Power Distribution Feasibility Studies, Ghana

Phase II Feasibility Assessment

Northern Electricity Distribution Company

Final

November 2014





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Prepared for

U.S. Army Corps of Engineers, Europe District

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In Association with

The Millennium Challenge Corporation

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United States of America

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Executive Summary

The Millennium Challenge Corporation (MCC), on behalf of the Government of Ghana, has engaged the U.S. Army Corps of Engineers (USACE), CH2M HILL, and NRECA International LTD to undertake a two-phased project screening and feasibility study for potential distribution system enhancement activities for the Northern Electricity Distribution Company (NEDCo). This report documents the findings of the Phase II feasibility assessment, which includes a technical feasibility assessment; environmental, social, and gender impact assessment; resettlement policy framework; financial and economic model; sustainability assessment; and monitoring and evaluation recommendations for NEDCo.

This report builds on the integrated loss management approach introduced in Phase I. The Phase II report provides a framework for program implementation, risk mitigation, and overall monitoring and control to ensure the program is meeting key objectives.

To better understand the existing system, a targeted load flow analysis and an evaluation of NEDCo's information and communication technology were conducted by a team from NRECA International LTD. The Tamale substation was selected for the load flow analysis. Results indicate that transformers are operating at less than 25 percent capacity resulting in significant efficiency losses. Results showed that power quality was poor; losses were primarily related to the low voltage system; and the system generally lacked standards. The analysis of the information systems confirmed the need to implement key geographic and customer service information systems. NEDCo could pursue virtualization and service provider-based solutions rather than purchase and installation of a significant hardware package.

Feasibility was assessed for 21 Sub-Activities based on consultation with MCC and recommendations from Phase I. Appendix A provides a summary of the Sub-Activities and Appendix C provides a detailed assessment of each Sub-Activity along with a recommended implementation timeline. An integrated program work plan is provided, including a recommended procurement strategy. This procurement strategy recommends that MCC engage a program manager, technical assistance contractor, and engineering contractor early to prepare the groundwork for effective management and coordination of follow-on activities.

In general, the proposed Sub-Activities will have relatively minor impacts, which can be effectively mitigated. Based on the results of the environmental, social, and gender impact assessment, 18 of the 21 Sub-Activities are classified as Ghana EPA Category A projects and therefore will only require the preparation of Form EA1; no Environmental Impact Assessment (EIA) will be required. The remaining three Sub-Activities, all involving substation construction, are Category B projects and will require the preparation of a Preliminary Environmental Assessment (PEA) after completing Form EA1. The need for a full EIA will be assessed depending upon the information provided in the PEA. Similarly, 15 of the Sub-Activities are classified as Category C projects according to the MCC categorization system and are likely to have minimal or no adverse environmental or social impacts, with no environmental and social impact assessment (ESIA) required. Six of the Sub-Activities that require construction of substations and distribution lines are classified as MCC Category B projects. These projects will have the potential to result in some level of environmental and social impacts; however, these impacts are likely to be site-specific and few if any will be irreversible. Environmental and Social Management Plans focusing on the anticipated impacts will be required for the MCC Category B Sub-Activities.

Most Sub-Activities occur along existing utility corridors and adjacent to public roads and are expected to have only minimal impacts to vegetation and wildlife habitat. One of the Sub-Activities (NEDCo-Comm-03: Customer census and normalization of existing service connections) has the potential to result in the identification of customers with illegal connections. It is customary practice for customers without legal connections to be disconnected from service. In some cases, financial and/or legal penalties can be imposed. This practice could result in negative impacts to the poor; it is recommended that a program of mitigation measures be developed and implemented to facilitate the legal reconnection of the poor.

All Sub-Activities were screened for their potential resettlement impact. Six Sub-Activities were identified as having the potential for involuntary resettlement. These activities include the three substations, the replacement of shield wire distribution lines, the replacement of aging underground cable, and the construction or modification of distribution lines, including the low voltage system bifurcation activity. In line with current NEDCo practice, sub-station sites are generally vacant or under-used and owned by institutions, thus reducing potential resettlement impacts.

The most extensive impact will be on current occupants of the sub-station sites and rights-of-way running along both sides of most public roads in Ghana - which is where the majority of new distribution lines will be located. In theory, rights-of-way should be unencumbered—that is, free from structures. In practice, it is common along many of Ghana's busy streets for vendors and shops to be located in structures that encroach into the utility corridors. These structures are predominantly either converted steel shipping containers or temporary structures made out of wood or other impermanent materials. Some of these businesses are legal in that they have received occupation licenses on condition that the license owner acknowledges that the license is temporary and the businesses may need to be relocated if the corridors are needed for the placement of utilities such as distribution lines. These relocations can be either temporary or permanent. For the most part, people do not live within the utility corridors and therefore, most of the involuntary resettlement requirements associated with the distribution Sub-Activities will involve economic displacement and not loss of shelter. Various impact avoidance or mitigation measures can be taken to minimize the need for resettlement, including:

- Line routing to avoid highly developed areas
- Undergrounding of distribution cables where necessary
- Minimizing temporary disturbance through advance notice of construction activities and the periods during which disruption will occur

Section 5 contains a summary of resettlement policies and issues. The Resettlement Policy Framework was prepared in accordance with the requirements of International Finance Corporation (IFC) Performance Standard (PS) 5, Land Acquisition and Involuntary Resettlement, and contains a detailed assessment of potential resettlement impacts, measures to reduce these impacts, and mitigate those that are unavoidable through compensation and in-kind assistance.

The financial model shows that through the integrated loss management approach, over a 20-year time horizon, ~$63.3 million (M) of MCC investments will reduce aggregated technical, commercial, and collection losses by approximately 27 percent and provide positive financial benefits to NEDCo. However, loss improvement investments are insufficient to achieve positive net cash flow. Additional financial modeling that includes both the MCC investment effects and a 25 percent tariff increase results in positive net cash flow for NEDCo. Returns to the Ghanaian economy as documented in the economic modeling effort, are dependent upon the inclusion of "access" projects.[1] With access projects, which included additional substations and bulk supply points, the economic internal rate of return (EIRR) is above the MCC 10 percent threshold; without access projects, the investment threshold is not met. Access projects provide additional customers and revenue to NEDCo, thereby providing greater economic benefit to the Ghanian economy.

The positive return due to the access projects is due to the valuation of new electricity supplies on the part of consumers. With grid power replacing the willingly purchased kerosine, battery charging services, and other methods of acquiring light and electrical energy, the value of electricity to new consumers is greater than the lifeline tariff of that service, considerably greater for many households. As a result, the change in social welfare due to additional electricity supply (access) exceeds the opportunity costs of supply given that the alternatives all cost Ghana more than the electricity supply option at the present time. It should be noted that the increased

[1] Access is a benefit category as defined in the economic model section which refers to adding additional consumers or load. Such projects include bulk supply points and substations. This should not be confused with the MCC Access program.

access is project and location specific, and does not apply to all access proposals, just those with sufficient density of demand.

The sustainability assessment identified a number of internal, external and management requirements that could hinder long-term program sustainability. Two critial external sustainability requirements include the need to improve Ghana government arrears and to revise the tariff structure to align to the cost of service. The other major sustainability risk was related to utility management support for significant organizational change. Without engagement and support of the NEDCo board of directors and senior management, it will be difficult for many of the programs to take hold.

System monitoring and evaluation is a critical component of the loss management approach. Many of the Sub-Activities that are proposed aim to ensure that NEDCo management has information to prioritize and respond to specific system requirements. This report provides a set of key loss-management metrics, including technical and non-technical losses, collection rate and outage information (System Average Interruption Duration Index and System Average Interruption Frequency Index) that should be tracked monthly. Proposed foundational Sub-Activities will ensure that NEDCo has the appropriate tools for to capture and report on this key data and at a level that will facilitate effective prioritization.

Key observations noted during the feasibility assessment will impact this project. Specifically, it is apparent that Ghana decision-makers have not fully embraced the idea of ensuring that NEDCo is a financially viable company. This requires a number of tough decisions regarding governance and focus. At the same time, NEDCo is experiencing high demand growth of approximately 4 percent, which further challenges NEDCo’s ability to maintain financial health. The utility needs to make a number of critical cultural shifts, especially in using business intelligence data to make prioritized decisions, building planning into the culture, and placing greater emphasis upon customer care.

The recommendations in this report is to focus first on an integrated loss management approach with specific, geographically focused investments to both capture short-term benefits as well as to establish a corporate skill set on reducing losses on a system-wide basis. Without a comprehensive and focused loss management program, it is doubtful NEDCo will be able to make the cultural shift required to achieve the aggressive targets needed to respond to growth in demand and to ensure financial sustainability. Loss management reduction challenges need to be elevated to the board of directors and senior management, with resources and funds allocated to areas that will result in the highest efficiency improvements. This need to focus on efficiency of the business is at odds with the GoG focus on investment in growth by extension. While improvement in access is an important social goal, and will make economic sense in some cases, the consultants do not advocate for the single minded pursuit of expansion. Indeed, in some cases other priorities will be more appropriate, especially activities that NEDCo management undertakes to improve efficiency. If the current emphasis on investment for expansion continues, the company’s deficit will continue to increase at the same pace as its customer growth without a significant restructuring of retail tariffs. In fact, investing in growth without improving corporate efficiency is more detrimental to NEDCo than not investing at all. NEDCo managers also need to engage their employees and capture their ideas as well as improve motivation Techniques to achieve these goals include skills training and transparency in organizational goals and objectives.Finally, the organization needs to improve its relationship with its customers by responding to customer needs and tracking key customer information to manage the relationship.

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Acronyms and Abbreviations

AMR	automatic meter reading
ATC&C	aggregated technical, commercial, and collection
BSP	bulk supply point
CIS	Customer Information System
DSM	demand side management
ECG	Electricity Company of Ghana Limited
ERP	enterprise resource planning
GECE	Global Energy Consulting Engineers India
GHS	Ghanaian Currency Cedi
GHp	Ghanaian Currency Pesewas (1/100 Cedi)
GIS	geographic information system
GWh	gigawatt hours
GRIDCo	Ghana Grid Company Limited
ICT	information and communication technology
km	kilometer(s)
kV	kilovolt(s)
kVA	kilovolt(s) ampere
kWh	kilowatt hour(s)
LCU	loss control unit
LV	low voltage
MCC	Millennium Challenge Corporation
MDA	ministries, departments and agencies
MDM	Meter data management system
MiDA	Millennium Development Authority
MW	megawatt(s)
MV	medium voltage
NEDCo	Northern Electricity Distribution Company
NRECA	NRECA International LTD
O&M	operations and maintenance
PS	Performance Standard
PURC	Public Utilities Regulatory Commission
PV	present value
SAD	Sub-Activity description
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SLT	special load tariff
VOLL	Value of Lost Load
VRA	Volta River Authority
W	Watt(s)
WTP	willingness-to-pay

SECTION 1

Introduction

1.1 Background

As part of a grant provided to the Government of Ghana (GoG) under the authority of Section 609(g) of the Millennium Challenge Act of 2003, the Millennium Challenge Corporation (MCC) engaged U.S. Army Corps of Engineers (USACE), CH2M HILL, and NRECA International LTD (NRECA), on behalf of GoG, to undertake the project screening and technical feasibility studies for a portfolio of potential distribution technical and commercial activities (Activities) for the Electricity Company of Ghana Limited (ECG) and the Northern Electricity Distribution Company (NEDCo).

The NEDCo Financial and Operational Turnaround Project is designed to provide support to NEDCo in reducing their technical and commercial losses through a private sector-led approach and will provide technical assistance in the areas of corporate governance, technical capacity of the regulators, and gender integration. The work is being performed in two phases:

- Phase I – Project Screening and Prioritization
- Phase II – Feasibility Study

The information presented herein documents the approach and findings for the Phase II feasibility assessment for NEDCo and builds on the approach and data presented in the Phase I report. The results of the study are intended to provide the MCC and its stakeholders with the information to initiate project implementation and procurement of proposed services and infrastructure.

1.2 Phase II Report Structure

The remainder of this report is organized as follows:

- Section 2: Objective and Approach
- Section 3: Loss Study/Load Flow Analysis and Information and Communications Technology (Task 3)
- Section 4: Technical Assessment of Commercial and Network Improvements (Task 3 and Task 4)
- Section 5: Environmental, Social, and Gender Assessment (Task 5)
- Section 6: Resettlement Policy Framework (Task 6)
- Section 7: Economic and Financial Assessment (Task 7)
- Section 8: Sustainability Arrangements (Task 8)
- Section 9: Monitoring and Evaluation (Task 9)
- Section 10: Summary of Recommendations
- Section 11: References

In addition, there is a standalone document on the Resettlement Policy Framework and there are two main appendices that contain the results of our feasibility assessment. Appendix A, Consolidated Sub-Activity List, provides an overall summary of the feasibility study results. Appendix C, Sub-Activity Descriptions, provides stand-alone descriptions and details of each Sub-Activity. The other appendices include:

- Appendix A Consolidated Sub-Activity List and Results
- Appendix B Loss Study Results
- Appendix C Sub-Activity Descriptions
- Appendix D Sub-Activity Unit Cost Analysis and Assumptions
- Appendix E NEDCo Work Plan
- Appendix F Environmental, Social, and Gender Impact Assessment
- Appendix G Financial Analysis Summary
- Appendix H Economic Analysis Summary
- Appendix I Sub-Activity Illustrations and Examples

SECTION 2

Objectives and Approach

2.1 Phase I Integrated Loss Management

In Phase I an integrated loss management approach was used to determine the project Activities and Sub-Activities that would proceed to the Phase II Feasibility Study. By using an integrated loss management approach, well-run utilities can actively track and respond to system losses and improve overall performance. The principles of integrated loss management include: 1) recognition that all departments play an integral part in improving performance; 2) sharing of systematic and transparent performance information throughout the organization; 3) use of quantifiable information to effectively direct resources.

An integrated loss management program provides a framework for breaking down the barriers in utility organizations whose functional units focus on their own performance outcomes without significant consideration to impacts to the other functional units that are integral to the overall performance of the utility. As illustrated in Figure 2-1, an integrated loss management program views the utility as an integrated system, and helps identify where interventions and metrics are needed to support attaining a sustained loss reduction program and continuous improvement.

FIGURE 2-1
Illustrative Overview, Integrated Loss Management Program

n an electrical distribution system, the primary functional units – herein after referred to as "Activities" – typically include engineering, operations, administration, and commercial management:

1. **Engineering** is responsible for evaluation of technical losses, design of loss reduction projects, and supervision of project implementation.
2. **Operations** is responsible for distribution system reliability and outage management.
3. **Administration** is responsible for contract management, procurement, oversight of buildings (including customer service centers), fleet management, and legal issues that may arise from energy theft.
4. **Commercial** management is responsible for non-technical loss reduction initiatives, such as anti-theft programs, improving collection rates, meter/service inspections, disconnections for payment/theft issues, updating the customer information system, and other commercial activities.

The goal is that the functional units will work in harmony to improve the quality of service, improve collections, and reduce technical and non-technical losses. To achieve the goal, activities and Sub-Activities should be considered that address:

- Geographic information system (GIS) for the service area, including substation locations and attributes, medium voltage (MV) line alignments and attributes, distribution transformer locations and characteristics, line devices (regulators, switches, fuses, reclosers, etc.), and low voltage (LV) distribution systems, with consumer locations linked to the facilities that serve them.
- Power flow analysis for service areas to establish technical losses for each segment of the system

- Consumer census data that include geographic location of each consumer, meter number and information, consumer category, unique location identifier linked to the infrastructure element that serves that consumer , and consumer name
- Power purchased and sales data for service area and feeder load data for all MV feeders
- Non-technical loss information for primary and secondary feeders based on the load flow model and energy loss analyses derived from sales data
- Monitoring of non-technical losses caused by intentional or non-intentional errors in consumption data.
- Inspection of large metering installations with meter testing instruments.
- Orientation, training, and auditing of employee activities to ensure that they are part of the solution to the loss problem and not contributors to it.
- Evaluation of meter reading routes, meter reading practices, and data management practices for all postpaid and prepaid meters
- Collection and dissemination of data through enterprise resource planning (ERP) to appropriate departments, management and board of directors on a timely basis to ensure departments and management can respond to critical issues and ensure corporate goals and objectives are reached.
- Evaluation of collection practices, disconnection procedures and fees, and opportunities to outsource collection activities

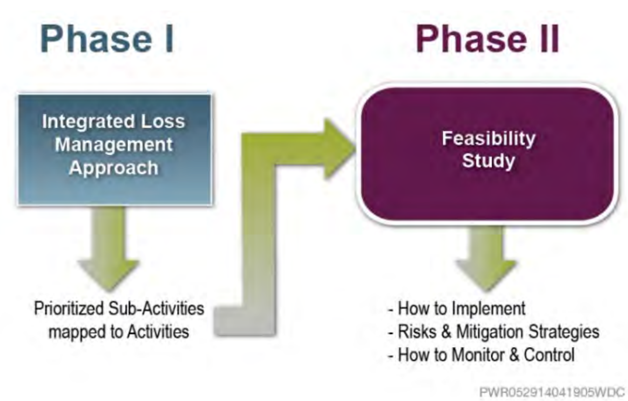
The Phase I Project Screening and Prioritization effort started with the assessment of roughly 60 activities and Sub-Activities. Using the Integrated Loss Management model, the list was reduced to 21 prioritized investments proposed for the Phase II Feasibility Study. The final result of the prioritization process concluded that NEDCo should focus on:

- Investment targeted the Northern and Sunyani regions because this is where NEDCo can achieve the greatest improvement to the Aggregated Technical, Commercial and Collection (ATC&C) losses.
- Sub-Activities that directly impact institutional (Administration) performance, commercial losses (Commercial), technical losses (Engineering), and outage losses (Operations).
- Foundational Sub-Activities that enable the utility to make informed decisions, such as customer census, GIS integration, and system metering.
- Non-foundational Sub-Activities with the greatest return on investment as identified by NPV.

