre East	0	0	0	0
Mampong Municipa	6	3,140	3,978	1,316,808
Obuasi Municipal	0	0	0	0
Offinso North	11	5,906	7,482	3,500,006
Offinso South Munic	3	1,818	2,303	961,598
Sekyere Afram Plain	4	7,882	9,989	4,052,503
Sekyere Central	16	17,351	21,986	8,982,906
Sekyere East	1	452	572	158,554
Sekyere South	2	1,281	1,623	655,150
Sub-Total for Ashan	216	169,478	216,782	76,039,367

Region / District	No of Towns	Estimated Pop.2010	Estimated Pop.2020	Cost Estimate (US$)
Brong Ahafo				
Asunafo North Mun	12	6,365	8,063	4,528,479
Asunafo South	10	6,408	8,119	3,564,043
Asutifi	5	4,217	5,342	1,721,266
Atebubu-Amantin	17	11,175	14,158	5,488,933
Berekum Municipal	0	0	0	0
Dormaa East	7	9,250	11,722	2,638,599
Dormaa Municipal	6	3,817	4,835	2,038,731
Jaman North	11	21,047	26,674	4,993,980
Jaman South	12	15,778	19,995	4,131,807
Kintampo North Mu	14	11,854	15,019	5,580,066
Kintampo South	27	28,951	36,687	9,793,779
Nkoranza North	2	1,068	1,353	995,890
Nkoranza South	11	8,214	10,406	4,292,978
Pru	17	27,294	34,589	7,364,914
Sene	10	6,815	8,634	4,485,675
Sunyani Municipal	1	1,767	2,239	418,429
Sunyani West	0	0	0	0
Tain	8	5,973	7,569	4,247,168
Tano North	3	1,812	2,295	950,939
Tano South	0	0	0	0
Techiman Municipal	10	5,865	7,430	3,116,238
Wenchi Municipal	9	6,058	7,676	2,857,860
Sub-Total for Brong	192	183,728	232,805	73,209,774

Region / District	No of Towns	Estimated Pop.2010	Estimated Pop.2020	Cost Estimate (US$)
Central				
Abura/Asebu/Kwam	1	413	523	266,327
Agona East	13	8,239	10,437	4,403,749
Agona West Municip	7	5,974	7,568	3,786,337
Ajumako/Enyan/Ess	16	10,387	13,160	3,491,600
Asikuma/Odoben/B	17	12,284	15,562	6,553,487
Assin North Municip	26	24,608	31,178	10,613,768
Assin South	15	12,463	15,793	6,911,478
Awutu-Senya	22	15,916	20,165	4,737,315
Cape Coast Metropo	0	0	0	0
Effutu Municipal	0	0	0	0
Gomoa East	8	4,900	6,206	2,152,742
Gomoa West	3	2,629	3,332	854,956
Komenda/Edina/Egu	3	1,745	2,210	902,420
Mfantsiman Municip	1	405	513	74,581
Twifo/Heman/Lowe	19	13,199	16,721	6,955,709
Upper Denkyira East	19	16,206	20,533	8,749,038
Upper Denkyira Wes	7	4,917	6,228	1,297,621
Sub-Total for Centra	177	135,603	173,503	61,751,131

Region / District	No of Towns	Estimated Pop.2010	Estimated Pop.2020	Cost Estimate (US$)
Eastern				
Akuapim North	3	1,691	2,143	717,765
Akuapim South Mur	14	7,302	9,248	2,889,425
Akyemansa	5	2,606	3,301	1,151,835
Asuogyaman	4	2,631	3,332	667,207
Atiwa	17	8,965	11,356	6,800,939
Birim Central Munic	14	9,539	12,085	3,778,959
Birim North	4	2,175	2,755	1,182,223
Birim South	3	1,691	2,142	917,175
East Akim Municipal	3	2,862	3,627	1,231,053
Fanteakwa	29	18,499	23,438	7,387,089
Kwaebibirem	10	6,826	8,649	2,256,790
Kwahu East	19	14,454	18,312	6,672,061
Kwahu North	0	0	0	0
Kwahu South	7	4,264	5,402	2,776,262
Kwahu West Munici	3	1,965	2,490	633,565
Lower Manya Krobo	7	3,985	5,047	2,235,359
New-Juaben Munici	4	2,422	3,068	760,475
Suhum/Kraboa/Coal	22	13,825	17,512	5,425,548
Upper Manya Krobo	40	23,274	29,486	10,135,602
West Akim Municipa	8	4,683	5,932	1,527,835
Yilo Krobo	31	17,185	21,767	6,359,834
Sub-Total for Easter	247	152,313	194,845	65,507,001

Region / District	No of Towns	Estimated Pop.2010	Estimated Pop.2020	Cost Estimate (US$)
Greater Accra				
Accra Metropolitan	0	0	0	0
Adenta Municipal	0	0	0	0
Ashaiman municipal	1	1,015	1,286	345,877
Dangme East	7	5,445	6,900	1,399,642
Dangme West	2	1,279	1,621	405,070
Ga East Municipal	0	0	0	0
Ga South Municipal	1	886	1,123	323,225
Ga West Municipal	0	0	0	0
Ledzokuku-Krowor M	0	0	0	0
Tema Metropolitan	0	0	0	0
Sub-Total for Great	11	8,709	11,143	2,473,815

Region / District	No of Towns	Estimated Pop.2010	Estimated Pop.2020	Cost Estimate (US$)
Northern				
Bunkrugu Yunyoo	49	40,421	51,718	4,923,080
East Mamprusi	41	38,767	49,606	6,832,638
Tolon kumbungu	68	50,836	65,044	6,494,470
Tamale	23	15,893	20,334	2,843,848
Bole	12	4,624	5,913	5,476,797
Savelugu	29	10,406	13,305	4,878,133
Central Gonja	19	10,730	13,726	8,662,721
Sawla Tuna Kalba	24	10,207	13,053	6,533,923
West Mamprusi	53	60,122	76,933	9,534,804
Gonja West	45	23,564	30,142	9,822,364
Kpandai	33	14,605	18,677	7,218,123
Gonja East	40	18,091	23,142	9,563,780
Karaga	21	7,095	9,073	7,130,862
Gushiegu	39	14,194	18,150	7,762,024
Nanumba South	13	4,280	5,474	3,674,414
Saboba	19	6,037	7,718	4,511,376
Nanumba North	25	7,973	10,196	4,084,621
Chereponi	30	9,555	12,215	4,691,347
Yendi	38	13,605	17,400	7,319,184
Zabzugu	34	13,374	17,099	7,473,648
Sub-Total for North	655	374,379	478,918	129,432,158

Region / District	No of Towns	Estimated Pop.2010	Estimated Pop.2020	Cost Estimate (US$)
Upper East				
Bawku Municipal	0	0	0	0
Bawku West	41	26,303	33,327	7,220,029
Bolgatanga Municip	23	18,417	23,333	3,245,444
Bongo	31	38,452	48,726	7,121,169
Builsa	42	28,711	36,373	8,166,369
Garu-Tempane	64	56,127	71,116	11,226,810
Kassena Nankana Ea	12	9,987	12,652	1,911,478
Kassena Nankana W	37	31,004	39,286	6,358,305
Talensi-Nabdam	51	46,690	59,160	9,515,761
Sub-Total for Upper	301	257,716	329,756	54,765,364

Region / District	No of Towns	Estimated Pop.2010	Estimated Pop.2020	Cost Estimate (US$)
Upper West				
Jirapa	30	22,399	28,657	3,598,970
Nadowli	44	45,660	58,427	6,156,203
Wa East	43	41,700	53,360	7,776,516
Sissla East	15	18,385	23,527	9,511,319
Wa Municipal	9	8,888	11,374	2,470,136
Sissla West	21	16,393	20,974	5,535,763
Wa West	62	44,793	57,306	6,373,578
Lawra	45	28,868	36,932	3,525,986
Lambussie-Karni	29	19,221	24,590	3,359,230
Sub-Total for Upper West	298	246,307	315,147	48,307,701