2.2 Phase II Objectives and Approach

The objective of Phase II was to evaluate the prioritized list of integrated loss management Sub-Activity investments to achieve reductions in technical and commercial losses leading to improved organizational performance. Figure 2-2 describes the approach used to conduct the feasibility evaluation for proposed investments starting with the Sub-Activity outputs from the Phase I Assessment and Prioritization and ending with the outputs from the Phase II Feasibility Study. The outputs provide a basis for recommendations to MCC for implementing the overall distribution sector Compact—specifically, procurement recommendations; approaches to manage program implementation, environmental,

FIGURE 2-2
Approach and Outputs



resettlement, and sustainability risks; and a recommended monitoring and evaluation approach to ensure the program is meeting key objectives.

It is apparent that the ILMP is oriented toward improved performance of the utility, both financially and operationally, and not towards growth through expansion. NEDCo's current investment program is heavily dominated by access improvement investments, i.e. those that increase the number of consumers by extending service to a greater number of citizens. While increasing access to modern energy sources is certainly a social imperative for all public electricity suppliers, simply adding consumers to an organization that is financially and operationally challenged to adequately serve the consumers it already has is not a recipe for sustainable success. If the utility cannot meet its current requirements for operational and financial viability the result of adding more consumers through expansion investments will be to increase the burden on the government and society as a whole, and the service provided will fail to meet the development objectives of providing it in the first place. The investments proposed here in loss reduction are modest in comparison with those required for system expansion, and have short recovery periods. However, they represent the backbone of a sustainable electric utility that will stimulate economic development in its service territory rather than burden it.

SECTION 3

Loss Study/Load Flow Analysis and Information and Communications Technology (Task 3)

3.1 Approach

Special studies have been separated out of Task 3 due to its impact on overall loss reduction and performance improvement targets. These studies included:

- Carry out high level sampling of technical losses to identify feeders with the most losses and addressing typical causes and remedies for technical and non-technical losses. This covered both load and non-load related losses.
- Conduct a review of computer systems (e.g., financial accounting, customer information, billing and outage management, etc.) in use at the utility, including their adequacy to run the business to an appropriate standard, and identify gaps. In particular addressing the requirements for improved customer service and ERP to improve overall management information for analysis and decision making.

The purpose of the field survey and engineering modeling task was to evaluate and segregate technical and non-technical losses for a specific high-loss area and to delineate technical losses by key system components. Components under consideration include distribution feeder conductors, distribution transformers, and the low voltage (LV) network apparatus.[2]

The feeder analysis focused on data collection and modeling for two substations, one each in ECG and NEDCo. The substations were selected based upon Global Energy Consulting Engineers India (GECE) study results that provided relative loss levels at ECG and NEDCo's substations (GECE, 2012). Selected substations are located in high population density service areas. At NEDCo, the Tamale Substation was selected for the study based on the magnitude and value of the losses in the area this substation servces. A team of GIS technicians from the utility was assembled and trained to collect system attribute data on pre-programmed tablet computers equipped with GPS receivers. The data was uploaded from the tablets to a GIS database each evening and later processed in a geographic information system with line and device attributes for medium and low voltage circuits. Once the GIS survey was completed, the geodatabase and the line and transformer attributes were exported to an engineering power flow software package, and the loss analysis was completed for all elements of each model.

The assessment of commercial software systems was performed through discussions with information and communication technology (ICT) and commercial staff at the utility.

3.2 Results

This section presents the results from the load flow study at Tamalesubstation and the NEDCo information systems and communication technology assessment.

3.2.1 Tamale Load Flow Loss Study

3.2.1.1 Summary

A load flow study is a mathematical simulation of the performance of the power system that predicts the consumer voltages and losses resulting from a particular set of conditions without the need for measuring them in the field. The accuracy of a load flow study for a particular system depends on obtaining the following information:

- A system map with accurate information on conductor sizes and transformer characteristics

2 Such work is commonly found in distribution master plans, such as the proposed Master Plan Sub-Activity, where upgrades to substation capacity, distribution lines, transformers, and LV networks to improve voltage profiles and reduce losses are considered. A master plan should establish a holistic planning methodology to identify areas that require capital expenditures to further reduce system losses.

- Energy consumption data for all the consumers connected to each element of the system
- Measured peak load at the source

The load flow study of Tamale substation was carried out by mapping all the feeders in the distribution system fed by the substation using tablet computers with integrated global positioning system receivers (GPS). The data from the tablet computers was converted and uploaded into a GIS, and then to a commercial load flow software called Milsoft Windmil. Windmil is widely used for analysis of distribution systems, and has the capability of analyzing balanced or unbalanced conditions and for presenting results geographically instead of in the traditional single line diagram presentation. Energy consumption data was obtained from the NEDCo Commercial department, although a number of approximations were necessary to develop acceptable data. Feeder load data was obtained from the NEDCo Operations department, although the nature of the data available also required approximations.

Tamale substation is a bulk supply point (BSP) for the NEDCo system, and power deliveries are made at the 34.5 kilovolt (kV) level for distribution by NEDCo 34.5 kV feeders and at 11 kV for local feeders. The results of the modeling show that technical losses for the 34.5 kV distribution feeders, transformers and associated LV networks are 7.5 percent, while technical losses for the 11 kV distribution feeders, transfomers and associated LV networks is 11.5 percent. Losses for the two distribution systems are broken down as follows:

- 34.5 kV distribution system: 7.6%
  - 34.5 kV line loss: 1%
  - 34.5/0.4kV transformer loss: 2.4%
  - LV Network loss: 4.2%
- 11 kV distribution system: 11.5%
  - 11 kV line loss: 5.5%
  - 11/0.4kV transformer loss: 1.8%
  - LV network loss: 4.2%

Losses in the LV network were evaluated based on examination of the LV networks on a single 11 kV feeder, and the value determined assumed to be representative. This assumption can be questioned, but all LV networks are built to the same standard, and the assumption that they have the same loss level system wide is not unreasonable.

The most significant contributor to 34.5 kV system loss, accounting for 56 percent of the total, is loss in the 415 volt (V) low voltage (LV) system. Losses in the 415 V system are subject to reduction by adding transformers and extending 34.5 kV line to reduce loading on the low voltage system in a process called bifurcation. The potential reduction in technical loss resulting from bifurcation is significant, taking LV loss from 3.5 percent to 0.7 percent in the case of ECG. No studies of bifurcation were conducted on the NEDCo system, but similar results can be expected as the LV system standard is the same in both companies.

For the 11 kV system, the most significant contributor to loss, accounting for 48 percent of the total, is 11 kV feeder conductor loss. Less important but still significant is LV system loss at 37 percent of total system loss. Reduction of 11 kV line loss is mainly affected by ensuring that line extensions are made at 34.5 kV, leaving 11 kV as an urban only voltage. This is a planning issue and can be achieved by improved distribution planning. Loss reduction in the LV network can be reduced using bifurcation of LV lines and intersetting of smaller transformers, as discussed.

3.2.1.2 Background

The GECE loss study (National Techcnical and Commercial Loss Study-NEDCo, 2012) identified the Tamale substation as having higher than average technical losses in the Northern area, and it was chosen for further analysis under the load flow study.

The Tamale substation is the BSP from the Ghana Grid Company, Limited (GRIDCo) system and delivers power to NEDCo at 34.5 kilovolts (kV) and 11 kV. The distribution system emanating from the Tamale BSP consists of eight 11 kV feeders and one 34.5 kV feeder. The 11 kV feeders are a mix of underground and overhead lines. Overhead

11 kV and 34.5 kV lines are typically 120 square-millimeter (mm^2) bare all-aluminum conductors (AAC) on main lines and 50mm^2 AAC on some laterals. The underground feeders are of various cable sizes. Distribution transformers are typically 200 kilovolt amperes (kVA) or larger, three-phase units that feed extensive LV networks. The LV system consists of overhead lines constructed mainly with 120mm^2 bare AAC conductors, although small numbers of other conductors, including 100mm^2 AAC, 50mm^2 AAC, and even 16mm^2 were found, which describes a potential issue with standardized sizing.

3.2.1.3 Prior Studies

The GECE study examined annual energy loss levels for the regions of NEDCo, and disaggregated the losses between technical loss, non-technical loss and collection loss. The 2011 distribution losses for the Northern area, of which the Tamale substation is a part, totaled 30.09 percent between technical and non-technical loss. Collection loss for the Northern area was 29 percent, giving a total ATC&C loss of 59.1 percent. Technical loss for the Northern region was estimated from power flow analysis to be 9.54 percent, including 4.9 percent for LV networks. Non-technical loss cannot be calculated or estimated directly, but is computed by subtracting technical loss from total loss. Non-technical loss in the Northern region of NEDCo is therefore calculated to be 20.55 percent.

The technical loss of the feeders served by the Tamale substation were estimated by GECE to be 6 percent for 11 kV and 34.5 kV distribution lines and transformers plus 4.9 percent for the LV system, for a total of 10.9 percent for the Tamale substation. This is slightly higher than the system average of 9.54 percent.

The GECE study based its power flow analyses on system models that relied on one line diagrams provided by NEDCo. Loading data was collected by NEDCo in the form of feeder peak loads in amperes. The data used by GECE in its 2012 analysis of Tamale is presented in Table 3-1.

TABLE 3-1
Data for Tamale Substation from GECE Technical Loss Report 2012

Feeder Name	Voltage (kV)	MV Length (km)	Transformer (kVA)	Estimated Peak kW
28F2B	11	5.46	4,315	2726
28F3b	11	68.63	8,545	3618
28F4B	11	32.73	5,815	3618
28F6B	11	1.3	50	51
28F7B	11	33.84	5,545	2966
28F8B	11	38.22	4,645	3309
28F9B	11	5.86	2,315	3618
28F10B	11	60.81	6,430	4630
28F1Y	34.5	263.06	8,040	3818
28F2Y	34.5	69.22	1,400	1828
28F5Y	34.5	14.85	2,895	807
Total		**593.98**	**49,995**	**30,991**

Total distribution line length is almost 594 km, of which almost 60 percent is 34.5 kV line. Total installed capacity of transformers is almost 50,000 kVA and total demand on the substation is 31,000 kilolwatts (kW).

3.2.1.4 The Tamale Loss Study

A GIS map was developed for all of the 11 kV and 34.5 kV feeders emanating from the Tamale substation. However, there was not sufficient time to map the full LV network for the Tamale BSP so the field team mapped all LV circuits for one 11 kV feeder, designated 28F11B. The GIS included the collection of data on line conductors, line locations, segment lengths, distribution transformer capacities, and transformer locations. Data for feeder peak loading was obtained from supervisory control and data acquisition (SCADA) records. In the case of feeder 28F11B, mapping of the LV network included a count of consumers by class (residential, commercial, etc.) that are connected to each pole. A summary of the characteristics of the Tamale distribution network is presented in Table 3-2. The Tamale substation is not the only source serving the Tamale area; there are still some legacy feeders from the shield wire system, and these were not mapped nor included in the data collection effort. This system is being supplanted with a more traditional three-phase line, and while it still serves a significant number of consumers, it is not being expanded or upgraded.

TABLE 3-2
Tamele Substation Distribution Network as Mapped 2014

Feeder Name	From GIS Field Survey				Estimated Feeder Peak (kW)
	Voltage (kv)	MV Length (km)	LV Length (km)	Total Connected (kVA)	
Transformer 28T1					
28F2B	11kV	5.7		2,830	1,935
28F3B	11kV	78.2		11,895	4,448
28F4B	11kV	47.8		11,155	4,718
28F6B	11kV	67.4		12,105	4,698
Sub-total 28T1:		**199.0**		**37985.0**	**15,799**
Transformer 28T2					
28F7B	11kV	41.2		12,315	5,582
28F8B	11kV	4.4		2,380	1,766
28F9B	11kV	45.8		12,795	5,435
28F11B	11kV	10.8	55.7	5,800	3,955
28F1Y	34.5kV	347.0		26,700	5,455
Subtotal 28T2		**449.2**		**60,440**	**22,193**
Total		**500.2**		**98,425**	**37,992**

It is apparent from comparison of Tables 3-1 and 3-2 that the configuration of the distribution system served by the Tamale substation has changed somewhat since the GECE study of 2012. The total number of feeders served by the substation has been reduced from eleven to nine. The total length of MV feeders is now 500km, down 15 percent from that found in the GECE study. The installed capacity of distribution transformers has increased by almost 100 percent, while demand on the substation has increased by only 22 percent. Given these changes in configuration, the loss data for 2014 will likely be somewhat different than that determined for 2012.

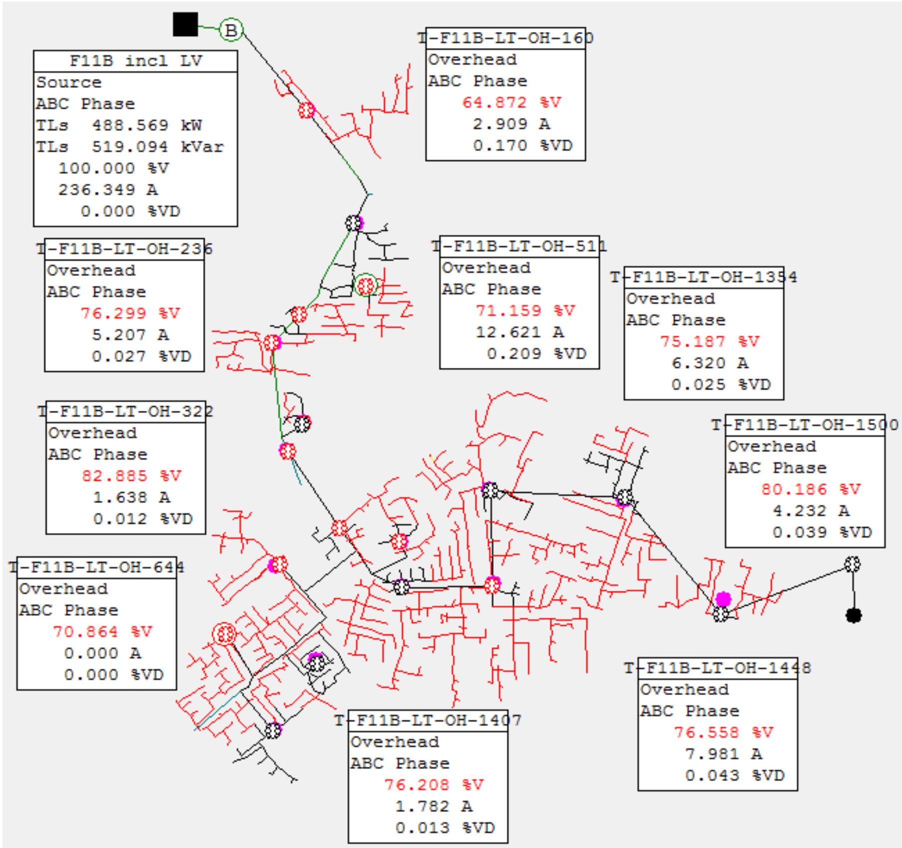
Collecting load data for Tamale substation was a straightforward process because all feeders are metered in SCADA and loading data are routinely provided to NEDCo’s engineering department. Loading data for distribution transformers proved to be more problematic, however. because consumers are not associated with the distribution transformers that serve them. The lack of Integration between the commercial data and the engineering circuit diagrams affects the ability to directly use sales data from the commercial system in the Milsoft load model. The problem is that the sales data for a particular consumer is not linked to the facility data, that is, to the LV pole, or even to the transformer that serves the consumer. This makes it impossible to use the detailed consumer sales data to simulate the load of a particular transformer or LV segment. For this reason NRECA used approximations to model load as described below. However, because the loss evaluation shows that sales data is not accurate due to the high level of non-technical loss, the inability to use individual consumer sales data was not critical to the development of the model. An additional problem of the same sort is that there are a large number of prepayment meters in the Tamale area and three separate prepayment meter management systems, which complicates the collection of data on the location of prepaid consumers.

Once the GIS data were collected, a power flow analysis was completed using the Milsoft Windmil® distribution modeling software package. Milsoft Windmil is a power flow software that is widely used because of its ability to model unbalanced conditions and to accept system modeling information from a GIS, and to present results in a geographic format. Data quality required a number of approximations to be made, but such approximations are realistic and do not have a significant adverse impact on the model outcomes. Approximations include:

- Because it was not possible to associate customers with the transformers that served them, loading of distribution transformers on the feeders for which no LV was mapped consisted of an allocation of total feeder peak load, prorated by transformer capacity.
- A somewhat more exact method was used to estimate loading of distribution transformers on the single feeder on which the LV network was mapped consisted of an allocation of the total feeder peak load, prorated by the total energy served by the transformer. Because it was not possible to correlate consumption data from the commercial software with the LV line element or transformer that served the consumer, the GIS team counted consumers served by each line segment. Loading was then calculated for each LV line segment as the product of the actual number of consumers connected to the segment, multiplied by the system average energy consumption for that consumer class. A few transformers were found to have unrealistically high loadings based on this approximation, and an upper bound of 150 percent of rated capacity was established to reflect a more likely loading picture. While this approximation is significant, it is not as important to the overall quality of model as it appears, since the feeder load in kilowatts or amps is what is allocated to the system elements in proportion to the energy of the consumers served by the element. The energy consumption of a particular element is not converted to demand so any errors due to the use of average data tend to be smoothed out over a feeder. The key piece of data then, is the feeder peak demand and considerable effort was used to make sure that this value was reasonable.
- Power factor data was not available. Accordingly power factor at the consumer was assumed to be 90 percent. This typically results in a power factor of 88 percent at the substation bus which is consistent with the GECE study and is reasonable based on NRECA's experience in other areas.