Region / District	No of Towns	Estimated Pop.2010	Estimated Pop.2020	Cost Estimate (US$)
Volta				
Adaklu-Anyigbe	5	3,089	3,913	1,068,916
Akatsi	1	537	680	239,137
Biakoye	9	5,463	6,920	2,791,001
Ho Municipal	3	2,404	3,046	1,022,667
Hohoe Municipal	3	1,427	1,807	851,966
Jasikan	4	1,927	2,441	1,198,662
Kadjebi	6	3,961	5,018	1,759,493
Keta Municipal	16	12,034	15,246	4,158,940
Ketu North	0	0	0	0
Ketu South	21	12,455	15,777	4,441,620
Kpando	2	1,241	1,572	573,810
Krachi East	1	1,039	1,330	232,711
Krachi West	2	1,790	2,290	670,009
Nkwanta North	19	24,990	31,669	8,659,207
Nkwanta South	37	41,024	51,984	14,479,410
North Tongu	33	20,044	25,392	7,055,565
South Dayi	3	2,078	2,633	2,028,206
South Tongu	6	3,026	3,832	1,091,087
Sub-Total for Volta	171	139,856	178,939	52,322,409

Western				
Ahanta West	0	0	0	0
Aowin/Suaman	40	49,345	62,531	22,895,087
Bia	34	51,881	65,749	28,721,898
Bibiani/Anhwiaso/B	0	0	0	0
Ellembele	9	10,159	12,874	11,161,021
Jomoro	18	24,422	30,950	4,374,612
Juaboso	34	46,650	59,119	12,144,726
Mpohor/Wassa East	26	26,863	34,040	12,052,930
Nzema East Municip	25	32,733	41,484	13,042,206
Prestea-Huni Valley	18	23,870	30,250	9,436,901
Sefwi Akontombra	28	34,739	44,022	9,133,253
Sefwi-Wiawso	5	8,456	10,717	2,310,093
Sekondi Takoradi M	0	0	0	0
Shama	4	8,973	11,374	1,721,070
Tarkwa Nsuaem Mu	6	15,483	19,625	2,756,685
Wasa Amenfi East	28	35,266	44,690	16,168,864
Wasa Amenfi West	20	25,844	32,750	12,039,831
Sub-Total for Weste	295	398,558	510,046	157,959,177

4.3. Technical Standards

In order to develop a distribution system that is unified and consistent throughout the country, even when it is constructed in different stages/programmes and by different organizations, it is imperative that common standards for design and construction be established, kept current and consistently applied during implementation of SHEP.

Each individual SHEP project under NES should necessarily pass through all the steps in electrification project implementation, namely; project identification, field survey & compilation of maps, design layout of MV and LV lines, detail cost estimate, etc. for successful early completion of the project.

4.4. Standard Sizes and Sources of Low Voltage Poles in Ghana

Wood pole construction has been specified for all distribution lines for the remaining NES Master Plan Review (2011-2020) electrification development. The table below indicates the specification for Ghanaian Teak (Tectona Grandis) Poles

Dimension of Tectona Grandis Poles

(Based on a Fibre Stress of 72.5 N/mm²)

Class		1	2	3	4	5	6	7
Minimum Circumference at top (mm)		685	635	585	535	485	435	380
Length of Pole (m)	Groundline Distance from Butt * (m)	Minimum Circumference at 1.8 m from Butt (mm)						
8	1.5	790	740	690	640	590	545	505
9	1.5	835	780	725	675	620	575	530
10	1.8	870	820	760	710	655	605	560
11	1.8	910	850	795	740	680	630	585
12	1.8	940	885	825	765	705	655	605
13	2.0	975	915	850	850	730	675	625

* The figures in this column are intended for use only when a definition of ground-line is necessary in order to apply requirements relating to scars, straightness, etc.

4.5. Electrification Project Implementation Schedule with timeframes

The National Electrification Scheme (NES) Master Plan (1990-2020) outlined an implementation plan made up of six five- year phases spanning the 30-year period. The proposed electrification projects from this review have been defined for the two 5-year phases (ie Phase 5: 2011-2015 and Phase 6: 2016-2020) on district and regional bases using the principle that the implementation of these electrification projects will be pursued in a reasonably balanced fashion in all districts and regions in each of the 5th and 6th phases.

5. PROVISIONAL ENGINEERING SURVEY AND COST ESTIMATE.

5.1. Provisional Engineering Survey

A reconnaissance survey of all the un-electrified communities was embarked upon to select line route, distance from the nearest medium voltage (MV) line connection point, substation location/terminal point to prepare the material quantity estimates. It was generally found to be technically feasible to extend the medium voltage (MV) networks from the closest substation to the selected communities.

The provisional cost estimates were derived from quantity estimates for the required medium voltage (MV) line, substations and low voltage (LV) networks including services for all un-electrified communities by district and region. Unit costs of the main items of the distribution system were obtained from similar works recently procured in Ghana.

5.2. Load Forecast

A key component of the economic assessment of electrification is the expected electricity demand in previously un-served communities. The load forecast provides the basis for evaluating the costs of electrification. In this Master Plan Review (2011-2020) the electricity load for a community is defined as the sum of individual customers' energy demand plus energy demand for point loads, namely non-residential loads (schools, retail shops, drinking spots and water pumping, etc) which are assumed to be 20% of aggregate demand of the community.

The main characteristics which influence electricity demand in a newly electrified community are as follows:

- Demographic characteristics: The absolute size of the market ultimately dictates electricity demand
- Socio-economic characteristics: Besides the major role played by income in electricity demand, the rate at which electricity is taken up in the new project area will affect the pattern of load growth. Both the initial and ultimate penetration rates will depend on the socio-economic characteristics of a particular community.
- Prices: Two types of prices will influence electricity demand; the price of electric energy and its substitute and the price of capital goods which utilize energy.

The Load forecast for each community was built from assumptions about initial and ultimate (end–of-10years) market penetration rates for households and commercial establishments, and the typical electricity demand per customer.

The following rates were assumed:

- Average maximum demand per household: 0.6kVa
- Load factor: 35%
- Energy demand growth rate for the ten-year period : 5%
- Ultimate (end-of -10 year) market penetration: 75% of total households.
- Number of three phase customers; 15% of total number of prospective customers in the community.
- Number of single phase customers: 85% of total number of prospective customers in the community.
- Proportion of single phase customer services that are distant: 5%.

5.3. Cost Estimation

The estimation of the costs of proposed projects was based on applying typical unit costs for identified items of work to the quantities determined from the field survey. The scope of work assumed to be part of each of the fourteen (14) different items of work is explained below and the rates applied are shown in the following table. The work items made up of:

Item 1: Cost of 33kV medium voltage lines to connect transformers in beneficiary communities to the sub-transmission system. They include the cost of 120mm2 overhead Aluminum conductor, 10m or 11m wood pole, pole top hardware and accessories. They also include the cost of Air Break isolators (ABI) on new lines and tee-offs.

Item 2: Cost of 11kV medium voltage lines to connect transformers in beneficiary communities to the sub-transmission system. They include the cost of 120mm2 overhead Aluminum conductor, 10m or 11m wood pole, pole top hardware and accessories. They also include the cost of Air Break isolators (ABI) on new lines and tee-offs.

Item 3: Cost of pole mounted distribution transformer substation complete. They include the cost of 33/0.4kV, 200KVA transformer, 33kV drop-out fuse-gear and fuse elements, transformer platforms, 33kV lightning arrestors, LV fuse-gear and HRC fuses, LV cables and accessories.

Item 4: Cost of pole mounted distribution transformer substation complete. They include the cost of 33/0.4kV, 100KVA transformer, 33kV drop-out fuse-gear and fuse elements, transformer platforms, 33kV lightning arrestors, LV fuse-gear and HRC fuses, LV cables and accessories.

Item 5: Cost of pole mounted distribution transformer substation complete. They include the cost of 33/0.4kV, 50KVA transformer, 33kV drop-out fuse-gear and fuse elements, transformer platforms, 33kV lightning arrestors, LV fuse-gear and HRC fuses, LV cables and accessories.

Item 6: Cost of pole mounted distribution transformer substation complete. They include the cost of 11/0.4kV, 200KVA transformer, 11kV drop-out fuse-gear and fuse elements, transformer platforms, 11kV lightning arrestors, LV fuse-gear and HRC fuses, LV cables and accessories.

Item 7: Cost of pole mounted distribution transformer substation complete. It includes the cost of 11/0.4kV, 100KVA transformer, 11kV drop-out fuse-gear and fuse elements, transformer platforms, 11kV lightning arrestors, LV fuse-gear and HRC fuses, LV cables and accessories.

Item 8: Cost of pole mounted distribution transformer substation complete. It includes the cost of 11/0.4kV, 50KVA transformer, 11kV drop-out fuse-gear and fuse elements, transformer platforms, 11kV lightning arrestors, LV fuse-gear and HRC fuses, LV cables and accessories.