A representative graphical output of Windmil software is shown in Figure 3-1 for Feeder 28F11B, the only one in which the LV network was mapped. The output of the simulation case shows voltages, in percent of nominal, at selected points in the LV network, as well as loading on system elements. The figure shows that voltages at the ends of the LV system are likely to be on the order of 70 percent of nominal voltages or less. It should be noted that in the United States, distribution planning criteria commonly requires voltages to be greater than 90 percent of nominal. Therefore the simulated data for the NEDCo feeder suggests that consumer satisfaction with the quality of service may be low. No measurements were made of actual voltage in the field, but low voltages are anecdotally known to occur in the project area. Many consumers have voltage boosters for at least a part of their load, so they can maintain equipment voltage at an acceptable level. Another common strategy is to install oversized lights so that even at low voltage the lights produce the required level of illumination.

FIGURE 3-1
Tamale Substation Feeder 28F11B Distribution Model



The total feeder losses are 488.6 kilowatts (kW). Feeder load at the source is 236.3 amps and a feeder load at the substation of 3,952 kW with a feeder power factor of 88 percent. The losses of 488.6 kW thus represent a feeder demand loss of 12.4 percent. The data in the case report show that the feeder peak loss value is subdivided as follows:

11 kV conductor Loss: 157 kW

Transformer Loss:

No Load loss 14.3 kW
Load Loss 61.2 kW

LV conductor Loss: 256 kW

Because losses are proportional to the square of loading, energy losses are calculated on the basis of losses on peak using a loss load factor as follows:

$$LLF = \text{Loss Load Factor} = 0.7*ALF^2 + 0.3*ALF$$

Where

ALF = Annual Load Factor

Annual load factor for the feeder is another item which cannot be derived directly from NEDCo data, once again due to the fact that energy sales are not correlated with the system elements that serve the consumers. It is therefore not possible to disaggregate energy sales to the level of a substation and certainly not to a feeder, so it is necessary to make a reasonable assumption. There are no large consumers on the LV network and no direct connected consumers on the 28F11B feeder, so load factor will be more typical of combined residential/commercial consumption. Such a mix of consumers rarely has a load factor above 50 percent.

At an assumed annual load factor of 50 percent, the resulting loss load factor is 32.5 percent. The loss analysis for this feeder is shown in Table 3-3. The table lists average annual energy losses, calculated as a percentage of input to the feeder as being 8.5 percent, with LV energy loss amounting to 4.2 percent or 50 percent of feeder losses.

TABLE 3-3
Feeder 28F11B Energy Loss

Feeder Type	11kV Conductor Loss	Transformer Loss	LT Network Loss	Annual Energy Loss
Feeder 28F11B Energy Loss	2.6%	1.7%	4.2%	8.5%

Assuming that the LV system on feeder 28F11B is reasonably typical of other feeders emanating from the Tamale substation, then LV losses on other feeders should be approximately equivalent to the results for feeder 28F11B. This is a reasonable assumption considering that the same LV standard is used for all distribution transformers. It is also consistent with the finding of the GECE study, which found LV loss to be 4.9 percent. Given this assumption, the overall loss analysis of the Tamale substation system is summarized in Table 3-4, Summary of Tamale Substation Losses, showing losses in percentage of the annual energy delivered to the feeders, as well as the segregation of losses between distribution conductors, transformers, and LV circuits.

TABLE 3-4
Summary of Tamale Substation Losses

Feeder Type	Feeder Conductor Loss	Transformer Loss		LV Network Loss	Annual Energy Loss
		No Load	Load Loss		
34.5kV Feeder	1.0%	2.1%	0.3%	4.2%	7.5%
All 11kV Feeders	5.5%	1.1%	0.7%	4.2%	11.5%
Total System	4.9%	1.2%	0.6%	4.2%	10.9%

Table 3-4 suggests that total losses associated with the Tamale substation are 10.9 percent of input and that LV losses are 40 percent of energy losses on all the feeders. These data also support the following observations:

- The losses for Tamale substation estimated in this study match those predicted by the GECE study of 2012 quite closely, in spite of the changes in configuration of the substation feeders over the intervening period.
- LV losses are a significant portion of total technical loss, and in light of the large conductor sizes used on the LV network, this means that LV line lengths may be excessive.
- Losses on the 34.5 kV feeder 28F1Y are 7.5 percent compared with losses of 11.5 percent for all 11 kV feeders, even though the length of the 34.5 kV feeder (347 kilometers [km]) is greater than the sum of all the 11 kV feeder length.
- The peak load on the 34.5 kV feeder is similar to that of a single 11 kV feeder. This argues for increased use of 34.5 kV distribution feeders.
- Transformer no-load losses at all voltage levels are important contributors to energy loss. This is especially true on the 34.5 kV feeder, where no-load losses represent 90 percent of the losses attributable to all transformers. This is because transformers on this feeder have an average load of no more than 23 percent of their capacity. This is an indication that the use of large transformers is not advisable on rural feeders.

3.2.1.5 Loss Benchmarking

In an effort to verify the analyses carried out in the power flow simulations, a benchmark was developed for the NEDCo system that is based on sales density (sales in megawatt hours [MWh] per km of the sum of all MV and LV distribution lines). This benchmark was developed to define acceptable loss performance on rural systems in the

United States and has been tested and found to be a valid indicator of the performance of distribution systems for many different designs and in many different countries. The benchmark is calculated on the basis of the empirical equation below:

Loss (%) = (-1.8458*(LN(D*1.62))+17)/100

Where:

D = Sales density in MWh/km of distribution line

Based on this approach, the results for NEDCo are shown in Table 3-5:

TABLE 3-5
NEDCo Loss Benchmarking Results

Year	2012
34.5 kV Overhead (km)	6,824
34.5 kV Underground (km)	18
30kV line length (km)	169
20kV line length (km)	313
11 kV Overhead (km)	1,794
11 kV Underground (km)	43
415 V line length (km)	10,796
Total Dist Line km	19,956
Sales MWh	580,501
Sales Density MWh/km	29.1
Loss Benchmark	**10%**

This benchmark suggests that NEDCo's technical losses would be projected to be 10 percent based on normal utility practice. The fact that NEDCo's technical losses (as based on the Tamale substation) are approximately 10.9 percent indicates that loss performance is only slightly poorer than expected levels.

3.2.1.6 Conclusions

While technical losses at 10.9 percent slightly exceed the benchmark values, non-technical loss in excess of 20 percent and collection loss in excess of 29 percent, as determined by the GECE study, make it clear that the primary loss challenges facing NEDCo are not technical, but commercial. Failure to accurately meter sales and failure to collect billed energy are the primary sources of financial loss to NEDCo, with correction of technical loss of considerably lower importance. That said, however, it is clear from the power flow analysis that voltages at the consumer (LV) level are often inadequate and poor service of this nature may create an excuse for non-payment and subsequent commercial loss. Correcting of voltage service quality, which is a technical issue, will therefore aid in correcting the commercial problems.

From this study we can recommend the following specific technical changes at NEDCo:

- Use shorter LV circuits fed by more and smaller transformers to reduce LV network losses
- Use less underground 11 kV construction, especially in areas that have LV lines on overhead poles.
- Use single-phase construction (current utility standards include single-phase construction)
- Move from open wire to multiplex cable for LV network, and create engineering standard limiting maximum permissible LV network length.

- Recognizing the importance of transformer no-load loss to overall loss performance, size transformers such that they would be more heavily loaded and procure transformers with lower no-load losses through specifications that evaluate guaranteed loss performance.
- Use line reclosers and other types of sectionalizers on the line and reduce the use of costly switching stations.
- Emphasize use of 34.5 kV for long distribution feeders and restrict the use of 11 kV to short, urban lines..

3.2.2 NEDCo Computer System Analysis

This section describes the review of NEDCo's software systems through discussions with ICT and the Commercial staff at NEDCo as well as a review of the e-Solution report to NEDCo regarding their IT Architecture and Strategy (e-Solutions Consulting May 2012).

Given that NEDCo was established as a new distribution utility in 2012, it has limited ICT infrastructure and functionality and relies on the Volta River Authority (VRA) for many of its core functions. These functions include accounting and staff payroll. NEDCo has no internal network of its own, and relies on the use of flashdrives to transfer data at its headquarters. NEDCo operates three separate prepayment metering systems, but these are standalone systems with limited coverage. Each of the prepayment vending systems is completely independent of the others and since they are not compliant with the South African Standard Transfer Specification (STS) prepayment protocol, and while they are not particularly secure they can and must be integrated into the new CIS when it is implemented.

The e-Solution report recommended a number of commercial applications and hardware platforms for an enterprise resource planning platform that would include the following modules:

- Accounting system
- Payroll
- Customer relationship management
- Billing
- Quotation and rate management
- Meter data management
- Field service and work management
- Asset management
- Maintenance management
- Stores management
- Supply chain management
- Project portfolio management
- Network management system
- Internet portal
- Identity management
- Business intelligence
- Business integration and business process management

The report further described the ICT organizational structure and training that will be required to successfully deploy the business system platforms outlined above.

The investments included in the ICT SADs presented in Appendix C generally follow the e-Solution recommendations listed above. The loss management program will require implementation of GIS, customer information systems (CIS), meter management, and engineering solutions to successfully reduce non-technical losses and to significantly improve collections.

It is recommended that NEDCo limit computer hardware requirements by taking advantage of virtualization and service provider-based solutions such as Amazon EC2 and Google Compute engines. Hosted service prices may be competitive and provide the distinct benefit that the service providers are responsible for hardware and firmware upgrades, not the client. Although user fees are significant, the life-cycle costs are lower than a solution that requires NEDCo to procure and manage hardware on site.

In addition to economic motives, ecommerce is also in line with the overall NEDCo approach to improved network connectivity. That is, NEDCo is increasing Internet connectivity and virtual private network technology for remote office communications. Should an Internet outage occur at the data center, it will result in a NEDCo-wide outage. Second, the computer hardware and software skills required to maintain such systems are highly advanced. NEDCo may not be able to recruit personnel who are sufficiently trained and willing to live in Tamale or Sunyani.

In the event that NEDCo is not able to attract talented and experienced ICT professionals in Tamale this will present significant difficulties for NEDCo. High skill sets are required to implement ERP, CIS, meter management, GIS, and other platforms at NEDCo. The efficacy of these platforms will drive NEDCo productivity in years to come. Realistically, this process should be managed by a consultant to ensure that it is successful, given the dependency of the NEDCo performance improvement program on successful implementation of these ICT platforms.

3.3 Conclusions

The results of the load flow study at the Tamale Substation and an examination of previous studies indicate that technical loss for the feeders served by Tamale substation is representative of the NEDCo Northern service area as a whole. Further, benchmarking the NEDCo Tamale substation technical loss against normal utility practice of similar systems shows that losses at Tamale are slightly above expected values. Given the extremely high non-technical and collections losses identified in the GECE report, it is clear that technical loss reduction is not the highest priority facing NEDCo. Nonetheless, the power flow study shows that consumer voltages are often inadequate for satisfactory service. Poor service tends to provide an excuse for non-payment, so resolution of technical issues is important to the overall loss reduction program. Performance improvement can be achieved through reduction in LV lengths, conversion to multiplex cable, and use of more, smaller transformers. It also recommended that transformers be resized to reduce no-load loss. Increased use of 34.5 kV distribution is also indicated, as is limiting the length of 11 kV feeders to minimize conductor loss.

NEDCo was established as a new distribution utility in 2012 and has limited ICT infrastructure and functionality, and therefore relies on the VRA for some of its core functions. Going forward, NEDCo will need to implement GIS, CIS, meter management, and engineering solutions to successfully reduce non-technical losses and to significantly improve collections. NEDCo could pursue virtualization and service provider-based solutions that provide distinct benefits where the service providers are responsible for hardware and firmware upgrades, thus removing this responsibility from the utility.

SECTION 4

Technical Assessment of Commercial and Network Improvements (Task 3 and Task 4)

4.1 Approach

Two of the primary tasks of the Phase II Feasibility Study were to conduct technical and feasibility assessments of the proposed investments associated with the Activities and Sub-Activities presented and prioritized during Phase I. The initial screening and prioritization of the Sub-Activities was based on their ability to modernize utility operations, reduce commercial losses, improve revenue collection, reduce technical losses, and reduce outages. Under Phase I, Activities and Sub-Activities were identified; costs were estimated; and benefits were calculated to develop a screening and preliminary prioritization of the initial proposed Activities and Sub-Activities. In Phase II, the factors affecting the economic and financial rate of return of the Sub-Activities were further refined following the methodology described below.

The Scope of Services for Phase II specifies 14 subtasks for Task 3, Technical Assessment of Commercial Improvements, and 15 subtasks for Task 4, Technical Assessment of Network Improvements. Because nearly all of the requirements were common for tasks 3 and 4, both are presented below in this section.

Given the abundance of data and analyses required for each investment, a data collection and reporting framework was designed to capture and present the characteristics, costs, benefits, and implementation timeline of each investment. The framework was employed to collect a common set of data for each Sub-Activity; Sub-Activity descriptions (SADs) were created for each of the prioritized interventions evaluated in Phase II.

The SADs were developed and information collected as Excel workbooks so that SAD data was linked to the financial and economic analyses. Once the analyses were complete for all Sub-Activities, the Sub-Activities were prioritized, taking into consideration the MCC program requirements and distribution sector priorities. SADs can be found in Appendix C of this report.

The SAD forms provide additional detail about design requirements and a general implementation plan. They were designed to conform to internationally accepted standards and customary operating procedures. Each SAD provides a summary of anticipated returns, investment costs, operating costs, revenue from new customers, and results from economic modeling. The SADs also describe the Sub-Activity's contribution to overall loss improvements, a schedule, and a risk assessment.

In conducting the feasibility assessment for each of the Sub-Activities, the analysis was broken down into the two broad categories shown below, with associated sub-tasks described in the Scope of Services.

1. Verification of data, costs, impacts, and schedule for Sub-Activities identified and prioritized in the Phase I report:
   - Prepare final list of project Activities/Sub-Activities that are prioritized based on financial, economic, environmental, social, and other factors considered in the prioritization process. This should also take into account the utility master plan and demand.
   - Assess whether Sub-Activities are implementable vis-à-vis MCC compact constraints.
   - Evaluate construction and operations and maintenance (O&M) costs for each Sub-Activity.
   - Review technical correctness of project design criteria based on anticipated increases in load and other factors. Review design parameters and ensure Sub-Activities comply with international best practices and prepare preliminary designs/specifications for selected Sub-Activities as needed.
   - Identify investment risks and evaluate mitigation measures.

- Prepare work plans for each prioritized Sub-Activity and an overall work plan/completion schedule for all Activities proposed under the MCC Compact.
- Assess requirements for refurbishing/replacing distribution lines, transformers, and other materials to improve voltage profiles and increase substation capacity (pertains to network improvements only).
- Assess need for land acquisition for new line alignments and/or substations (pertains to network improvements only).

2. Establishment of baseline conditions and future performance targets to measure Sub-Activity progress:

- Characterize baseline conditions for loss levels, collection efficiency, and other performance measures.
- Set performance targets for each investment program.

4.1.1 Verification of Data, Costs, Impacts, and Schedule for Sub-Activities Identified and Prioritized in the Phase I Report

For those subtasks that address Sub-Activity relevance to the utility master plan, costs, scheduling, and impacts, the CH2M HILL team worked closely with the utility staff from the engineering, commercial, financial, ICT, and other departments. A detailed design review was performed of the BSPs, primary substations, and the distribution structure drawings for the utilities. This approach enabled us to confirm that Sub-Activity design, cost, and performance data obtained from multiple sources was consistent with the NEDCo's internal practices.

The MCC principal requirements for program execution were carefully reviewed to evaluate the ease of implementation for the various Activities and Sub-Activities. Requirements that were analyzed were as follows: achieving a minimal economic rate of return of 10 percent, clear program logic, Sub-Activity completion within the 5-year time frame, pro-poor in orientation, consistent with policy reform objectives, sustainable in a post-Compact environment, environmentally sustainable, and scalable. Each Sub-Activity was initially reviewed in the context of these baseline requirements as part of the Phase I screening process, and was reviewed again in Phase II to verify compliance based upon further studies.

For each Sub-Activity, the investment costs for construction, maintenance, and operation were estimated. The CH2M HILL team used recent construction prices received from the utilities and compared those with cost data from recently completed projects across the African continent that was similar to the proposed Sub-Activities. Prices were also back-checked against a US cost database for further verification.

The team also evaluated the land requirements of each Sub-Activity type, including construction of new distribution lines, primary substations, and BSPs. In each case, the team coordinated directly with the utility representatives to evaluate land requirements for typical Sub-Activities.

Operating costs for infrastructure are composed principally of the costs associated with employees who operate and maintain the infrastructure, and because these investments will be integrated into a significant existing asset base of the utility, the team decided to evaluate O&M costs by using historical operating data benchmarked against the total facility in service value. These benchmarks were derived from the utility's financial data and typical utility O/M costs. For Sub-Activities that principally focus on software applications such as CIS, ERP, or OMS applications, estimates of annual licensing fees were applied to the software estimates, while the benchmarked O&M ratios were applied to ICT infrastructure allocations.

With the exception of the LV feeder bifurcation subactivity, the Sub-Activities identified and evaluated in Phase II all employ systems that have been used by either VRA or NEDCo for many years and meet applicable international standards. Therefore, these Sub-Activities will generally not require substantial changes in engineering design standards. The LV bifurcation subactivity does call for significant changes in construction approaches, to emphasize greater use of medium voltage laterals and smaller transformers to reduce LV network loss. These changes are all variations on existing standards and while they will result in changes in construction practice, they are not unfamiliar or technologically unusual.

The CH2M HILL team developed a matrix of project development, implementation, operations, environmental, and other risks as they pertain to the categories of proposed Sub-Activities, including: 1) technical, 2) financial, 3) economic, 4) environmental, 5) sustainability. For each risk that was identified, mitigation strategies were derived based on best practices and experience. The matrix of Sub-Activity types, risks, and mitigation measures is presented in Section 4.

As required in Task 8, the team also prepared implementation plans for each proposed Sub-Activity in the form of activity Gantt charts. The charts illustrate design, procurement, construction, and data collection Activities for each intervention.

4.1.2 Establishing Baseline Conditions and Future Performance Targets to Measure Sub-Activity Progress

Performance monitoring for significant investment programs such as the MCC Ghana Compact II requires an established well-defined set of baseline conditions before the investment portfolio is implemented. Although NEDCo is data-challenged in terms of the technical performance of its distribution system, the utility has managed to keep relatively consistent records of power purchased, energy sales, overall energy losses, and billing and collection statistics. These data sets allowed the CH2M HILL team to establish baseline data for energy losses (combined technical and commercial losses), collection efficiency, and the composite index referred to as ATC&C losses. Recommendations and processes for Activity baselines and proposed improvements are provided in the monitoring and evaluation section of the report.

4.2 Results

Tasks 3 and 4 respond to the technical assessments of commercial and network loss reduction improvements. Overlapping analysis between these two tasks prompted an integration of both commercial and network improvements with regard to the analysis and presentation of recommendations found in this section. Feasibility results associated with Task 3 and 4 Sub-Activities are found in Appendix C. The intent of these descriptions is to provide sufficient detail to explain the importance and role of each Sub-Activity and their place in the overall integrated loss program. Results from this task are broken into four main sections. These include findings from the Sub-Activity feasibility assessment, assumptions, risk assessment, and proposed work plan/procurement plan.

4.2.1 SADs Feasibility Assessment

The integrated Task 3 and 4 loss management program recognizes that losses need to be targeted in 4 ways. 1) Reduce technical losses; 2) Reduce commercial losses; 3) Reduce outages 4) Improve overall institutional loss management practices.

The problem statement for each SAD activity responds to one of these four loss categories. This formed the basis of identifying key activities that will improve efficiency in each of these areas. Specific baseline requirements focus on the identified ATC&C information. These baselines were described in Phase 1 and are the proposed baselines in Task 9. This section also provides interim loss targets, which are tied to the SAD work plan is described later in this section.

As part of the Phase I Prioritization, NEDCo identified a list of recommended activities intended to improve system performance. The total capital cost of these activities is approximately $200 million. During the Phase I evaluation, additional technical and commercial investment opportunities related to the integrated loss management approach were identified that would help round out a comprehensive integrated loss management approach for sector improvement.

All activities were initially prioritized without regard to total cost rather foundational activities and then by net present value. MCC provided cost guidelines to guide the prioritization process. A summary of the Sub-Activity descriptions is provided in Table 4-1. The prioritized Sub-Activities represent a total approximate capital investment of $61.5M.

TABLE 4-1
NEDCo Prioritized Sub-Activities

Sub-Activity Name	Region	Activity	Foundational (Yes/No)	Cost	Dur. (Month)	NPV
NEDCo-Comm-04: Enterprise customer information system and integration with existing enterprise applications	All	Institutional Support	Yes	$4,838,000	26	$31,551,000
NEDCo-Service-02A: Procurement of vehicles, tools and equipment	Northern Sunyani	Commercial Losses Reduction and Collection Efficiency Improvement	Yes	$4,506,000	22	$12,949,000
NEDCo-Comm-03: Customer census and normalization of existing service connections	All	Commercial Losses Reduction and Collection Efficiency Improvement	Yes	$7,836,000	39	$8,051,000
NEDCo-Ict-01: Communication network	Northern Sunyani	Institutional Support	Yes	$315,000	27	$3,823,000
NEDCo-Service-05: Technical Assistance Program	All	Institutional Support	Yes	$4,950,000	54	$2,280,000
NEDCo-Ict-04: Data center at VRA or Sunyani	Northern Sunyani	Institutional Support	Yes	$981,000	22	$1,492,000
NEDCo-Engr-24: Metering at critical nodes of the distribution system	Northern; Sunyani	Commercial Losses Reduction and Collection Efficiency Improvement	Yes	$1,377,000	31	$1,314,000
NEDCo-Service-06 Distribution System Master Plan	All	Institutional Support	Yes	$437,000	28	$923,000
NEDCo-Engr-22: Update distribution construction standards based on current low loss practices	All	Technical Losses Reduction	Yes	$314,000	10	$795,000
NEDCo-Ops-03: Installation of outage reporting and call center system	All	Outages Reduction	Yes	$194,000	14	$543,000
NEDCo-Engr-29: Sectionalizing study of MV networks within NEDCo's territory	All	Outages Reduction	Yes	$498,000	23	$533,000
NEDCo-Engr-03A: Replace faulty and aging underground conductors	Tamale; Sunyani	Outages Reduction	No	$4,888,000	37	$18,050,000
NEDCo-Engr-11: Install Fiapre primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	Sunyani	Technical Loss Reduction	No	$3,105,000	39	$17,392,000
NEDCo-Engr-08: Install Banvim primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	Tamale	Technical Losses Reduction	No	$3,758,000	39	$17,172,000

TABLE 4-1
NEDCo Prioritized Sub-Activities

Sub-Activity Name	Region	Activity	Foundational (Yes/No)	Cost	Dur. (Month)	NPV
NEDCo-Engr-09: Install Islamic primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	Northern	Technical Losses Reduction	No	$3,338,000	39	$17,111,000
NEDCo-Service-01A: Construction of customer service centers	Northern Sunyani	Institutional Support	No	$3,670,000	22	$15,771,000
NEDCo-Engr-07: Shield wire conversion to 34.5 kV system Techniman-Ahafour	Techniman	Technical Losses Reduction	No	$4,420,000	37	$12,615,000
NEDCo-Engr-19A: Low voltage feeder bifurcation with medium voltage upgrade	Tamale; Sunyani	Technical Losses Reduction	No	$6,652,000	37	$887,000
NEDCo-Engr-18: Reactive power compensation for primary substations and MV lines	Sunyani	Technical Losses Reduction	No	$1,822,000	31	$537,000
NEDCo-Ops-02 Procure operations and maintenance materials	All	Outage Reduction	No	$1,800,000	31	($933,000)
NEDCo-Comm-01: Service connection materials	Northern Sunyani	Commercial Losses Reduction and Collection Efficiency Improvement	No	$3,933,000	18	($1,098,000)
	Total			**$63,632,000**		**$161,758,000**

4.2.2 NEDCo Estimates and Assumptions

Estimated cost, schedule, and assumptions for the SADs were provided by NEDCo. SAD cost detail is provided in Appendix E (Sub-Activity Unit Cost Analysis and Assumptions). Cost information was reviewed for cost reasonableness through a combination of verifying costs based upon regional cost data as well as verifying overall costs were aligned to US-based construction and material costs.

Some general observations about the NEDCo estimates and assumptions indicate that:

- Unit costs of equipment as estimated by NEDCo were low as compared with the cost of similar equipment in the U.S. market. This was due to the fact that the utility generally allowed for lower quality equipment. An example is the prepaid meter systems that have been installed, using meters that are low in cost but which do not meet normal utility standards, and are not robust enough for reliable use. Unit prices used for cost estimates prepared by the CH2M HILL team were based on actual bids for high quality equipment received on other projects in Africa.
- Based on verified costs, labor was estimated to be 30 percent of material costs when specific labor cost was not available. We also assumed that most of the technical and engineering support could be generally found in the local region. Experience on other projects indicates that adequate technical expertise normally exists locally, though appropriate oversight must be exercised to ensure an acceptable result. Pricing for certain technical and management skill-sets were assumed to be at international rates.
- Project duration was estimated based upon the availability of a qualified technical assistance team providing support to NEDCo. This is particularly important for projects such as the Enterprise Resource Planning effort (NEDCo-Comm-04) that involve requirements for expertise that NEDCo has not yet developed.
- O&M expense was assessed 3.4 percent of installed costs, which is the value reported by NEDCo based on historical operating costs. O&M costs are composed mainly of labor costs for staff connected with the operations and maintenance functions, as well as repair and maintenance materials and consumables such as fuel for vehicles.

4.2.3 Risk Assessment

The objective of conducting risk assessments is to identify specific events that may affect the success of each SAD. Individual events are catalogued in a risk register and a mitigation strategy is formulated for each event, as shown in Table 4-2. The primary input components of risk analysis are the consequences (impacts or effects) associated with each event and the probability that each event might occur. Consequence and probability are coupled to formulate a composite risk score for each event. While quantifying consequences and probabilities is desirable, practical considerations and limited data commonly cause measurements to be based on opinions or qualitative information. For the Risk Register in Table 4-2, we have relied upon experienced engineers to provide qualitative estimates for the risks.

TABLE 4-2
Risk Register

Event	Type	Likelihood	Consequence	Overall Risk Score	Mitigation
Errors in the accuracy of distribution network data	Technical	Medium	Medium	Medium	Ensure that the technical advisor is engaged in the GIS implementation and quality control
Employees do not have sufficient or necessary computer skills	Institutional	Medium	Medium	Medium	Ensure appropriate training is budgeted with each software package deployment and verify or provide employees with basic computer skills training prior to system deployment
Failure to integrate new systems and work methods into existing work processes and management practices	Institutional	High	High	High	Ensure technical advisory team is engaged in implementation of new systems. Establish a detailed roll-out process with executive support and oversight. Ensure NEDCo develops procedures and corporate standards to enforce adoption to include effective data management and transparent and effective report development for management and board of directors. Verify that NEDCo has a quality assurance practice in place to verify work practices Provide for possible vendor follow-up of systems integration and training to respond to respond to unforeseen staffing, management or process integration issues. Provide for multi-year service agreements after installation is complete to maintain licenses, provide training, troubleshooting and on-call support.
Failure to integrate new and existing systems	Technical	High	High	High	Ensure systems are reviewed prior to deployment to establish integration requirements (include as a requirement in procurement). Ensure consultant allocates resources for debugging and programming of the interfaces between the different systems. Ensure that procurement of new systems includes provision of long term (multi-year) service agreements to maintain licenses, provide training, troubleshooting, on-call support, and periodic system maintenance. Provide for possible vendor follow-up of systems integration issues and to respond to unforeseen staffing management or process issues
Failure to select a qualified consultant who is capable of delivering the scope of the project, on time, and within budget	Institutional	Low	High	Medium	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with their accommodations and other fringes Develop strong qualifications statement and ensure that procurement follows through to verify qualifications of bidders..
Failure by NEDCo to follow or to timely implement recommendations from MIDA's technical assistance contractor and program manager	Insitutional	Medium	High	Medium	Ensure adequate management information system is in place to monitor NEDCo compliance with process of implementation of recommendations by MIDA technical assistance contractor and program manager; condition release of subsequent disbursements of funding on evidence of compliance and implementation
Failure to implement a wide area network communication, which is sustained	Technical	Medium	Low	Low	Ensure that nodes with high traffic are equipped with redundant links through different providers and physical infrastructure. Verify the communications back-bone has an effective O and M and repair structure in place.
Not able to gain access to consumer premises	Technical	Low	Medium	Low	Ensure that all required documentation to access premises are procured and put in place procedure to send inaccessible premises location to the loss control unit for further action and escalation

TABLE 4-2
Risk Register

Event	Type	Likelihood	Consequence	Overall Risk Score	Mitigation
Unable to engage utility staff to cooperate and participate in Sub-Activity	Institutional	High	High	High	Vet staff members involved in the implementation process and obtain NEDCo's agreement to reassign them if they are not engaging wholeheartedly in the program. Establish a reward program based on performance and difficulty of the Sub-Activity to entice utility personal to participate
Failure to maintain safe clearances from electrical equipment	Technical	Medium	Medium	Medium	Reroute lines away from structure and their original path when possible and include a contingency to use designs that do not require clearance or remove structures causing clearance issues
Selecting a skilled local contractor who is capable of delivering the scope of the project, on time, and within budget.	Technical	Medium	Medium	Medium	Open bids to include international bidders and plan for line-man training classes on new standards before start of work
Insufficient real estate and rights of way	Technical	Medium	Low	Low	Include multiple sites location alternative for the substation location and plan for a higher contingency
Failure to deploy CIS software successfully	Technical	Low	High	Medium	Ensure that the technical advisors come aboard as early as possible and include a contingency ICT budget for the implementation of the CIS
Customers lose electrical service as a result of Sub-Activity	Social	Medium	Low	Low	MCC/MiDA to develop a means test and mitigation approach with utility
Landownership/resettlement requirements are greater than expected	Social	Medium	Medium	Medium	Commercial interventions, which have the highest returns, do not require resettlement, so impact on project is moderate; to minimize impact due to construction project resettlement requirements,minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement cannot be avoided.
Utilities fail to place an effective data management system in place	Technical	Medium	Medium	Medium	Prior to deploying all the data management activities, the utility needs to complete a data management integration plan and storage plan that will verify how the information will be stored, managed and integrated into utility management reports and systems.
NEDCo fails to assign the right staff to Sub-Activity operations and data management	Institutional	Low	Medium	Low	During detailed Sub-Activity design, staffing requirements and recommendations should be established by the vendor. This will include minimum skill requirements. Job descriptions should be created and possible staff skills training included in the system rollout.
Failure to establish control mechanisms to review data management practices	Institutional	Medium	Medium	Medium	Utility should consider developing a quality assurance system to conduct periodic assessments of NEDCo procedures and processes as implemented by field teams. This includes records management, data quality etc.
Insufficient O&M funding and practices	Institutional	Medium	Medium	Medium	For any capital projects, verify practices are in place to periodically inspect and conduct maintenance. This includes having sufficient stock of consumables and materials for emergency repairs on hand.

The above risk register suggests that there are three risks that have an overall risk score of High and are therefore critical for program success. The most significant of these is the potential for failure of the utility staff to engage in the proposed changes or to actively oppose them. If this risk cannot be mitigated, any improvements will be difficult to achieve and will be temporary at best.

The mitigation strategy described calls for a dual approach involving incentives and consequences. Staff members who engage effectively in the program should perceive some reward for their participation. Such rewards would not necessarily have to be monetary, though monetary rewards should not be overlooked. Rewards may include membership in an elite “Implementation Team” for which interviews would be carried out and selection criteria imposed. The Implementation Team would enjoy enhanced freedom of decision and authority for carrying out the improvements, and would report in a streamlined management structure. This is the approach that the successful Florida Power and Light reform program of the 1970’s employed.

The next two items on the risk register with High scores are related to each other and consist in a failure to integrate new systems with existing systems, a technical risk, and failure to integrate new work processes into existing work processes, an institutional risk. These risks are common to all transformational projects, particularly those involving large scale information and communication technologies (ICT), and their mitigation requires a holistic approach to system design. Holistic design considers the business requirements of the organization in an integrated fashion, with new applications being designed to address perceived needs rather than to force users into a particular vendor’s predetermined menu. Implementation of a holistic design requires careful consideration of system design at the outset, including areas outside the scope of the IT solution itself to encompass ancillary requirements. A classic example is the introduction of an improved CIS, which requires consideration of meter reading strategies, data transfer strategies, opportunities for validation of input data, validation of output, delivery of bills, management of customer connection and disconnection, and control of meter inventory, as well as the preparation of consumer bills.

Dealing with the technological requirements for integration of systems requires careful selection of the consultants hired to advise the company so that they do not have any commercial biases, as well as identification of resources within the company that can address business processes and requirements. Dealing with the institutional requirements for integration is also linked to the willingness of employees to engage in the process, and requires active involvement by utility staff in reviewing and validating existing business rules to determine whether they should be incorporated as is into the new system , modified, or replaced.