Item 9: Cost of LV system (three phase four wire). It includes the cost of 9m or 8m wood pole, 120mm2 Aluminum conductor, associated pole top hardware and accessories.

Item 10: Cost of LV system (single phase three wire). It includes 9m or 8m wood pole, 50mm2 Aluminum conductor, associated pole top hardware and accessories

Item 11: Cost of LV system (single phase two wire). It includes 9m or 8m wood pole, 50mm2 Aluminum conductor, associated pole top hardware and accessories

Item 12: Cost of customer services (three phase). It includes three phase energy meter, associated fuse cut-outs and 25mm2 Al aerial conductor and accessories.

Item 13: Cost of customer services (single phase). It includes single phase energy meter, associated fuse cut-outs and 16mm2 Al aerial conductor and accessories.

Item 14: Cost of customer service (single phase) with service pole. It includes single phase energy meter, 7m service pole, associated fuse cut-outs and aerial conductor.

5.4. Sources of Rates

The unit costs of the distribution system were CIF (Materials +Transport & Installation) prices obtained from similar works procured recently. The table below provides the derivation of the unit rates applied for project cost estimation.

Unit Rates for Project Cost Estimation					
Cost Item	Rates Applied	Sources & derivation of Rates			
		Eltel US$	China Water US$	GEDAP (US$)	Average Rate
33Kv Wood Pole Line/km	**26,222 /km**	42,781	20,827	15,058	26,222
11KV wood Pole line/km	**24,690 /km**	40,623	19,450	13,996	24,690
200KVA Trafo/Unit(33kv)	**16,253**	18,477	15,879	14,403	16,253
100KVA Trafo/Unit(33kv)	**13,815**	15,172	13,875	12,399	13,815
50KVA Trafo/Unit(33kv)	**11,851**	13,431	11,799	10,323	11,851
200KVA Trafo/Unit (11kv)	**13,344**	16,937	12,218	10,876	13,344
100KVA Trafo/Unit(11kv)	**11,529**	14,192	10,856	9,540	11,529
50KVA Trafo/Unit(11kv)	**10,243**	12,591	9,727	8,411	10,243
3-phase 4-wire LV Line/km	**16,597 /km**	16,678	18,056	15,057	16,597
1-phase 3-wire LV Line/km	**14,869 /km**	14,927	15,867	13,812	14,869
1-phase 2-wire LV Line/km	**12,958 /km**	13,175	12,839	12,858	12,958
3-phase Cust Service/Unit	**531**	665	591	338	531
1-phase Customer Service/Unit	**275**	335	265	226	275
1-phase Customer Service with 7m pole/Unit	**594**	-	653	536	594

In addition to the base cost derived from the above rates, a 10% price contingency was applied to cater for price fluctuations. Furthermore a physical contingency of 10% was included in the total cost since the unit cost was based on conceptual design of the distribution system. Engineering cost (detailed survey and design) was estimated at 10% while Construction Supervision cost (supervision and management of the construction phase) was estimated at 20%

It should be understood that the provisional cost estimates derived in this report are based on a conceptual design and are therefore only indicative. Accordingly, they will require revision upon completion of detailed designs. However, the overall actual cost for these projects is not expected to be significantly different from the estimate presented. This is because although the assessed individual project costing for specific towns may, after detailed design, vary significantly from the provisional estimates in this report, the variations are expected to offset each other. Thus the overall cost estimates for the projects are not expected to be significantly different from the estimate presented here.

Thus the overall provisional cost of the distribution system was estimated to cost US $ 722 million.

5.5. Project Packages

The proposed electrification projects have been grouped into packages by considering the geographic location of the various electrification projects and the administrative boundaries of the two implementing utilities. The grouping into packages has also considered technical efficiency, cost effectiveness of

implementation and expeditious execution of the electrification projects and by district and region. Volumes 3 – 12 of this report provide for each region the detailed material and cost estimates for each project in the region sorted by district.

It should be noted that the provisional cost estimates provided in this report are based on a conceptual design, and therefore will require revisions upon completion of detailed design. Although the final costing after the detailed design for the individual project packages and specific towns may vary significantly from these provisional estimates, the variations are expected to offset each other. Thus the final cost estimates for the projects overall are not expected to be significantly different from the estimate presented here.

5.6. Transmission and Sub-transmission Upgrade Costs

As a result of the incremental power demand of the newly connected communities, a number of new sub-transmission lines as well as upgrades of existing transmission and sub-transmission lines may be required to meet the load growth during the ten year period (2011-2020). In the cases where an upgrade is not directly attributable to the proposed projects, it is certain that the additional burdens imposed on the transmission and sub-transmission systems would advance the timing for their subsequent capacity enhancements. Accordingly, the additional cost implication of the proposed projects arising from consequential transmission and sub-transmission capacity upgrades has been estimated by applying typical unit rates for such upgrades to the projected demand. The estimated upgrade costs are shown on the attached tables.

Region	Estimated Max.Demand KVA (2020)	Additional Traformer Capacity Cost (US$)x1000	Primary Source Substations (69kV,33kV & 11kV)	Bulk Supply Points (BSPs) (161/33/11kV)
Ashanti	16,839	420,975	1.Kumasi,183MVA	1.Kumasi,183MVA
			2. Obuasi, 45MVA	2. Obuasi, 45MVA
			3. Mim, 34.5kV	3.Sunyani, 53MVA
			4.Konongo, 5MVA	4.Konongo, 5MVA
			5. Techiman, 20MVA	5. Techiman, 20MVA
Brong Ahafo	18,431	460,775	1. Mim, 34.5kV	1. Sunyani, 53MVA
			2. Wenchi, 3MVA	2. Techiman, 20MVA
			3. Berekum, 10MVA	
Central	16,516	412,895	1. Cape Coast, 10MVA	1. Cape Coast, 35MVA
			2. Winneba, 15MVA	2.Winneba, 15MVA
			3.Takuse, 10MVA	3. Mallam, 100MVA
			4. Akim Oda, 10MVA	4.Akwatia, 30MVA
Eastern	16,596	414,900	1. Koforidua, 20MVA	1. Tafo, 20MVA
			2. Akim Oda, 10MVA	2.Akwatia, 30MVA
				3. Nkawkaw, 13.3MVA
Gt. Accra	837	20,925	1. Tema,40MVA	1.Tema, 215MVA
			2. Weija, 10MVA	2.Mallam, 100MVA
			3. Ashiaman, 40MVA	
Northern	19,200	480,000	1. Tamale, 40MVA	1. Tamale, 40MVA
			2. Yendi, 13.3MVA	2. Yendi, 13.3MVA
Upper East	14,797	369,915	1. Bolgatanga, 20MVA	1. Bolgatanga, 20MVA
			2. Zebila, 13.3MVA	2. Zebila, 13.3MVA
			3. Navrongo, 2MVA	
			4. Bawku, 3MVA	
Upper West	16,411	410,265	1. Sawla, 13.3MVA	1. Sawla, 13.3MVA
			2. Wa, 5MVA	
Volta	16,516	349,845	1. Sogakope, 15MVA	1. Asiekpe, 50MVA
			2. Ho, 10MVA	2. Yendi, 13.3MVA
			3. Kpando, 15MVA	
			4. Yendi, 13.3MVA	
Western	28,012	700,305	1. Asawinso, 50MVA	1. Asawinso, 50MVA
			2. Bogosso, 25MVA	2. Bogosso, 25MVA
			3. Tarkwa,75MVA	3. Tarkwa,75MVA
			4. Esiama, 25MVA	4. Esiama, 25MVA
			5.Sekondi, 50MVA	5.Sekondi, 50MVA
Total	**164,154**	**$ 4,040,800**		

6. ELECTRIFICATION DATABASE

6.1. Software Tools for Electrification database.

The consultant has created an electrification database using Microsoft Access as the database engine and developed an interface application using Windows Visual Studio 2010, Visual basic.Net. Given the anticipated small to medium size of the data to be held, Microsoft Access was considered to be most suitable for this application. This software was also chosen because runtime applications based upon it would not require the user to acquire a software license. The Windows Visual Studio 2010 software was selected for the development of the NES database application because; it's widely used in the development of customized windows applications and also has a wide user support group which makes future updates of the database sustainable. Considering that the electrification database need to be modified in future, the choice of a platform which was being continually supported was very important hence the choice of using Microsoft windows Visual basic.net for the development of this application.