We propose that MCC and MiDA engage a qualified consultant to work with the utility board of directors and senior management to establish how they will create a cultural shift in the utility from an organization that appears to react to loss issues rather than being proactive. This includes establishing how they will ensure that divisions and employees are engaged in the change process

4.2.4 Work Plan

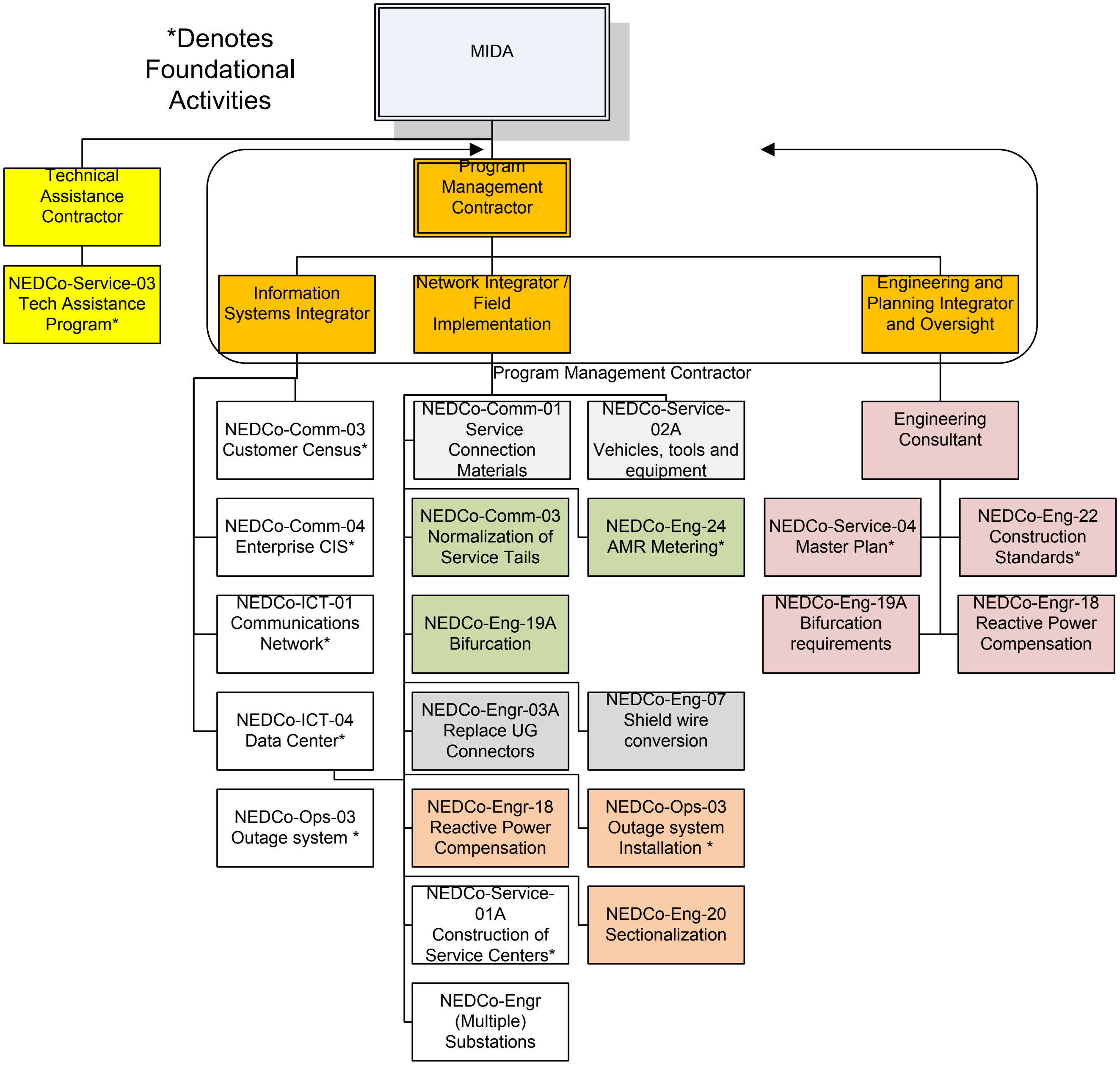
This section describes the proposed work plan for NEDCo, which is described in greater detail in Appendix E (NEDCo Sub-Activity Proposed Detailed Schedule). The purpose of the work plan is to define the work breakdown structure for critical activities and Sub-Activities including critical path links. This program has identified a number of critical-path activities that should start as quickly as possible which ensure follow-on activities are effectively developed and provide the foundation for effective system monitoring. The early interventions include: 1) The consumer census and GIS information since integration of this data into the CIS is required to effectively account for sales and calculate an accurate commercial loss baseline; 2) The Customer Information system will ensure that customer data is effectively managed and controlled; 3) Data system and communication Network is in place; 4) Updating design and construction standards, which are needed prior to starting system designs; 5) Development of a System Master plan to determine specific requirements and general locations for system improvements. We recommend that these specific activities start during the CIF period prior to actual compact. Once these activities are completed, service normalization, meters and most of the technical loss reduction activities can occur. It is critical to have the technical assistance advisor in place as soon as possible to support the utility in effectively managing and using the proposed tools. The presence of the advisor will also assist in achieveing close coordination between the proposed compact program and any ongoing or planned projects NEDCo may have in process outside the compact.

In addition, land acquisition and resettlement issues should be addressed as early as possible in the process. The overall Resettlement Policy Framework is therefore defined as the same level of the specific Sub-Activities given its critical nature to overall risk management. This activity starts as the actual design work begins as this process needs to be in place as lines are sited.

4.2.5 Procurement Plan

Figure 4-1 describes our proposed procurement approach and proposed contractors. This graphic describes three key contractors that MiDA should consider engaging early in the process to ensure that timely procurements are effectively developed and managed. Specifically, MiDA should bring on the Technical Assistance (TA) contractor and the Program Management (PM) contractor on as early as possible to prepare for the follow-on procurements. Although MiDA could consider combining these two contracts, it is not recommended. PM and TA contracts should not be combined as there could be a conflict of interest for a single contractor given the inherent relationships that the PM contractor will have with MiDA (as their due diligence contractor) and the fact that they would be essentially evaluating their own performance if they were the TA. Having separate contractors for these two functions will ensure independence for the PM s well as let the TA act as a true ‘advisor’ and not be seen as an organizational threat. The form of contract used for the TA consultant and the PM is a capped time and material (T&M) contract. This type of contract should be reserved for situations in which a scope of work needs to be flexible so that unexpected situations can be addressed without generating debates over what is and is not covered by the original task assignment. The use of T&M contracts should be limited in any project to situations in which the advice obtained from the contractor has a disproportionate impact on project components of much greater cost than that represented by the T&M contract. The selection of the PM and TA advisors fits this requirement, as the cost of the contracts for these two key advisors will be small compared to overall size of the projects for which the advice is sought.

FIGURE 4-1
NEDCo Procurement Process



It is also recommended that construction labor and materials contracts are not bundled for various reasons:

- Better pricing will be obtained for a bulk purchase of materials for all or a major part of the compact projects due to the economies of scale.
- Better pricing will result from the perception on the part of the material vendors that they have a greater likelihood of being paid because the purchases are secured by international funding, rather than having to depend on the good offices of a labor contractor
- The project will have better control over quality of materials if the material vendors are answerable directly to the PM than to a turnkey construction contractor

- Separating material and labor contracts allows qualified local contractors to participate in the labor only portion of the construction. Such local contractors would not normally have the financial strength to supply materials as well as labor
- If material and labor are combined in a turnkey type of contract the contractor has a strong incentive to undercut quality of materials and even if discovered and corrected, the impact on project schedule and overall quality is significant.

Material procurements will be managed as requests for quotations using detailed lists of materials specified in accordance material specifications that will be determined in coordination with NEDCo. The form of contract will be a fixed price purchase order with delivery schedules that would be structured to match the likely requirement for materials. Construction labor procurements will be requests for quotation on unit prices for estimated quantities of construction units. Construction units are specific assemblies of components as specified in drawings and material lists and cover such things as the setting of one pole of a specified length, the construction of one pole top assembly for a three phase line, installation of one transformer, etc. Any project is composed of a number of construction units and the labor contract will be let on a fixed unit price basis, based on an estimated quantity of construction units and with the total value of the contract subject to adjustment based on the total number of units authorized to be constructed. The total value of the contract, as adjusted for the actual number of units constructed as determined by an inventory, may vary from the original value by no more than 10-20 percent.

Because of the substantial electricity access projects underway in many countries, and also in Ghana, the market for all standard utility material is robust, with a number of suppliers available to provide materials. Much of the material would be imported, but this is not an uncommon situation and experience has shown that, if material procurements are sufficiently large, at least $2 million there is ample competition among numerous vendors.

The technical assistance contractor will be expected to work closely with NEDCo which would likely impact the independence required by the Program Manager. The Program Management Contractor would be responsible for developing the schedule, working with MiDA to prepare procurements and ensure coordination between vendors. They would track and manage program deliverables and help MiDA manage risks. As shown in Figure 4-1, there are three key areas of expertise that the PM contractor needs to have to manage the process. These include distribution information systems and integration, network integration/field implementation and engineering/planning expertise for overseeing the engineering aspects of the program.

The third key contract could be an engineering contract. Figure 4-1 describes one engineering contractor responsible for multiple activities with a primary focus on master planning and development of engineering standards. By engaging one engineering firm, MiDA will likely achieve better coordination and improved efficiency. The PM should not have combined responsibility for carrying out engineering design. The PM will need to oversee the engineering contractor, which requires independence between the two functions.

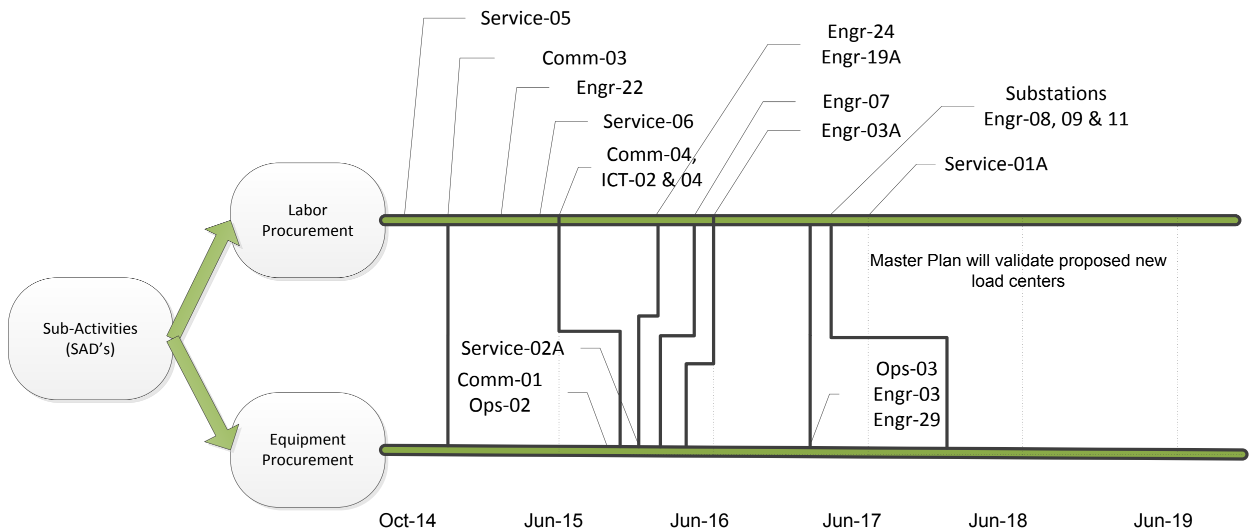
The other vendor packages are shown in Figure 4-1 which may or may not be bundled. A few of these coded with similar colors could be bundled given their similar procurement and scope requirements. More details and suggestions regarding such bundling can be found in the Table 4-3 at the end of this section. This table also describes some recommendations regarding the type of procurement and contract time that should be considered for each of the different Sub-Activity procurements.

Two considerations include:

- Bundling of material purchases into blanket purchase agreements. Such an agreement could be made with major suppliers and provide MiDA with flexibility with actual quantities and limit the number of procurement actions. Once in place, this would allow for rapid purchasing.
- Creating multiple fixed unit-rate contracts with ‘owner-furnished’ materials for such activities as bifurcation, meter placements etc. These could be let to multiple small contractors and would allow for similar flexibility as material blanket purchase agreements.

Figure 4-2 describes the process/flow in which the procurements need to happen. Likewise Table 4-3 describes the procurement package prioritization.

FIGURE 4-2
NEDCo Procurement Timeline



Within the procurement plan (see Appendix J) there are a number of specific studies required to ensure development of effective scopes of work. Table 4-3 describes these key studies. The table describes what need to occur prior to study finalization as well as the Sub-activities they impact. Appendix J also provides a Gantt chart for the procurement activities.

TABLE 4-3
Distribution Program Studies

NEDCo Study	Sub-Activity	Delivery Date	Impacts
GIS development and CIS consumer census	Ongoing	December 2015	The development of the GIS and the consumer census is a pre-requisite to all distribution planning studies and all performance improvement projects. GIS mapping is currently underway and it will be necessary to coordinate with the Swiss donors to ensure that funds for GIS are released in time.
Distribution Master Plan	NEDCo Service 04	June 2016	Requires GIS and CIS data to begin system modeling, but procurement should occur at the same time as the GIS data. This study impacts siting of proposed substations and focus areas for bifurcation
Capacitor Placement Study	NEDCo-Engr-18	May 2017	This study follows the distribution master plan. Impacts power compensation capacitor placement
Material and Construction Standards	NEDCo-Engr-22	July 2015	This study impacts metering, line construction, service installations, substation development and line device/material standards

4.3 Conclusions

Our feasibility assessment did not uncover any significant changes to the prioritization or Phase I approach. Nevertheless, it did identify a number of key considerations.

- First, our cost review identified some price discrepancies that were tied to poor material quality and the need to improve construction standards. Therefore, the development of construction standards is critical to ensure that NEDCo builds its system with appropriate equipment that will both improve system performance and reliability.

- The risk assessment identified NEDCo staff engagement as being a significant implementation risk. Although most of the proposed activities are not complicated, they do require significant engagement and process change by employees of the utility. It is critical that the NEDCo board and senior management support the integrated loss management program. This risk and proposed recommendations are further defined in the sustainability section of the report.
- Work plan development described the need for effective coordination between the different program elements. This led to the recommendation for three key contractors: a Program Management contractor; a Technical Assistance Contractor; and an Engineering firm. It is critical that these three consultants are brought on early to manage the multiple activities that will need to occur during the program.

It is the conclusion of the team that the overall program can be successful but there are critical risk factors that could impede either its initial success or its sustainability. The likelihood of success would be greatly increased under the following conditions:

- Engagement of the senior management and the affected staff members in such a way that all are committed to achieving the goals of the project and that they perceive project to success to be critical to their own success as professionals.
- Effective oversight and an adequate organizational plan on the part of the PM to ensure coordination and control of project activities.

SECTION 5

Environmental, Social, and Gender Assessment (Task 5)

5.1 Approach

A Framework Environmental and Social Impact Assessment (FESIA) was prepared for the NEDCo Sub-Activities. The objective of the FESIA was to assess the potential for environmental and social impacts and applicable mitigation associated with the construction and operation of the various Sub-Activities. The FESIA is based on existing Sub-Activity information, which includes the conceptual design and general project locations, both of which will be further refined during a later phase of the MCC Ghana Compact II.

Once MCC has selected the specific Sub-Activities to be funded, final siting and design work can be initiated. As part of the final siting and engineering design work, appropriate Sub-Activity detailed analyses and Environmental and Social Management Plans (ESMPs) should be developed. The categorization and level of required assessment of each Sub-Activity were established based on the *Environmental Assessment Guidelines for the Energy Sector* (Ghana EPA, 2012) and the 2012 MCC Environmental Guidelines. The Ghana EPA is the Ghanaian regulatory agency responsible for implementing environmental regulations and environmental permitting in the country. All projects with the potential to result in environmental or social impacts must obtain an Environmental Permit from the Ghana EPA. The Sub-Activities were evaluated against the requirements of the GoG and the environmental and social standards and guidelines established by the MCC [International Finance Corporation (IFC) Performance Standards (PSs). The Sub-Activities were evaluated against the requirements of the GoG and the environmental and social standards and guidelines established by the MCC [International Finance Corporation (IFC) Performance Standards PS)].

The full FESIA is provided in Appendix F, which further defines the process and findings.

5.2 Results

Table 5-1 contains a summary of the characteristics and potential impacts of the NEDCo Sub-Activities. This assessment is based on the currently available information and will need to be refined once locations and designs have been finalized. Mitigation measures were identified based on best international practices relating to the impacts identified in the table. A summary of the key findings is presented below. Impacts relating to resettlement and policies to deal with these findings are contained in Section 6. Status of Sub-Activities

5.2.1 Project Classification

All projects in Ghana with the potential to result in environmental and social impacts are required to obtain an Environmental Permit from the Ghana EPA. The level of environmental and social analysis required to obtain an Environmental Permit is dependent upon a projects potential for impact. An evaluation of the likely level of environmental and social analysis to be required for each of the proposed NEDCo Sub-Activities was conducted. The evaluation was based on the Ghana EPA's *Guideline for Environmental Impact Assessment for the Energy Sector* and the MCC 2012 Environmental Guidelines project classification system.

As indicated in Table 5-1, 18 of the 21 Sub-Activities are classified as Ghana EPA Category A projects and therefore will only require the preparation of Form EA1; no Environmental Impact Assessment (EIA) will be required. The remaining three Sub-Activities, all involving substation construction, are Category B projects and will require the preparation of a Preliminary Environmental Assessment (PEA) after completing Form EA1. The need for a full EIA will be assessed depending upon the information provided in the PEA.

According to the MCC categorization system, 15 of the Sub-Activities are classified as Category C projects according to the MCC categorization system and are likely to have minimal or no adverse environmental impacts, with no EIA required. The six Sub-Activities that are likely to require some resettlement are classified as MCC Category B projects. These projects will have the potential to result in some level of environmental and social impacts, however, these impacts are likely to be site-specific and few if any will be irreversible. ESMPs focusing on the anticipated impacts will be required for the MCC Category B Sub-Activities.

5.2.2 Potential Impacts and Mitigation

Because of the nature of the proposed Sub-Activities, potential impacts will be relatively minor and should be able to be mitigated effectively using international best management practices. Those Sub-Activities involving construction of substations and distribution line may result in the following impacts and risks:

- Ground disturbance, resulting in sedimentation and possible impacts to surface water drainages.
- Soil and groundwater impacts from the improper disposal of construction-related chemicals, sanitary waste, and oil and grease associated with equipment maintenance.
- Temporary localized impacts to air quality and noise from transportation of workers and materials and operation of construction equipment.
- Generation and disposal of wastes from site clearing, equipment packaging, and other small quantity sources.
- As with any work-related activity, some level of potential worker health and safety risk associated with substation and distribution line projects through traffic accidents as well as injuries during installation of the new substation and distribution lines.
- Short-term positive impacts on local economic activity and employment due to the need for construction and maintenance workers.
- Temporary impacts to traffic and commercial, residential or recreational land uses.
- Risks to community health and safety related to construction hazards, possible interactions with construction workers, and safety issues associated with construction activities at the substation and along the distribution line ROWs.

All of these potential impacts can be effectively mitigated and should be addressed in the Sub-Activity-specific ESMPs. NEDCo will develop an overall Environmental and Social Management System (ESMS) that envelopes all of the individual Sub-Activities.

Because most distribution line construction will take place in existing utility corridors adjacent to public roads, minimal impacts to soils, water quality, vegetation, wildlife habitats, critical habitat, protected species, and legally protected and internationally recognized areas are expected. Screening for these resources should be included as part of the further environmental screening of the substation sites and distribution line ROWs as part of finalization of the Sub-Activities.

The most important impacts associated with the various Sub-Activities are the potential need for resettlement and the disconnection and loss of electrical service by customers. Resettlement impacts and their mitigation are discussed in Section 6, and issues related to disconnections are examined below.

TABLE 5-1
Summary of Sub-Activity Characteristics and Impacts

Sub-Activities	Ghana EPA Category[a]	MCC Category[b]	Potential Resettlement	Potentially Important Impacts[c]
Activity: Institutional Support				
NEDCo-ICT-01: Communication Network	A	C	No	None
NEDCo-ICT-04: Data center at VRA or Sunyani	A	C	No	None
NEDCo-Comm-04: Enterprise CIS and integration with existing enterprise applications	A	C	No	None
NEDCo-Service-01A: Construction of customer service centers	A	C	No	None
NEDCo-Service-05: Technical Assistance Program	A	C	No	None
NEDCo-Service-06: Technical Assistance Master Plan Development	A	C	No	
Activity: Commercial Losses Reduction and Collection Efficiency Improvement				
NEDCo-Comm-01: Service connection materials	A	C	No	None
NEDCo-Comm-03: Customer census and normalization of existing service connections	A	C	No	Potential customer disconnections
NEDCo-Engr-24: Metering at critical nodes of the distribution system	A	C	No	None
NEDCo-Service 02A: Procurement of vehicles, tools, and equipment	A	C	No	None
Activity: Outages Reduction				
NEDCo-Engr-03A: Replace faulty and aging underground conductors	A	B	Yes	Possible resettlement for distribution lines
NEDCo-ENGR-29: Sectionalizing study of MV networks within NEDCo's territory	A	C	No	None
NEDCo-OPS-02: Procure materials	A	C	No	None
NEDCo-OPS-03: Installation of outage reporting and call center system	A	C	No	None
Technical Loss Reduction				
NEDCo-Engr-07: Shield wire conversion to 34.5 kV system Techniman-Ahafour	A	B	Yes	Possible resettlement for distribution lines
NEDCo-Engr-08: Install Banvim primary substation with interconnecting sub-T lines, MV offloading circuits, and LV network	B	B	Yes	Possible resettlement for distribution lines
NEDCo-Engr-09: Install Islamic primary substation with interconnecting sub-T lines, MV offloading circuits, and LV network	B	B	Yes	Possible resettlement for distribution lines
NEDCo-Engr-11: Install Fiapre primary substation with interconnecting sub-T lines, MV offloading circuits, and LV network	B	B	Yes	Possible resettlement for distribution lines

TABLE 5-1
Summary of Sub-Activity Characteristics and Impacts

Sub-Activities	Ghana EPA Category[a]	MCC Category[b]	Potential Resettlement	Potentially Important Impacts[c]
NEDCo-Engr-18: **Reactive power compensation for primary substations and MV lines**	A	C	No	None
NEDCo-Engr-19A: **LV feeder bifurcation with MV upgrade**	A	B	Yes	Possible resettlement for distribution lines
NEDCo-Engr-22: **Update distribution construction standards**	A	C	No	None

Note:

Both the Ghana EPA and the MCC have developed categorization schemes to classify projects according to their potential for causing environmental and social impacts. These categorization schemes also establish the level of impact analysis that is required for each category. The Ghana EPA and MCC categorization schemes are presented below.

[a] **Ghana EPA Categorization**

Category A - This undertaking or development requires that the proponent fills out Form EA1. This category is used when the undertaking/development is unlikely to have significant negative environmental impacts. No EIA is required.

Category B - This category of undertaking or development requires that the proponent carry out a PEA after completing Form EA1 because the undertaking/development may have specific negative environmental impacts.

Category C - This category of undertaking or development requires that the proponent fill out Form EA2. This category is used when the undertaking/development is likely to have diverse and significant negative environmental impacts and the preparation of an EIA is mandatory.

Category D - Strategic Environmental Assessment (SEA). This is an environmental assessment process applied to national policies, plans and programs by providing a framework within which important matters such as cumulative effects, greenhouse gas policies, conservation of resources, and issues of sustainability are taken into account. SEA is a two-stage EIA; the first stage is the overall environmental impact on the country and the second stage is a site-specific enquiry.

[b] **2012 MCC Environmental Guidelines Categorization**

Category A - A project is classified as Category A if it has the potential to have significant adverse environmental and social impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. Category A, in principle, includes projects in sensitive sectors or located in or near sensitive areas. For Category A projects, MCC will require an ESIA in accordance with the 2012 MCC Environmental Guidelines as well as an ESMP, which describes the process of mitigating and managing adverse environmental and social impacts during the implementation of a project.

Category B - A project is classified as Category B if its potential environmental and social impacts are less adverse than those of Category A projects. Typically, these impacts are site-specific; few if any of them are irreversible and mitigation measures are more readily available. For a Category B project, MCC requires specific environmental and social impact analyses, including ESMPs, as appropriate.

Category C - A project is classified as Category C if it is unlikely to have adverse environmental and social impacts. Although MCC generally will not require environmental and social impact analyses for a Category C project, MCC reserves the right to require specific environmental and social impact studies, reporting, or training where relevant or where positive environmental and social impacts may be enhanced.

Category D - A proposed project is classified as Category D, if it will involve an intermediate facility (such as a municipal public grant fund) that will use MCC funding to finance subprojects that may potentially result in adverse environmental and social impacts.

5.2.3 Overview of Energy Losses Due to Electricity Theft

Recent studies indicate that a considerable number of NEDCo customers are not legally connected to the electric system and are involved in the theft of electricity. A summary of the major findings regarding the theft of electricity is provided below.

The 2012 study Report on NEDCo Loss Control Units (LCU), prepared by Global Energy Consulting Engineers Private Limited, India (GECE, 2012) was conducted to assess losses from the NEDCo system due to the theft of electricity. The results of the study showed that the loss control units in each of the five resions served by NEDCo are not doing an adequate job detecting theft of electricity and that reliable estimates of energy theft are not available. A similar study conducted for ECG showed a theft rate of 12.8 percent, it is likely that energy theft at NEDCo is similar to that experienced by ECG.

A wide range of customer types were found to be involved with pilfering of electricity. The LCU study showed that the recovery of the estimated theft amount in 2011 ranged from a low of 2.14 percent in the Upper East Region to a high of 100 percent in Techiman Region. These results indicate that in three of the five regions which were able to recover 66.7 percent or more of the lost revenue due to theft, many of those who were stealing energy were in fact capable of paying their electric bill but chose not to. The major sources of energy theft were through meter by-passing (81 percent) and meter tampering (19 percent).

In a 2011 study of the urban poor by the World Bank, Energy Access and Productive Uses for the Urban Poor (World Bank, 2011), it was found that despite high access to electricity in the slums studied, only 46.2 percent of the households acquired their electricity connection directly and legally from ECG and thus had functioning electric meters. Many of the remaining 53.8 percent of the households were connected to their neighbors' electric meters, a phenomenon that is referred to in the slums as 'by-pass' and considered as illegal. A major reason for the illegal electricity connections was households' inability to provide building permits or police certification to make valid their applications for electricity connection from NEDCo. Other issues that are contributing factors to the elevated number of illegal connects include easy access to wires in the home that make it easy to connect lines up gradient of the electric meters (this is being addressed by the installation of new meters and normalization of service interconnections), lengthy wait times for legal connections, inability to pay for legal connections and the belief that the theft will not be caught or prosecuted.

The following Sub-Activity has the potential to result in customers with illegal connections to lose their service:

- NEDCo-Comm-03: Customer census and normalization of existing service connections

This Sub-Activity will involve NEDCo employees visiting customers and inspecting the existing electrical connections and modifying the connections and installing prepaid meters. Through this process, some customers with illegal connections will be identified, and NEDCo's practice is to disconnect all illegal connections. Illegal connections may reflect theft of electricity or on-selling by one customer to another; in both cases, the existing connections will be terminated. This may present a financial burden for some customers who may not be able to afford the reconnection fees.

NEDCo's standard procedures regarding illegal connections include disconnecting the line, imposing a requirement that the estimated value of the stolen electricity be paid back, along with a 50 Ghanaian Currency Cedi penalty. It is anticipated that MCC and the Millennium Development Authority (MiDA) will work closely with NEDCo to develop an equitable procedure to address the needs of customers who suffer a termination of electrical service.

While it is clear that some individuals who engage in theft of electricity can afford to pay for the legal connection and the subsequent electric bill, there are other segments of the population who cannot. To minimize adverse impacts to the poor who could lose their current illegal access to electricity, MCC/MiDA will have to work closely with NEDCo to develop programs to increase access to legal connections at an affordable price. One of the proposed Sub-Activities, the installation of prepaid meters, will give customers better control over their electric use and payment schedule and should minimize the number of disconnections for lack of payment and subsequent additional fees for reconnection. The current use of lifeline tariffs, which provide subsidized electric rates for low volume users, will continue to help the poor with paying for their electric service. Other mitigating actions that can moderate the negative impact on poor customers who lose their electrical service due to illegal connections include:

- Development of an amnesty program where customers in an area can be informed of planned activities that could result in their loss of service due to illegal connections and provide the customers with the opportunity to come forward in advance of the activities and request a legal connection.
- The cost of new connections cud be subsidized for members of the community without the financial resources to pay for the full cost of the legal connection.
- Development of a public information program to explain the importance of having a legal and safe electrical connection and how this can be accomplished.
- NEDCo can improve their electrical connection installation service and schedule.
- Provide access to high efficiency electric bulbs and other common household appliances to help reduce overall electric consumption and overall household electric costs.
- Revise the documentation requirements for obtaining a legal connections to be more in line with documentation that is typically available to those customers with limited financial resources.

The above potential mitigation measures and others should be evaluated NEDCo, MiDA and MCC to finalize a set of actions that will assist those with limited financial resources to obtain legal electrical connections and pay for continuing electrical services without imposing significant financial burdens on NEDCo.

5.2.4 Gender Assessment

The Gender Assessment carried out for Compact II Sub-Activities is contained in Appendix F, Section 9. The summary conclusions of this assessment are summarized below.

The increased availability and reliability of electricity supplies resulting from Compact II will bring benefits to a significant proportion of Ghana's population, be they male or female, young or old. By and large, these benefits will affect men and women in much the same way – increase income-generating potential and reduce the negative impact of outages. They will also increase the quality of domestic living. The same goes for the construction of new customer service centers.

The differential gender impacts relate mainly to home activities that are largely carried out by women, who would therefore benefit from improved lighting in the home for both domestic and small income-generating activities. Improved street-lighting will also increase their sense of security during the hours of darkness.

The most likely negative impact relates to disconnections due either to non-payment or presence of illegal connections. As women tend to spend more time in the home during the day, such disconnections will have a greater impact on them. Night-time impacts will, on the other hand, tend to be gender-neutral.

Other potential negative impacts are hard to identify based on available information and revolve around the use of pre-payment cards and the introduction of new meters.

Generic measures to enhance potential beneficial impacts and reduce potential adverse impacts are provided in the ESMP contained in Appendix F and will be elaborated during the preparation of Sub-Activity-specific ESMPs. These generic measures include:

- Adoption of appropriate measures to reduce the potential impact of disconnections.
- Provision of training to meter readers and maintenance staff on dealing effectively with the public, including awareness of sensitive gender issues where appropriate.
- Awareness campaigns for new payment methods and the introduction of new meters.
- Ensuring that opportunities for training existing personnel and hiring additional personnel have no gender bias.

The overall conclusion of this gender assessment is that increased availability and reliability of electricity supplies will bring significant benefits to women, as they will to most of the population, and that there will be little in the way of negative impacts – for which a number of mitigating measures are available.

5.2.5 Health and Safety

Currently, there are no NEDCo personnel with responsibility for environmental, social, or health and safety issues and management. These services, when needed, have historically been provided through VRA's staff, policies and procedures. Although VRA has the necessary EHS instructional capacity to support the proposed NEDCo Sub-Activities, formal arrangements will need to be made with the oversight of MCC to properly address all necessary environmental, social health and safety issues. A summary of VRA's environmental, safety and health policies is provided below.

The VRA Safety Policy commits the organization to making safety a primary concern throughout the organization in its activities and operations. It also seeks to achieve an acceptable standard of safety for its employees by effectively managing all risks resulting from or associated with its activities and operations. The VRA Safety Policy provides for measures to be taken to secure and maintain compliance with all relevant legislation on environmental protection and safety and the health and welfare of all its employees.

Safety rules, protection code, and safe working practice documents have subsequently been prepared to inform, educate, and ensure adherence. The VRA's safety rules provide information on major safety areas as follows:

- General safety rules for workers engaged in construction, operation, or maintenance work
- Safety guidelines relating to the use of tools and equipment
- Safety procedures associated with the transportation and of personnel and materials
- Safety procedures relating to forestry work
- Safety procedures relating to distribution line work
- Safety procedures for materials handling, storage, and disposal

The VRA Corporate Health Policy statement commits the organization to establishing and maintaining health standards, facilities, and services to promote and safeguard the health, well-being and safety of the organization's employees, their families and dependents, as well as others who may be affected by its operations. Conclusions

The objective of the FESIA was to assess the potential for environmental and social impacts and applicable mitigation associated with the construction and operation of the various Sub-Activities. After a Sub-Activity is selected for implementation, ESMPs can be developed and permits obtained according to the requirement of the Ghana EPA.

The results of the Phase II Feasibility Study identified 21 Sub-Activities, 18 of which will only require the preparation of Form EA1 and not an EIA for the Ghana EPA. The remaining three Sub-Activities, all involving substation construction, will require the preparation of a PEA after completing Form EA1. The need for a full EIA will be assessed depending upon the information provided in the PEA.

Similarly, 15 of the Sub-Activities are classified by the MCC as likely to have minimal or no adverse environmental impacts, with no EIA required. Six of the Sub-Activities that require construction of substations or distribution lines have the potential to require the preparation of Sub-Activity specific ESIAs.

Resettlement conditions were considered for all 20 Sub-Activities. Seven of the Sub-Activities having to do with the construction of substations and/or distribution lines have the potential to require some level of resettlement. The remaining Sub-Activities will not require resettlement.

Based on the requirements of the proposed Sub-Activities, potential impacts will be relatively minor and should be able to be mitigated effectively using international best management practices. Because most distribution line construction will take place in existing utility corridors adjacent to public roads in urban areas, only minimal impacts to vegetation, wildlife habitats, critical habitat, protected species, and legally protected and internationally recognized areas are expected. Likewise it is not expected that Sub-Activities will impact cultural or heritage sites.

The most important impacts associated with the various Sub-Activities are the potential need for resettlement from the disconnection and loss of electrical service by customers. It is customary practice for customers without legal connections to be disconnected from service and in some cases, financial and/or legal penalties can be imposed. This may present a financial burden for those customers who may not be able to afford the reconnection fees. It is therefore recommended that a program of mitigation measures be developed and implemented to facilitate the legal reconnection of the poor, as appropriate.

Measures to identify, mitigate, and monitor potential negative environmental and social impacts are contained in the ESMP presented in Appendix F. Sub-Activity specific ESMPs will be developed where necessary according to the requirements of the Ghana EPA, the 2012 MCC Environmental Guidelines and the IFC PS 1.

SECTION 6
Resettlement Policy Framework (Task 6)

6.1 Approach

Resettlement is considered involuntary when affected persons or communities do not have the right to refuse land acquisition or restrictions on land use that result in physical or economic displacement. For the purpose of the Resettlement Policy Framework (RPF), the term "involuntary resettlement" refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood as a result of Sub-Activity-related land acquisition and/or restrictions on land use).

All Compact II Sub-Activities were screened for their potential involuntary resettlement impacts. Once the institutional and capacity building Sub-Activities had been screened out, six NEDCO Sub-Activities were identified as potentially requiring involuntary resettlement. These Sub-Activities involve the construction or modification of substations and distribution lines.

At present, only representative area locations for these Sub-Activities are known; design studies, including routing, have yet to be completed and therefore specific locations have yet to be identified. It is therefore not possible to identify any ensuing involuntary resettlement impacts involving physical displacement and/or economic displacement.

For these reasons, Sub-Activity-specific Resettlement Action Plans (RAPs) cannot be prepared at this stage. Accordingly, a single RPF was prepared, which addresses resettlement issues and procedures for the six NEDCo Sub-Activities identified as having the potential to require involuntary resettlement. The RPF was designed to present the overarching guiding principles, PAP entitlements for compensation and in kind assistance, grievance redress procedures, consultation and monitoring mechanisms, RAP requirements and content, and organizational arrangements and implementation procedures which will facilitate the subsequent preparation of the RAPs.

In accordance with the requirements of PS 5, Land Acquisition and Involuntary Resettlement, the RPF addresses all involuntary resettlement activities, including those that result from damage to property caused by construction activities integral to project implementation. These types of damages will lead to a temporary disruption of business operations that are capable of reinstatement and will require neither relocation nor permanent changes in land use. Compact activities may also give rise to shorter-term disturbances to business operations and household activities.[3] These types of disturbances will be identified and managed by applying the requirements of PS 1, Assessment and Management of Environmental and Social Risks and Impacts, and PS 4, Community Health, Safety, and Security. As such, measures to mitigate these types of disruption are included in the ESMP presented in Section 10 of Appendix F, Framework Environmental and Social Assessment.

This section presents a summary of the main features of the RPF, which is provided in its entirety as a stand-alone document.

6.2 Potential Resettlement Impacts of Compact II SADs

Table 6-1 presents a summary of the technical components of the NEDCo Sub-Activities identified as potentially requiring involuntary resettlement. The total length of the proposed distribution lines is around 520 km. Just over half is for MV lines and around 40% for LV lines. The most extensive Sub-Activity is NEDCO 07 which covers 370 km of new and upgraded MV and LV lines. Two sub-stations will be built: one in Tamale and one in Sunyani.