6.2. Data Sources

The information used for the database was obtained from varied sources which included; the Consultant, the Ministry of Energy (MoE), the Ghana Survey Department (GSD), Statistical Services (GSS).

The list of Communities with their 2000 population and 2010 projections were received from the MoE but all the community and electrification project information was primary information which was collected and processed by the Consultant. All the locations of the Un- electrified communities were obtained from the field using handheld GPS. The base maps which were used for the districts maps were obtained from the "Ghana-Country at a Glance" dataset.

6.3. Volume of Data

In all, a total of two thousand seven hundred and eleven (2,711) records of un-electrified communities with projected population above 500 by 2020 based on the 2000 National population census have been stored in the database. In addition one hundred and seventy (170) maps of electrified and un-electrified communities for all the districts in Ghana are also stored in the database and can be retrieved from the database software. Each record (for un-electrified community) in the database has the capability to hold the following data:

- Population (2000, 2010 , 2020)
- GPS coordinates (UTM Zone 30N and 30S in Meters)
- Economic Activities (Farming subsistence & commercial, Fishing etc.)

- Educational Institutions(Nursery, Primary, JHS, SHS, Vocational)
- Energy Options (Solar, Biomass, Wind)
- Utilities (Water, Electricity, telecom)
- Health facilities (Clinic and Hospital)
- Electrification project information

6.4. Database Usage.

The developed database application can be used to access information on communities, districts and region of the status of their electricity connectivity and other related information such as; Distance from connection point (km), MV Line Type (33KV/11KV), MV Line Pole, GPS Location, technical challenges, Road Accessibility, Educational and Health facilities etc. Based on this information which is stored, a community can be selected or grouped according to a set of criteria.

The database is designed to be utilized by several classes of users seeking responses to sets of queries, some of which have been the anticipated as indicated below:

For Policy Makers and Planners

How many communities in the district do not have electricity supply?
What is the population in the Region or District that is not served?
What is the distance from supply source town to un-electrified community?
What are the challenges to supplying a particular un-electrified community?
What is the population of the community or district? (Gender disaggregated)
What are the economic activities in the community and the district?

For the Ministry of Energy and Contractors

What is the challenge to supply an un-electrified community?
What is the estimated cost to supply.
What is the source town or take-off point for supply to a community?
What is the line voltage and type
What are the MV and LV distances to the un-electrified community
What are the transformer capacities and quantities?

For Investors and Project Developers

What is the expected timeframe for supply connection to a community
What is the supply voltage level in the District and community
What is the supply capacity in the District and community?
What is the grace period (capacity of the substation for next capacity upgrade)

For Consultants and Researchers

What are the line routing options
What is the demographic profile of the community?
What are the energy uses – Economic profile and activities
What is the expected energy demand

What is the supply timeframe?

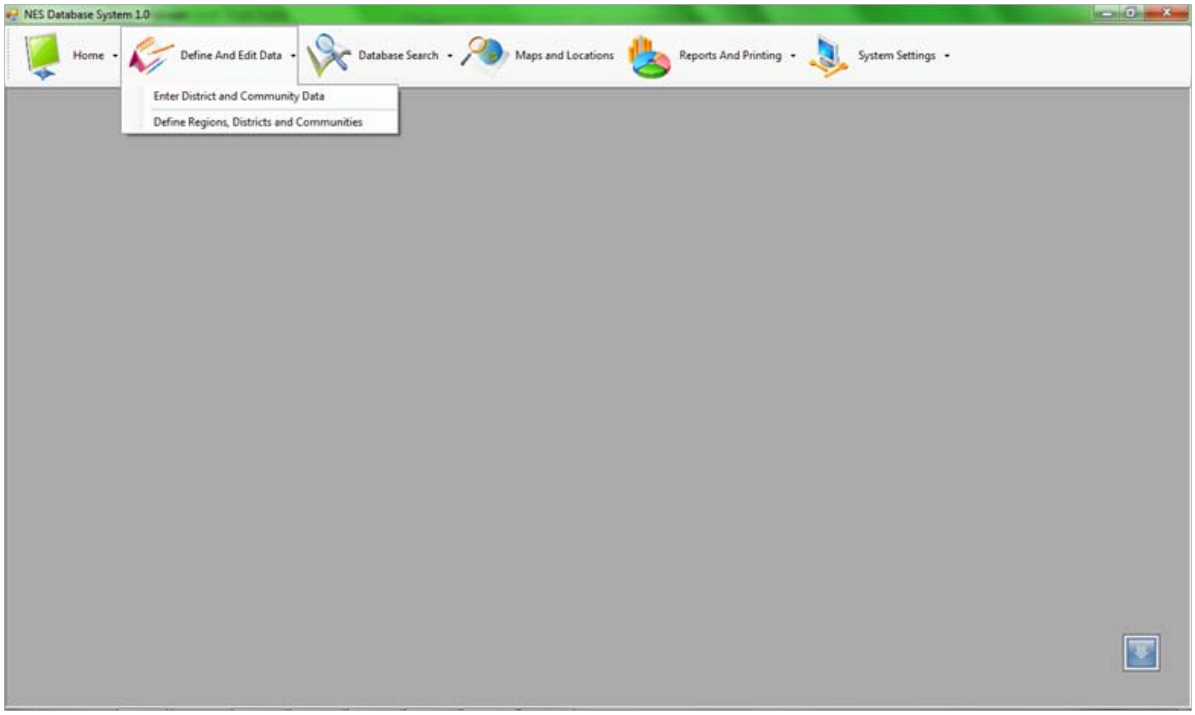
An operations manual containing Screen prints of all the different modules and tabs of the database with detailed description of what can be can done with each module of the application has been prepared. This manual also shows how to update and input new information into the database. The software will be installed on the client's computer. Electronic copies of the database software will also be provided on DVDs which will have both the software and a soft copy of the Manual or user guide.

6.5. Development and Features of Database Software

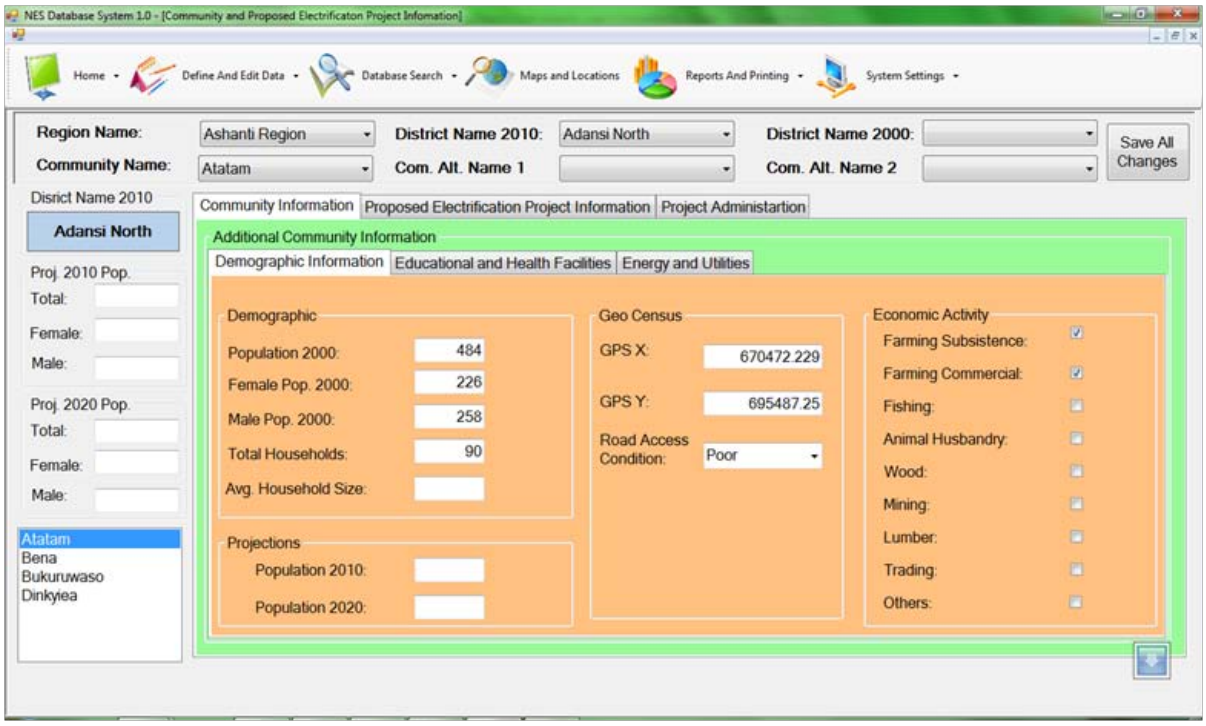
The consultant commenced the development of an electrification database with the creation of a database structure for the electrified and un-electrified communities that included the following contents:

- Status of services (eg. Good, Fair, Poor) to communities
- Electrified communities in the District
- Number of households
- Percentage of population served (ie. coverage)
- Population (Gender and children disaggregated)
- Economic activity of the community
- Electricity supply source towns
- Distance of communities from source towns

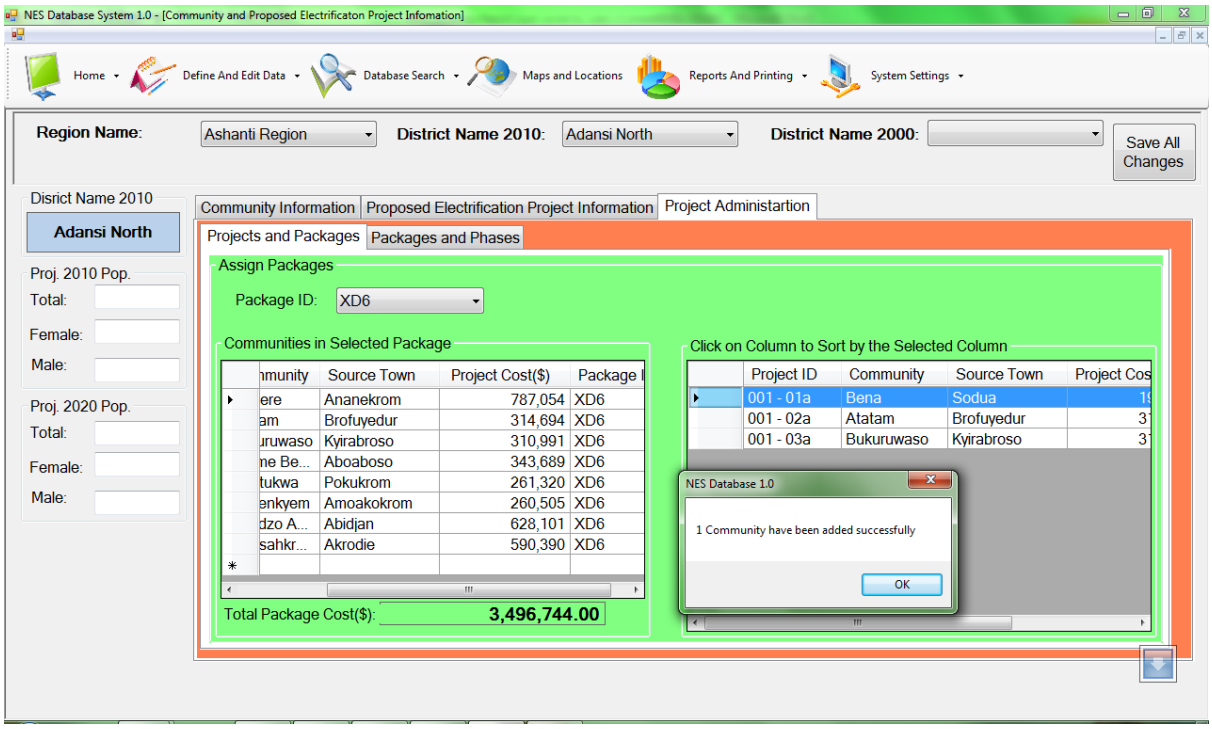
The development of the database continued with the creation of a windows-based user interface. The screens were developed in such a way that the queries and input parameters can be extended in future by the Client after some training. The interface that has been developed has six main menu choices at the top level. These are: Home; Define and Edit Data; Database Search; Maps and Locations; Reports and Printing; and, Setting. The drop down sub-menus that are pulled down from the top level give easy, direct and intuitive access to all the features of the software. The basic level for data storage is the community. All stored data are related to a particular community. A prominent feature of the interface is the consistent use of the same drill down arrangement in managing the input and extraction of information. A sample screen showing the drop-down submenu for Define and Edit Data is shown below.



The screen shot below is of the *Input Screen* from where data editing or entry of all new data will take place.



The interface also allows the user to easily administration of proposed electrification projects as well as their assignment to specific packages and phases. The screen shot below illustrates this project administration feature.

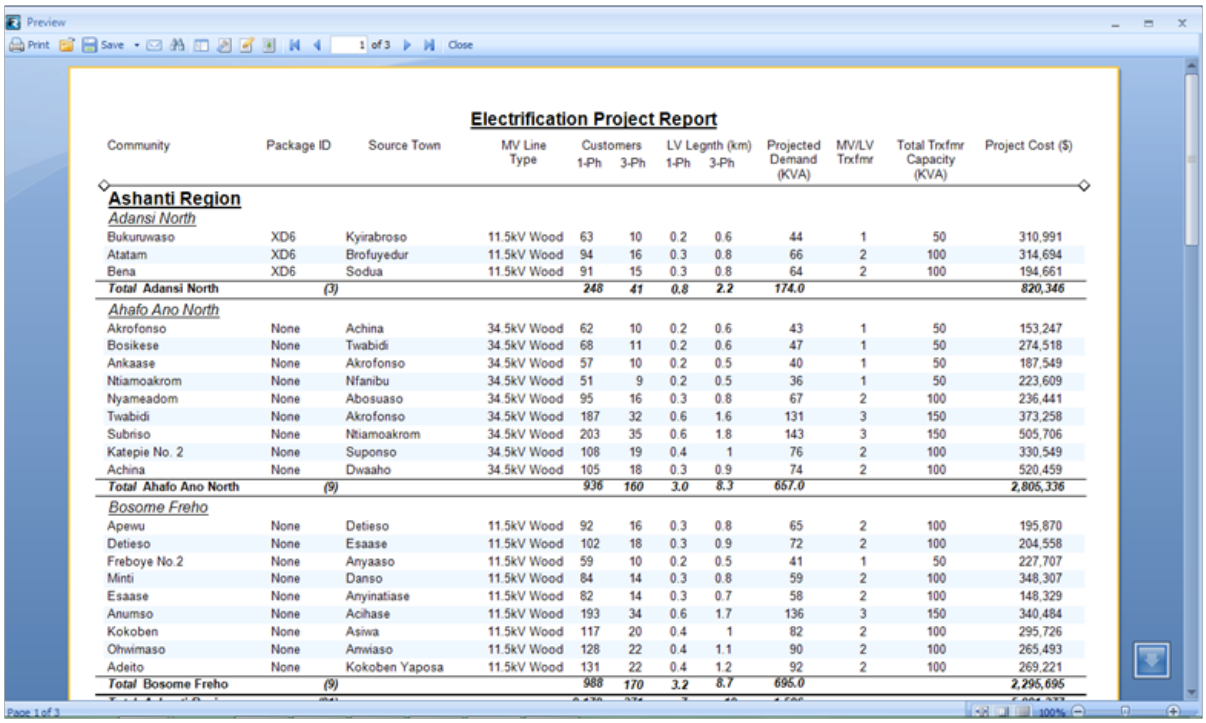


The database interface that has been developed also allows the easy creation of reports to extract information relating to the electrification projects from the database. The interface also gives maximum flexibility to the user to define the contents and structure of database reports. The report interface is interactive so the user can print only the information which is required.

There are however a few important and typical reports which have been pre-designed and incorporated as standard reports. These reports are grouped under the following:

- Electrification projects by regions. This report allows one to print the electrification data stored in the system grouped by regions. The user can select the region(s) of interest to be printed.
- Electrification projects by Districts. This report allows one to print the electrification data stored in the system grouped by regions and districts. The region(s) and district(s) of interested can be selected and printed.
- Electrification projects by Packages. Using this report the user can print the electrification data stored in the system grouped by project packages, then by districts and finally by regions. The user has to select the region(s) followed by the Project package(s) that is of interest to be printed.
- Infrastructure Report By Region. This report allows one to print the infrastructure report by selecting the region(s) of interest
- The infrastructure Report By District. This report allows one to print the infrastructure report by selecting the district(s) of interest. This is achieved by first selecting the region(s) followed by the district(s).

The Electrification Project Report shown below is one example of the pre-designed reports.