[3] Examples are the need for temporary health and safety buffers around some construction activities that could cause minor, short-lived (e.g., in the order of a few minutes to a couple of hours) disruptions,

TABLE 6-1
NEDCo Sub-Activities with Potential for Involuntary Resettlement

SAD ID	Name	Location	Type of Area	Sub-station	SAD Distribution Components (km)					
					Sub-transmission (34.5 kV)		MV (11 kV)		LV	Total Length
					UG	OH	UG	OH	OH	km
NEDCo-03	Replace Underground Cables	Sunyani, Techiman, Bolgatanga, Tamale	Urban		0	0	33	0	0	33
NEDCo-07	Shield Wire Conversion (Techiman to Abofour)	Brong Ahafo Region	Rural/ small town		0	0	0	170	200[c]	370
NEDCo-08	Banvim Substation	Tamale	Peri-urban	1	0	10	0	6	10	26
NEDCo-09	Islamic Substation	Tamale	Peri-urban	1	0	6	0	8	10	24
NEDCo-11	Fiapre Residential Substation	Sunyani	Urban	1	0	8	0	3	5	16
NEDCo-19	Line Bifurcation	NEDCO service area			0	0	0	55	0	55
		TOTAL - NEDCo		**3**	**0**	**24**	**33**	**242**	**225**	**524**

[a] NEW – 50 km; Upgrade – 120 km

[b] 50 km –new (replacement of 34.5 kV shield wire); 150 km – upgrade

SAD – Sub-Activity Description; OH – overhead; UG – underground.

In line with current NEDCo design standards and practice, sub-station sites are generally small (up to 1 hectare but more typically around 0.5 hectare). Sites are most often vacant or under-used and owned by institutions, thus reducing potential resettlement impacts.

The majority of the involuntary resettlement will be focused on the construction and/or the modification of distribution lines. These lines are most frequently located within existing 6-meter-wide utility corridors that are located on both sides of most public roads in Ghana, in order to reduce the potential impact on private land.

In theory, ROWs should be unencumbered, that is free from structures. In practice, it is common along many of Ghana's busy streets for vendors and shops to be located in structures that encroach into the utility corridors. These structures are of two general types: converted steel shipping containers and temporary structures made out of wood or other impermanent materials; conversely few permanent structures are located within ROWs. Some of these businesses are legal in that they have received licenses from the local municipality to operate within the utility corridors. A condition of these licenses is that the license owner acknowledges that the license is temporary and that the businesses may need to be relocated if the corridors are needed for the placement of utilities such as distribution lines. These relocations can be either temporary or permanent. In most cases, people do not live within the utility corridors and therefore, most of the involuntary resettlement requirements associated with the distribution Sub-Activities will involve economic displacement and not loss of shelter.

Based on the assessment contained in the RPF, the potential resettlement impacts resulting from Compact II activities are the following:

- Acquisition of land for sub-stations and relocation of occupants: unlikely to result in many PAPs due to the selection of vacant and under-used plots.
- Permanent acquisition of land or structures for distribution networks: again relocation is expected to be low because existing ROWs will generally be used for new distribution networks and design flexibility will be applied in routing trenches, overhead lines, and erecting poles. In addition, many roads already have existing

overhead lines; this will reduce the need for the creation of wholly new distribution lines and further reduce potential acquisition, relocation, and disturbance.

- The most widespread impact will be temporary disturbance to encroachers as a result of trench digging and replacement of existing wires and poles. Most establishments will, however, be able to carry on their operations throughout much of the construction period, thereby limiting potential loss of income. Petty traders will be largely unaffected because they can easily relocate within the plot or to another location on the road.
- Periods of disturbance will be longer where underground rather than overhead construction is carried out – up to 3 months based on current construction methods. However, most establishments will be able to continue in operation for most of his time, so income loss will be minimal if at all.
- For overhead lines, the period of disturbance will be much lower – around 1 to 2 hours for line work and up to 1 day for pole operations. The latter disturbance will not be continuous, thereby reducing potential income loss.
- There will be few requirements to acquire permanent structures or residential premises because these are rarely located within ROWs.
- For schemes in rural and peri-urban areas, some acquisition of small parcels of land (up to 10 m^2, which includes the space required for construction) will be required for the erection of poles, and the loss of one season's harvest will occur on a portion of the parcel.

Notwithstanding the qualitative nature of the current assessment, the severity of potential resettlement impacts that could potentially arise from the Compact II Sub-Activities will almost certainly be low. This is a very different situation from resettlement on Compact I, where most PAPs had to be relocated. Furthermore, the most prevalent impact will be temporary disturbance to establishments located within ROWs who will be affected by the construction of the trenches for the underground schemes, and to a considerably lesser extent from the overhead schemes. PAPs will however be able to maintain their operations throughout much of the construction period and will not need to relocate.

Ultimately, the level of involuntary resettlement required for the Compact II Sub-Activities will depend upon the final location of the various proposed Sub-Activities, the existing level of development within the utility corridors and surrounding areas, their technical design, and the extent to which measures recommended below to reduce involuntary resettlement are adopted.

6.3 Resettlement Objectives and Guiding Principles

6.3.1 Objectives

The resettlement principles and objectives contained in the RPF are governed by the requirements of IFC PS 5. The overarching objectives of PS 5 are summarized as follows:

- Minimize and mitigate impacts of involuntary resettlement on affected persons resulting from the implementation of the MCC Ghana Compact II.
- Ensure that people who are adversely affected are fully compensated and successfully resettled; the livelihoods of displaced people are re-established; and that their standard of living is, wherever possible, improved.
- Prevent the impoverishment of affected persons as a consequence of compulsory land acquisition or loss of livelihood for purposes of implementing these Sub-Activities.
- Make certain that all affected persons are informed of the process and aware of procedures for expressing grievances that are accessible and responsive.
- Provide needed additional assistance for vulnerable groups, such as women-headed households.

- Provide full and accurate information about the project, and afford potentially affected person (PAPs) meaningful opportunities for participation in design, implementation and monitoring.

6.3.2 Guiding Principles

These objectives will be achieved for Compact II through the application of the following guiding principles:

- Minimize involuntary resettlement (see next-sub-section).
- Implement an inclusive approach to entitlements that includes compensation and other assistance for those with no legal land occupancy right as well as those with legal or recognized customary title to their land and those with land use rights.
- Compensation for land that will be lost will be at full market value, and assets at full replacement value.
- Provide cash compensation and/or in-kind assistance, including relocation sites where economically feasible, that best suits the needs of affected persons commensurate with the extent of the impacts that they will experience.
- Provide disturbance payments to mitigate the impact on the livelihoods of affected persons having to relocate their residence and/or business, whether on a permanent or temporary basis, in order that they are able to restore their incomes and living standards to the pre-project level.
- Implement additional measures to address the relocation needs of vulnerable groups.
- Maintain a continual process of consultations, disclosure, and negotiations with affected persons throughout the entire resettlement process, including establishing an accessible and transparent grievance redress procedure.
- Have a clear and transparent process for the disbursement of any monetary compensation and ensure that all persons having to relocate receive their compensation before they have to vacate their land or property.

6.3.3 Minimizing the Need for Resettlement

Of the objectives listed above, the most important is the minimization of involuntary resettlement. Ways in which resettlement impacts can be minimized include:

- Selecting routes within the existing designated utility corridors.
- Adopting flexible design standards: current practice in Ghana is that formal requirements for fully clearing the ROWs for 11 kV and 440 V transmission lines are waived where these would give rise to involuntary resettlement. Likewise, not imposing the 2-m setback for conductors where these pass over temporary structures.
- The flexible routing of trenches: (i) using less-encumbered roads; (ii) using the less-encumbered side of a road; (iii) switching the trench alignment between the front and rear of roadside structures; (iv) putting the trench in a conduit that runs under structures; and (v) shifting existing structures within the existing land parcel, thereby enabling current occupants to remain in their current location and avoiding their permanent relocation.
- Replacing existing lines and poles, which exist on most roads, instead of creating new alignments.
- Varying pole spacing to avoid concentrations of establishments and switching the alignment from one side of the road to the other.
- Designing the distribution structures, cross arms, and conductors to minimize the area needed to increase clearance from existing structures.
- In cases where distribution lines must cross a congested area, installing the line underground, thereby minimizing impacts to existing structures.

- Selecting sites for sub-stations that are vacant or under-used and reducing the area required as much as possible.
- With respect to easements over agricultural land, the same general principles apply, such as siting transmission lines along existing ROWs and avoiding more-productive land areas.

Adopting the above practices can substantially reduce the need for involuntary resettlement. However, the most important point is that, with the possible exception of the design of distribution structures, all the above are already current practice for NEDCo engineers because they are well aware of the potential difficulties and costs that would result from removing existing structures from utility corridors. These standard practices, which all serve to reduce involuntary resettlement, will be further strengthened by ensuring that project resettlement experts work with the design teams during the preparation of the final designs for each Sub-Activity.

With respect to temporary disturbance, the following specific measures shall be adopted:

- Phasing trench-digging and cable-laying in such a way that the period of disturbance is decreased—e.g., minimizing the period when there will be an open trench and providing temporary access across the trench for this period (or temporary backfilling); reducing, as far as possible, the gap between trench digging and cable-laying; and ensuring a high level of reinstatement where trenches have damaged hard standings and other ancillary structures.
- Whenever feasible, employing mechanical methods to dig holes and erect poles for overhead lines.
- Providing timely information to ROW occupants on: (i) the day on which construction activities will take place; (ii) the time of day when these operations will occur; (iii) the type of activities that will take place; and (iv) any precautionary measures that ROW occupants will need to take.
- When appropriate, providing assistance to vendors in identifying and occupying temporary selling locales during periods of disturbance.
- Ensuring that a safety officer is on hand to warn occupants when their movements need to be restricted.
- In rural areas, timing construction with the cultivation cycle so that land is taken after, and not before, the harvest season.

The implementation of these measures will be managed under the requirements of the ESMP presented in Section 10 of Appendix F.

Collectively, these measures have the potential to substantially reduce the need for involuntary resettlement from Compact II Sub-Activities. This is a different situation from many projects where design constraints limit the potential for reducing resettlement in this way.

6.3.4 Gap Analysis of National Legislation and PS5

Adherence to IFC PS 5 is a requirement of the MCC. MCC therefore requires that the executing authorities do not rely solely on current legislation but must satisfy the requirements of PS 5. The gap analysis of the Ghanaian legislation related to resettlement and PS 5 requirements revealed the following compatibilities and divergences:

- Ghanaian legislation covers several of the requirements of IFC PS 5: an acceptance that those losing land or property should be properly compensated; compensation is valued at replacement value; additional allowances for 'disturbance' and other impacts resulting from involuntary resettlement may be provided; notification of compulsory purchase is required; redress is provided through the legal system; and limited consultation procedures are required. There is no explicit requirement to minimize involuntary resettlement, although there is little incentive for design teams not to do so given that unresolved resettlement issues can seriously delay projects and add to their cost.
- There are significant gaps between the law and the requirements of IFC PS 5. The most important of these is that, under current GoG legislation, those who do not have a legal (or customary) right to land are not entitled to any compensation for lost property or assets. These groups, who would therefore not qualify for

compensation, include squatters (including occupiers of ROWs), whether residential or business, renters, and employees of affected enterprises.

- There are no provisions for additional measures to aid livelihood recovery or for increased assistance to vulnerable groups.
- Requirements for consultations with affected persons and other stakeholders, disclosure of relevant documents, and grievance redress procedures fall well short of IFC PS 5 requirements. Act 125 has no provision for public consultation and involvement in the acquisition process - although some provision does exist within the environmental legislation and there is no provision for grievance redress outside recourse to the legal system.
- There is no legal requirement to prepare RAPs or to undertake monitoring of the resettlement process.

It should however be noted that recent projects financed by the World Bank and the MCC have incorporated provisions related to these legislative gaps to ensure compliance with World Bank Operational Policy 4.12 or IFC PS 5. These include additional assistance to squatters, enhanced consultation, disclosure and grievance procedures: "as a result of the compliance with WB OP 4.12, PAPs are involved in resettlement through public hearings and forums; they are given compensation at open market value and those previously considered as squatters receive supplementary assistance to help them relocate" (MCC, 2009; Volta River Authority, 2007). There are, therefore, precedents for the full adoption of IFC PS 5 which mean that compliance with PS 5 is unlikely to be a controversial issue when addressing resettlement impacts arising from MCC Compact II Sub-Activities.

6.4 Resettlement Planning and Implementation

Resettlement impacts resulting arising from Compact II Sub-Activities will be planned and implemented according to the requirements of PS 5. These are set out in the RPF. The RPF establishes the general policies and procedures that will be adopted for all resettlement activities related to Compact II. In addition to providing more detail on potential resettlement impacts and resettlement objectives and principles described in preceding sub-sections, the RPF contains, in summary, the following:

- Entitlements: The rights to compensation for PAPs experiencing different types of loss, such as land, structures, or business location, as well as temporary disruption to business operations. Entitlements are based on three over-arching principles of PS 5: (i) physical losses should be compensated at full replacement value; (ii) PAPs will receive compensation irrespective of their legal right of occupation of the affected land; and (iii) compensation for loss of income during periods of relocation or temporary disruption to their activities.
- Establishment of a Grievance Redress Mechanism to ensure that PAPs have a means of redress should they consider the compensation offered to be insufficient to cover their losses.
- Consultations and participation: Required consultation procedures to ensure that PAPs are adequately and effectively involved throughout the resettlement process.
- Implementation arrangements: Agencies involved (e.g. MiDA, NEDCo, Land Valuation Division); institutional arrangements (resettlement teams and oversight committees); staffing and training needs.
- Specification of a monitoring and evaluation system designed to: (i) report on the progress of RAP implementation; and (ii) to ensure that PAPs are able to regain pre-project incomes and living standards.
- Procedures for the valuation of assets, negotiating and agreeing on compensation and in-kind assistance packages with PAPs, disbursing compensation, and site vacation.

The policies and procedures contained in the RPF will, unless there are site-specific considerations that dictate otherwise, guide the preparation of RAPs for all Compact II resettlement activities. In relation to RAP preparation, the RPF sets out the following requirements for RAP preparation and content:

- A description of measures undertaken to minimize resettlement.

- Carrying out the census and inventory of assets that identify: (i) the numbers and characteristics of PAPs; (ii) the extent of their losses; and (iii), where appropriate, options for cash and in kind assistance.
- Collection of information needed to establish unit costs for all relevant types of compensation.
- Preparation of PAP compensation packages.
- Resettlement cost estimate and implementation program.
- Schedule of consultations held.

SECTION 7

Financial and Economic Assessment (Task 7)

7.1 Financial Modeling

7.1.1 Approach

This section provides an overview of the financial assessment methodology used, including the analytic tools, assumptions, and data sets. The impact of investment in loss reduction and performance improvement interventions can be evaluated in two ways:

1. On the basis of each individual intervention, or
2. As a complete portfolio of activity interventions on utility financial performance

Task 3 of the Scope of Services requires financial analysis of each Sub-Activity based on the implementation cost of each investment and the predicted benefits. The Sub-Activity Descriptions (SADs) provide the calculated NPV, IRR, and investment assumptions for each Sub-Activity and are provided in Appendix C. For this section (Task 7), the impact of all of the Sub-Activities on the overall financial performance of the utility is addressed.

7.1.1.1 Sources of Data

The primary source of data for model inputs was the financial data presented in the *Ghana Power Distribution PSP: Due Diligence Report* Volumes III and IV (AF Mercados, 2014) and updated with data provided by AF Mercados on March 26, 2014. The Mercados due diligence studies present a comprehensive overview of legal, market, governance, technical, and commercial performance; human resource issues; capital expenses; operational expenses; and financial analyses. Data for financial modeling was derived primarily from the financial and accounting sections of the report, although market, capital, and operational expense sections were also employed to inform sections of the model.

At the outset of this project, commercial data requests were sent to NEDCo including requests for information about purchased power, sales, energy losses, collections, and number of consumers by category. Where data from the Mercados report conflicted with utility source data, the NEDCo data was given a higher priority. This consideration primarily applied to energy loss and collection rate information, for which significant variances were noted between the NEDCo data and the data provided in the Mercados report. In all cases, the Mercados data was reviewed against information and data obtained directly from the utility. For purposes of consistency with other projections performed for MCC, financial data reported for calendar year 2012 were employed in the financial model.

7.1.1.2 Structure of the Financial Model

The financial model was developed by using a combination of historical and projected revenue and cost data to evaluate profit and loss for the utility, and to evaluate the impact of MCC performance improvement investments on future power purchases, revenues, and profitability. The model integrates commercial data provided by the utility with sales and cost projections obtained from the AF Mercados due diligence report. The AF Mercados data are comprehensive on the level of the utility, but are not presented by service region.

Given that the proposed investments are geographically focused, it was necessary to disaggregate the sales and cost projections by service region.[4] To accomplish the disaggregation, NEDCo's 2012 sales data were used to create the ratio of total sales to sales for each service region; these ratios were then employed to allocate projected sales by service region for future years based on the Mercados growth projections for each utility. The same methodology was employed to allocate consumer growth by service area for the models. The use of this approximate approach was required due to the lack of disaggregation of the data, which would not support any greater level of detail. The effect of this approach is to assume the same growth level for all regions. This was

4 For purposes of consistency, service territories are referred to hereinafter as "regions."

considered an acceptable approximation because electric utility modeling often averages growth across the entire market. In addition, many costs are aggregated in utility accounting for the entire utility, so while the MCC projects are geographically based, their impact will be shown at the aggregate utility level.