Electrification Project Report

Community	Package ID	Source Town	MV Line Type	Customers 1-Ph	Customers 3-Ph	LV Legnth (km) 1-Ph	LV Legnth (km) 3-Ph	Projected Demand (KVA)	MV/LV Trxfmr	Total Trxfmr Capacity (KVA)	Project Cost ($)
Ashanti Region											
Adansi North											
Bukuruwaso	XD6	Kyirabroso	11.5kV Wood	63	10	0.2	0.6	44	1	50	310,991
Atatam	XD6	Brofuyedur	11.5kV Wood	94	16	0.3	0.8	66	2	100	314,694
Bena	XD6	Sodua	11.5kV Wood	91	15	0.3	0.8	64	2	100	194,661
Total Adansi North		*(3)*		*248*	*41*	*0.8*	*2.2*	*174.0*			*820,346*
Ahafo Ano North											
Akrofonso	None	Achina	34.5kV Wood	62	10	0.2	0.6	43	1	50	153,247
Bosikese	None	Twabidi	34.5kV Wood	68	11	0.2	0.6	47	1	50	274,518
Ankaase	None	Akrofonso	34.5kV Wood	57	10	0.2	0.5	40	1	50	187,549
Ntiamoakrom	None	Nfanibu	34.5kV Wood	51	9	0.2	0.5	36	1	50	223,609
Nyameadom	None	Abosuaso	34.5kV Wood	95	16	0.3	0.8	67	2	100	236,441
Twabidi	None	Akrofonso	34.5kV Wood	187	32	0.6	1.6	131	3	150	373,258
Subriso	None	Ntiamoakrom	34.5kV Wood	203	35	0.6	1.8	143	3	150	505,706
Katepie No. 2	None	Suponso	34.5kV Wood	108	19	0.4	1	76	2	100	330,549
Achina	None	Dwaaho	34.5kV Wood	105	18	0.3	0.9	74	2	100	520,459
Total Ahafo Ano North		*(9)*		*936*	*160*	*3.0*	*8.3*	*657.0*			*2,805,336*
Bosome Freho											
Apewu	None	Detieso	11.5kV Wood	92	16	0.3	0.8	65	2	100	195,870
Detieso	None	Esaase	11.5kV Wood	102	18	0.3	0.9	72	2	100	204,558
Freboye No.2	None	Anyaaso	11.5kV Wood	59	10	0.2	0.5	41	1	50	227,707
Minti	None	Danso	11.5kV Wood	84	14	0.3	0.8	59	2	100	348,307
Esaase	None	Anyinatiase	11.5kV Wood	82	14	0.3	0.7	58	2	100	148,329
Anumso	None	Acihase	11.5kV Wood	193	34	0.6	1.7	136	3	150	340,484
Kokoben	None	Asiwa	11.5kV Wood	117	20	0.4	1	82	2	100	295,726
Ohwimaso	None	Anwiaso	11.5kV Wood	128	22	0.4	1.1	90	2	100	265,493
Adeito	None	Kokoben Yaposa	11.5kV Wood	131	22	0.4	1.2	92	2	100	269,221
Total Bosome Freho		*(9)*		*988*	*170*	*3.2*	*8.7*	*695.0*			*2,295,695*

7. GIS-BASED ELECTRIFICATION MAPS (E-MAPS)

It was one of the goals of this assignment to prepare maps that will give an overall picture of the communities with a population of 500+ by the year 2020 in Ghana and give a clear picture of the electrification status (electrified, committed or un-electrified) of each of the communities mapped.

7.1. Software Choice and Rationale.

The base maps and shape files were created using the ARCGIS software. For simple editing of the shapefiles an open source software (MapWindow) can be used. However the open source software has some limitations. ArcGIS has more functionalities hence was used to create all the shape files and also produce the e-maps. However due to anticipated cost for maintenance and renewal of licenses for ArcGIS9.3 MapWindow could be used. MapWindow is an open source software which could be used for further development/editing of the shapes files and for the production of e-maps. MapWindow is supported by the Geospatial Software Lab of the Idaho State University in the United States of America and has a very wide user community who contribute to the periodic updating of the software and also offer support to solve problems that may be encountered at its' user forums.

7.2. Preparation of e-maps:

The maps were created following the procedure outlined below.

7.2 (a) Spatial data Capture/Acquisition

Base maps were obtained from the Survey department of Ghana and the "Ghana-Country at a Glance" dataset. This included the following:

- Regional and District boundaries
- Road network
- Railroads network
- Forest Reserves
- Rivers and other water bodies
- Towns
- 103 Tiles of the 1:50000 Ghana Topo maps

Due to the unavailability of comprehensive base maps, the GPS coordinates of all the un-electrified communities with projected population above 500 by 2020 were taken on the field with a hand-held GPS device. This was necessary due to the fact that all accessible un-electrified community had to be captured. During the field visits other data about the communities were collected and used as attributes of the community which have been listed under section 1. Due to the same problem, a comprehensive town's map had to be created from the topographical maps.

7.2 (b) Spatial data Editing and Projections

Geoprocessing operations (Merging, Selecting, clipping, splitting, dissolving etc of features) were carried out on the base maps to produce the district maps.

The shape files were created using the WGS1984 UTM Zone 30N and 30S.

7.3. Features of the Maps Created

District electrification maps have been created to show electrified and un-electrified communities. These maps also depict electricity connection status and important landmarks like roads, reserves, railroads, clinics and rivers have been created. The maps created for the districts in Ghana were then aggregated to the regional and national levels. This aggregation was particularly useful for minimizing situations where districts with similar community names are mixed up when joining the database to the map.

The consultant has successfully created GIS-based electrification maps for all the one hundred and seventy (170) administrative districts in Ghana from GPS data obtained from the field and base maps developed from spatial data captured from a variety of sources. The District NES Map for Ahafo-Ano South is shown overleaf as a sample.

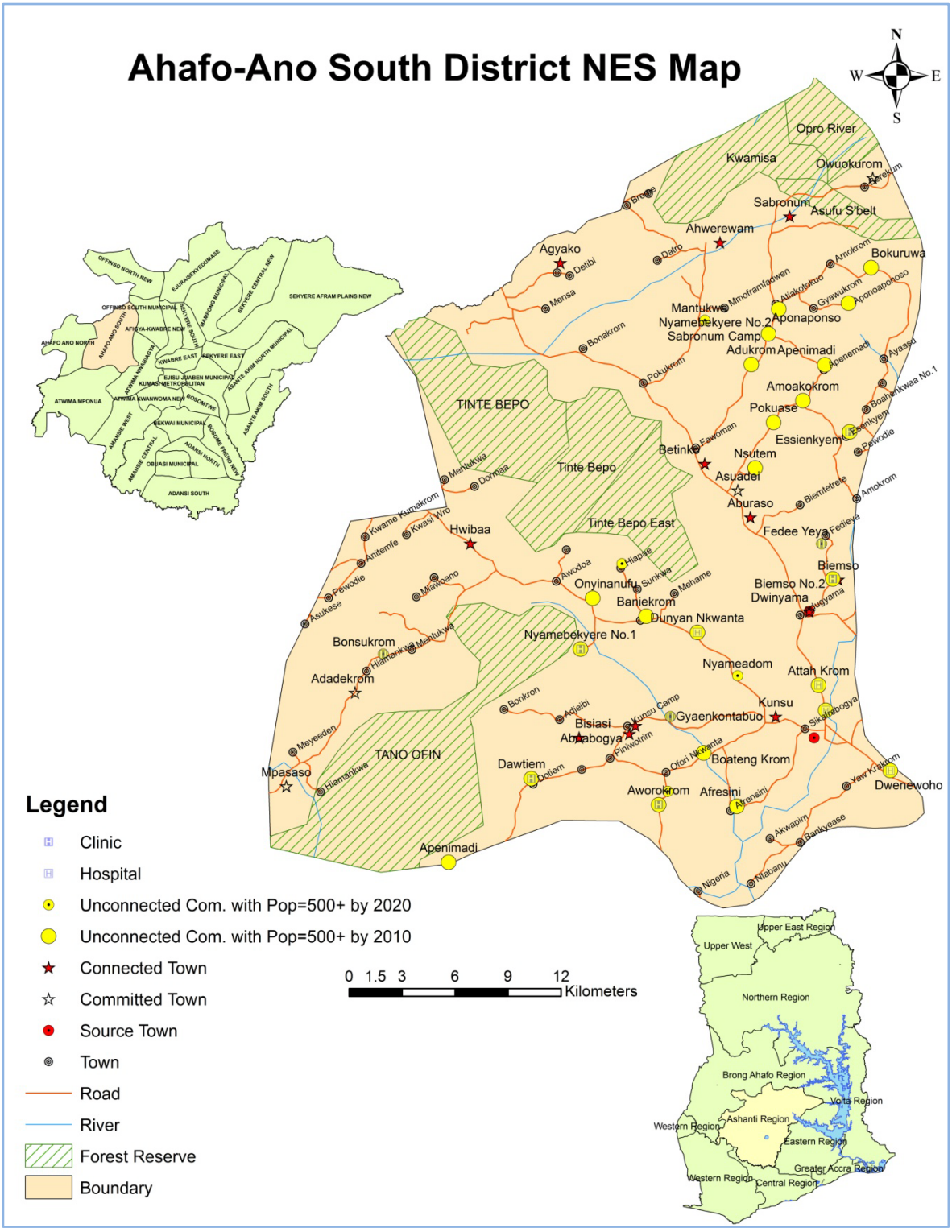
All maps created have been exported to the JPEG format so that they can be viewed on all computers that have a picture editor or viewer. This also allows the reprinting of the maps or their inclusion in reports without problems. All the maps will be made available on a DVD. Also the GIS files which are in the Shape file format (*.shp) will be made available on the DVD. From the shape files additions/changes can be made to the maps and reformatted to produce new or modified maps. This modification or update can however only be done using a GIS software like MapWindow GIS or ARCGIS.

7.4. Map Accuracy

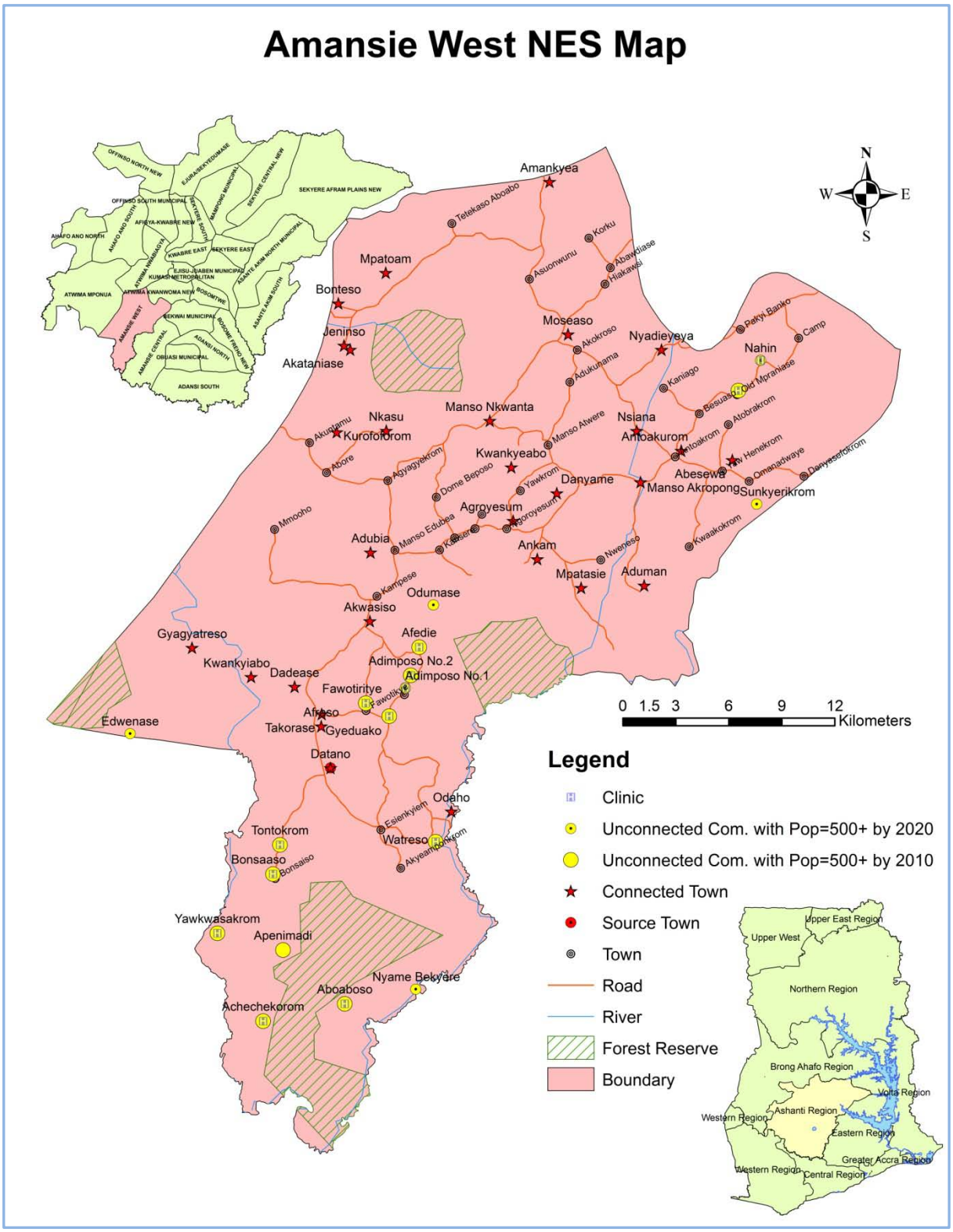
The consultant was able to record the GPS coordinates for two thousand seven hundred and eleven (2,711) un-electrified communities which constituted about 95% of the eligible communities. The locations of these un-electrified communities have therefore been plotted with the greatest accuracy possible.

However, as a result of the un-availability of a comprehensive community map the 1:50000 Topo map (tiles) was used to locate the towns. The locations of towns were represented by their names as text with no points defining them. To get the points to represent the towns, the texts (names) on the tiles were converted to points using the midpoint option hence some of the points used to represent the community could deviate up to about 1km from their actual location on the ground. However since there was no point on the tile to represent the communities, this was adjudged to be the best approach in the circumstances. It must be well noted that the towns

were mapped from a 1 in 50000 topographical map which happened to be the highest resolution available at the time of carrying out the assignment.



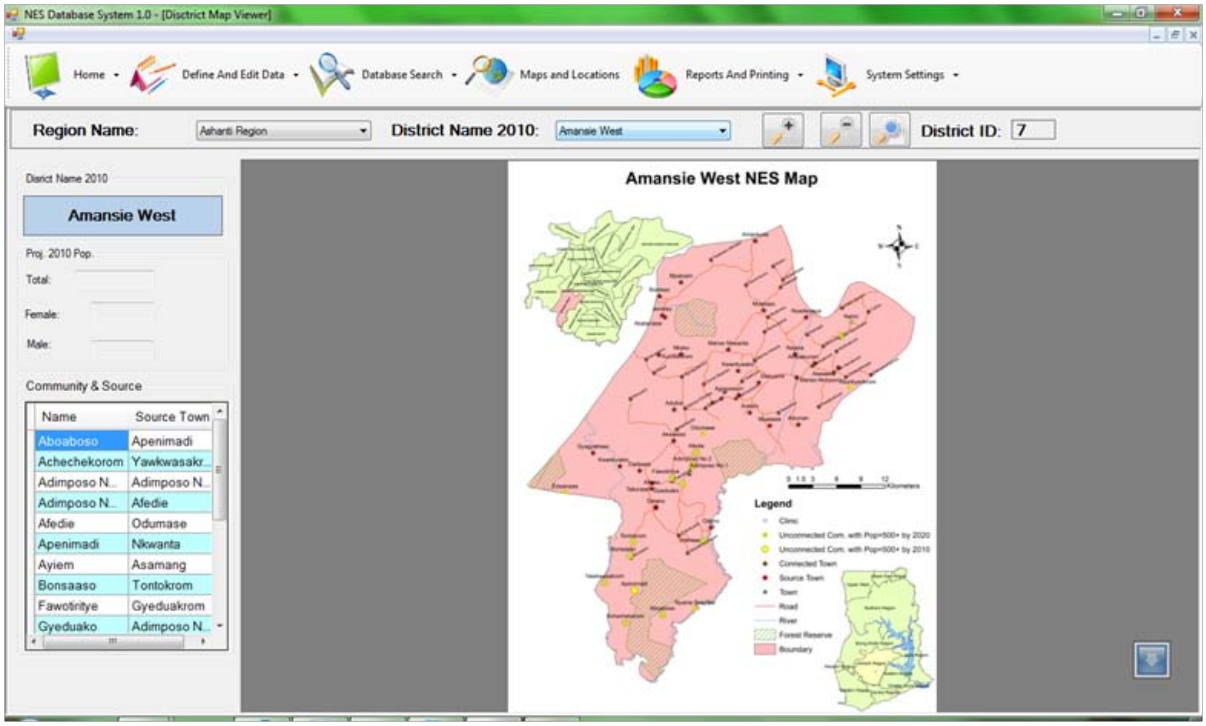
Another example of the maps created (Amansie West) is shown below.



7.5. Linkages and GIS Features

Significant for the use of the maps is the fact that a linkage has been provided between the maps created and the electrification database. Currently however, the link between the database and the maps is not dynamic. The maps also have a database attached (attributes) which have all the relevant information needed to modify or create new maps based on these attributes. The use of a GIS software is

required for the management of these attributes and the creation of any new maps of interest. The screen shot below depicts the link between the map created for the Amansie West district and the electrification database. It should be noted that the database application provides in the lower left corner of the screen a listing of the proposed source towns for each of the un-connected communities to enhance the information provided by the map.



8. NES MASTER PLAN REVIEW (2011-2020)

The National Electrification Scheme (NES) defined by the National Electrification Planning Study (NEPS) comprised six 5-year phases that would interconnect 3654 population centers. This chapter outlines a revised NES Master Plan (2011 - 2020) that focuses on the achievement of Universal Access by year 2020.

The remaining electrification projects involve 2563 population centers in 147 districts in the ten regions of Ghana with the number of inhabitants greater than 500. The population centres to be covered by these projects have a combined population of about 2,066,650 persons.

8.1. Technical Implementation Plan

The projects have been programmed into two implementation phases; NES Phase 5 and NES Phase 6. The implementation of the electrification projects in these phases of the NES would be from 2011 to 2015 and from 2016 to 2020 respectively. The target communities would be supplied by radial extensions from existing networks. The most appropriate voltage for distribution works within the communities would be 33kV and 11kV, whichever is available from the sub-transmission system.

8.2. Project Management

The Ministry of Energy (MOE) should have both policy planning and executive responsibilities for organizing the electrification programs as well as dealing with funding agencies and tendering for consultants and materials. The two utilities, ECG and VRA/NED should be fully responsible for all utilities' involvement with planning, designing, construction and commissioning the projects.

8.3. Project Funding Strategy

It is anticipated that NES Master Plan Review (2011-2020) would be funded by soft loans, grant-aid, electrification levy and margins on tariff. Bi-lateral funding may affect whether the electrification package is undertaken on a turnkey basis or as separate deign, supply and install contract packages. The differences will have significant impacts on the resources needed for implementation, and particularly on the proportion of staff that is provided under contract as contrasted to the permanent staff of the implementing utilities.

8.4. Contracting Strategy

The NES project implementation over the next ten years will entail major increases in the workload of the three agencies involved (ie MOE, ECG & VRA/NED). It will be

necessary to retain individuals or consulting engineering organizations on consulting and construction contracts. Consultants and contractors could be assigned functional responsibility for some or the entire project implementing process on a turnkey basis. Clearly the turnkey arrangement would require fewer staff resources at the implementing agency than would the approach with separate design, supply and installation phases. The turnkey approach is also likely to have a shorter schedule since only a single tendering process is involved rather than a multiplicity, and all activities are coordinated by a single organization within a single contractual framework.

8.5. Expected Results

The immediate objective of the NES program is to increase the access of citizens to electricity services. It was generally accepted based on the information available at the end of 2009, that the national electricity access rate could be assumed to be about 66%.

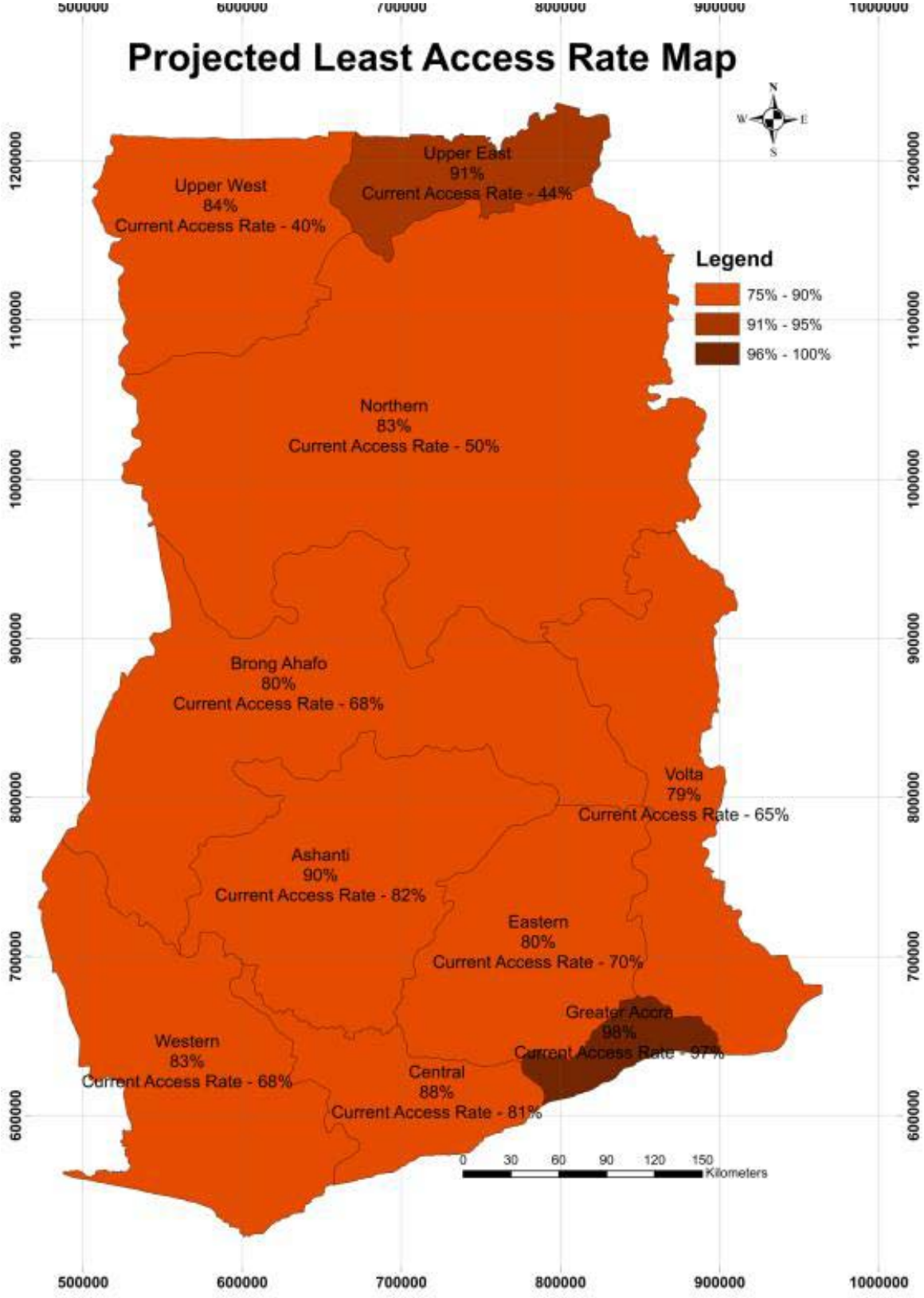
Following the consultant's field verification of the electrification status of supposedly un-electrified communities, it has been established that the actual access rate as at mid-2010 when the survey was conducted was about 72%.

It has been further projected that the nation access rate would have increased, after implementing the electrification projects proposed under this NES Master Plan Review (2011 – 2020), to 86.5%. The table below shows the change in access rates by region over the period.

Region	Access Rate		
	Assumed (2009)	Mid 2010	Projected 2020
Ashanti	80%	82%	90%
Brong Ahafo	63%	67%	80%
Central	70%	81%	88%
Eastern	62%	70%	80%
Greater Accra	96%	97%	98%
Northern	44%	50%	83%
Upper East	30%	44%	91%
Upper West	32%	40%	84%
Volta	58%	65%	79%
Western	59%	68%	83%

The expected result of the implementation of the proposed electrification projects is that virtually all the ten regions in Ghana would boast of an electricity access rate in

excess of 80%. The resulting graphic of electricity access is shown on the map below.



9. APPENDIXES

9.1.