Wholesale power costs were projected by service region using a similar methodology. The utility records wholesale power cost by service region; its 2012 cost data provided were integrated into the model to provide the basis for future cost projections. The 2012 cost data were used to define the ratio of wholesale power cost for each service region relative to wholesale power cost for the entire utility. The service region/entire utility whole power cost ratios were then applied to future wholesale power cost projects for the entire utility to provide wholesale costs for each service region on a year-by-year basis.

Operating costs, depreciation allowance, and other costs were not disaggregated by service area simply because the differences are not material. An analysis of the impact of the Sub-Activities on financial performance can be performed while allocating operating costs at a global level.

7.1.2 Results

The financial model integrates growth in sales, revenues, costs, and implementation of MCC Sub-Activities to yield resulting profit/loss for NEDCo based on the revenue and cost structure embedded in the historical performance of the utility. The behavior of NEDCo financial performance pre- and post-Sub-Activity improvement investments can thus be forecast by varying levels of technical and non-technical losses as well as collection rates. The model can also be used to adjust tariff levels over the forecast horizon.

To illustrate the impact of the MCC investments in NEDCo, this section first presents the model results without any improvements. Results of the impacts of the proposed performance Sub-Activities on NEDCo financial performance are then presented. Following the presentation of expected results, the sensitivity analyses are discussed for the performance improvement targets.

One additional change was modeled to help to understand the potential for healthy financial performance. An analysis of the degree to which tariff increases, independent of additional loss reduction activities, will be needed to achieve positive financial returns is presented.

Impacts of the loss reduction/performance improvement portfolio were analyzed by varying the energy losses and collection rates projected by the implementation schedule for all Sub-Activities in the MCC investment portfolio. Sensitivity analyses were performed to evaluate how the performance of the portfolio affects NEDCo's financial performance. Given that the investments are targeted to specific geographic areas of the utility, the reduction in losses and improvement in collections are applied only to the service area in which the investments will occur. The performance improvements (i.e., reduction of losses and improvements in collection rates) were integrated into the utility-wide financial model. While the performance improvements contribute significantly to revenue recovery and cost reduction in the geographic focus regions, the overall impact is not as pronounced when integrated into the pool of enterprise-wide utility cost and revenue streams.

7.1.2.1 Baseline

NEDCo reports sales by station. Each station's sales was summed to the region (for NEDCo "area") to calculate the 2012 sales information. For wholesale purchases, a similar approach was used, in which station sales were summed to the region level. Table 7-1 shows the power purchased and sales data for all NEDCo regions for calendar year 2012.

TABLE 7-1
NEDCo Purchases and Sales Data by Region for 2012

Region	Purchases (MWh)	Sales (MWh)
Sunyani	263,420	183,033
Techiman	150,537	103,703
Northern	243,797	177,614

TABLE 7-1
NEDCo Purchases and Sales Data by Region for 2012

Region	Purchases (MWh)	Sales (MWh)
Upper East	103,686	73,858
Wa	60,111	44,035
Total	**821,552**	**582,243**

Source: NEDCo commercial data.

It was next necessary to forecast sales, purchases, and operating expenses by area over the 20-year horizon. The baseline model presents a 20-year financial horizon employing existing loss levels and collection rates, using historical tariffs for 2012 through 2014. Table 7-2 presents financial results for NEDCo for the baseline—that is, before the ILMP is implemented. Operating revenues increased because of increases in demand as well as implementation of tariffs already enacted by the Public Utilities Regulatory Commission (PURC). The average retail tariff, per the PURC order was/is:

- 2012-Sept 2013: GHS 0.2204/kWh
- Oct 2013-Jan 2014: GHS 0.355348/kWh
- Jan 2014-May 2014: GHS 0.382487/kWh
- May 2014 and onward: GHS 0.424564/kWh

The cost of wholesale power for 2014 and all subsequent years was obtained from the PURC ruling that became effective January 1, 2014, and PURC ruling planned for April 1, 2014, but expected to be implemented later in 2014. The wholesale rate includes a bulk generation charge as well as a transmission service charge. The rate is 0.175013 GHS/kWh, or about $0.06/kWh at an exchange rate of 0.34529. This is a lower value than what ECG pays because NEDCo is charged a preferential rate from VRA. The wholesale purchase rate is kept constant between 2014 and 2032 (no inflation). The demand for purchased power grows at a compound annual growth rate based on AF Mercados projections. The projected annual growth rate varies from 2.7 percent to 21 percent in different years of the projection, but the average growth rate is approximately 6.5 percent over the forecast period.

Annual operating costs reflect historical NEDCo records. O&M costs grow as a function of the NEDCo asset base relative to the current value for O&M. Distribution expenses grow as a function of the increase in customers linked to current values for distribution expenses per customer. Administrative costs are a function of the ratio of current expenses relative to the number of customers and costs grow in direct proportion to the annual increase in customers. Similarly, “other” operating expenses are tied to the current expenses and reflected in annual growth as a proportion of customer growth.

Both expenses and revenues are calculated in constant Ghanaian Cedi. This assumes no inflation, and is standard practice for long term financial analysis. Inflation is an unpredictable factor, and rather than attempt to incorporate some estimate for inflation which is certain to be incorrect, this analysis assumes an inflation rate of zero. In effect, because the PURC has approved a tariff increase that is likely to be effective in May 2014 and this is incorporated into the analysis, the value of the Cedi is fixed as of May 2014.[5]

As shown in Table 7-2 and Figure 7-1 the results of the baseline financial model show a pattern of improving financial performance beginning in 2014, when the impact of the tariff changes take place. However the improved performance is insufficient in that even with tariff increases, NEDCo does not show a profit, even before accounting for collection losses. And over time, by 2017, losses again increase as revenues are insufficient to keep up with operating costs.

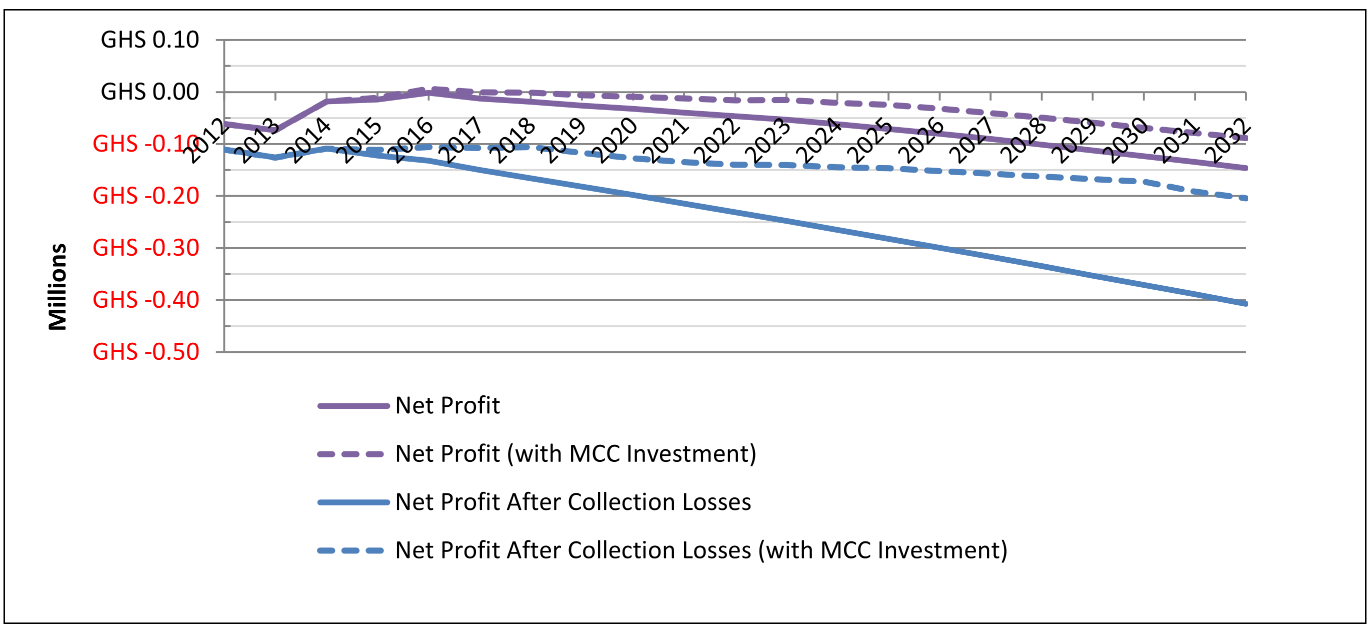
[5] Tariffs in Ghana are indexed to inflation but PURC has not been passing the full costs through to consumers.

TABLE 7-2
NEDCo Baseline Financial Projection through 2017 (GHS 000)

	2012	2013	2014	2015	2016	2017
Energy Sales (MWh)	582,243	608,593	679,522	781,902	947,496	992,680
Average tariff (GHS/kWh),	0.26	0.26	0.41	0.43	0.43	0.43
Revenue from Energy Sales	150,771	161,201	279,459	332,811	403,295	422,527
Operating Revenue	151,821	162,258	280,521	333,880	404,371	423,609
Cost of Wholesale Power	89,920	100,857	143,262	171,482	207,800	217,709
Gross Margins	61,901	61,400	137,259	162,398	196,571	205,900
Operating Costs						
O&M and Distribution Expenses	47,713	57,930	74,458	90,986	107,514	124,043
Administration Expenses	27,521	28,506	31,018	33,637	36,357	38,142
Total	75,234	86,436	105,476	124,624	143,871	162,184
Depreciation	49,751	49,643	51,130	52,735	54,453	56,276
Financing Costs	-	510	1,335	2,160	2,985	3,810
Operating Profit/Loss	(63,084)	(75,189)	(20,682)	(17,121)	(4,738)	(16,370)
Non-Operating Income/Expenses	1,246	1,332	2,302	2,740	3,319	3,477
Net Profit/Loss	(61,838)	(73,857)	(18,380)	(14,381)	(1,419)	(12,894)
Collection Losses	(48,850)	(52,229)	(90,545)	(107,831)	(130,668)	(136,899)
Net Profit/Loss after Collection Losses	(110,688)	(126,087)	(108,924)	(122,212)	(132,087)	(149,793)

Source: CH2M HILL NEDCo financial model

FIGURE 7-1
NEDCo Baseline Financial Projection



The biggest issue facing NEDCo is that a large percentage of its customer base is on a tariff that is too low (Life Line customers), and the utility simply has insufficient revenue to offset expenses.The lifeline tariff is an explicit subsidy and the challenge is to set the lifeline at a level that provides necessary social benefits without compromising the ability of NEDCo to operate. The high level of collection losses exacerbates the challenge, but even if collections were 100 percent, the utility would still not show a profit. Collection losses are a significant cost and reducing them is a high priority. Collection loss is over 30 percent of operating income in 2012, and throughout the forecast period under the baseline scenario. ATC&C loss is 46 percent in 2012 and throughout the forecast period in the baseline scenario.

7.1.2.2 Financial Impact of Sub-Activity Investments

The financial impact of the MCC projects included in the ILMP are shown as a second set of curves on Figure 7-1. Table 7-3 provides information on losses, including ATC&C, technical, commercial, and collection categories that will result from implementation of the ILMP Based on the implementation schedule of the Sub-Activity investments, the ILMP is projected to reduce overall ATC&C from 46 percent to 35 percent over 4 years (see Table 7-3). While this level of improvement due to the ILMP cannot be guaranteed it is a reasonable projection based on the assumption of a vigorous loss reduction program.

TABLE 7-3
Projected Loss and Collection Values with Implementation of ILMP

Category	2012	2013	2014	2015	2016	2017	2018	2019
ATC&C	46%	46%	46%	43%	41%	38%	35%	29.9%
Technical Losses	10.9%	10.9%	10.9%	10.4%	9.9%	9.4%	8.9%	5.0%
Commercial Losses	9.3%	9.3%	9.3%	8.78%	8.3%	7.8%	7.3%	21.2%
Collection Efficiency	67.6%	67.6%	67.6%	70.2%	72.6%	75.1%	77.6%	95.0%

Sources: NEDCo commercial data; CH2M HILL projections.

Using the information in Table 7-3, the financial model of Figure 7-1 shows the improvement over the baseline model results in terms of net profit/loss after collection losses. Net profit improves due to ILMP improvements. However, the model also shows investment in the ILMP Sub-Activities is insufficient to provide positive net profit.

With the financial model and the incorporation of the ILMP investment, operating revenues remain unchanged from the baseline. Because costs have been reduced and NEDCo is still not profitable, it is plausible to consider an increase in revenues to achieve a profitable status for NEDCo. If the tariff is increased by the percentage of net loss over the operating revenue for 2015, NEDCo should begin to achieve profits from that point forward. Figure 7-2 illustrates the effect of a real tariff increase of 15 percent in 2015, with additional increases of 5 percent in both 2016 and 2017, for a total real increase of 25 percent spread over 3 years (and no increase in the wholesale power rate). NEDCo achieves zero loss in that year, and begins to earn margins thereafter – without any further performance improvements. Note that if NEDCo were not to implement any of the MCC ILMP investments, the real tariff increase necessary to achieve a break-even status is approximately 41 percent.

Note that these tariff increases are real, that is, based on the May 2014 purchasing power of the Ghanaian Cedi. This means that any increases in cost of operations due to inflation of the Cedi would be in addition to this tariff increase. Thus, if inflation between May 2014 and the effective date of the tariff increase were 6 percent, the total tariff increase in actual Cedis (as opposed to real Cedis) would be 21 percent in 2015.

Both the tariff increases cited for the baseline case and those proposed in the analysis of Figure 7-3 are significant, begging the question of how the consumers will react to a tariff increase of this magnitude and whether the projected revenue increase will be forthcoming. It goes without saying that it will be necessary for utility staff to increase vigilance to minimize increases in theft of power, but the question of whether consumers will react by reducing their consumption is more complex.

FIGURE 7-2
NEDCo Net Profit after Tariff Increase (GHS 000)

Tariff increases that are designed to compensate for inflation and which are consistent with other cost increases in the economy generally have no effect on consumption, since consumers perceive them only as a general decline in the value of the currency. This is the case of the tariff increases in 2013 and 2014, i.e. they are the result of inflation-related declines in the purchasing power of the Cedi and are not real increases. They will therefore not have a significant impact on consumption.

Experience has shown that significant real tariff increases (increases over and above the rate of inflation) can result in observed reductions in consumption as consumers adapt to a higher real cost of power. Such reductions in consumption are limited, usually temporary, and do not greatly effect net revenue projections in any case, since reductions in consumption are accompanied by reductions in the total cost of purchased power. Simple math shows that if sales are reduced such that the total revenue at the new tariff is the same as the total revenue under the original tariff, and neither loss nor purchased power tariff change, the NET revenue increase will still be 87 percent of the revenue increase anticipated without any reduction in sales. It is unlikely that sales will decrease to the point that revenue is actually flat, so NET revenue increases due even to real tariff increases can be considered robust.

7.1.3 Conclusions – Financial Modeling

Based on the financial modeling, the following conclusions were reached:

- Based upon the technical model results, MCC investment supporting an ILMP of $63.6M in 21 Sub-Activities will reduce ATC&C from 46 percent to approximately 35 percent in 6 years.
- Over the 20-year forecast horizon, NEDCo net profit after collection losses improve, with an NPV of about $162 million with the ILMP.
- ILMP investments reduce the cost of wholesale power purchases, but are insufficient on their own to achieve positive profitability.
- A staged real tariff increase of 15 percent in 2015, 5 percent in 2016, and 5 percent in 2017 will provide sufficient revenue to allow NEDCo to achieve a profitable annual performance. Note that this would be a real tariff increase, net of inflation occurring over the period.

7.2 Economic Modeling

7.2.1 Approach

Similar to the financial analysis section, the following paragraphs provide an overview of the economic modeling effort. The economic model was developed by the CH2M HILL team to assess the benefits in the power sector arising from the proposed Sub-Activities in the service region. A detailed description of the model is provided in Appendix H.

The approach used in this model is a partial equilibrium method that calculates the costs and benefits of proposed Sub-Activities in terms of the opportunity costs of the resources involved in the electricity supply sector only.[6] Primary benefits and costs were calculated using this opportunity cost approach. Secondary benefits were imputed to the extent that certain kinds of valuations (for example, new service and restoration of lost load) represent activities that occur outside the electricity supply industry. The model used present value methods to put all of the proposed investments on an equivalent temporal footing. The economic model was directly incorporated with the SAD spreadsheet and financial analysis workbook that summarize costs, performance characteristics and expected benefits for each of the proposed investments.

Benefits were evaluated in each of four categories:

1. Access – new customer connections[7]
2. Technical loss reduction
3. Non-technical loss reduction, which includes both management and operational loss categories as well as collection efficiency
4. Outage reductions

An additional sheet was added to the SAD spreadsheet presenting the parameters and controls used to modify the operation of the model. One set of parameters includes overarching economic assumptions such as discount rates, foreign exchange rates, and tariffs and is shown in Table 7-4. A second set of modifications (see Table 7-5) permits the user to construct scenarios from the parametric values. The information describing the parameter values is presented in Appendix H).

TABLE 7-4
General Parameters and Inputs used in Economic Model

Parameter	Value
Discount Rate	11.1%
Bulk Generation Charge (Gx)	$0.0839/kWh
FOREX rate (Ghana Cedi:USD)	2.4
Transmission losses (Tx)	5%
Retail tariff	0.427 GH₵/kWh[1]
Electricity average annual demand growth, 2015-2025	5.18%[2]

1 The retail value is illustrative for one scenario and reflects a full cost recovery tariff/valuation of electrical energy at distribution. This number changes from one scenario to another, depending on various parameters regarding generation costs, losses, etc., as determined by least cost generation mix simulations for the electricity supply system

2 This figure is based on Mercados demand forecasts for electricity in the NEDCo service area. The 5.18 percent is the average over the period of the annual Mercados numbers, which varied considerably from one year to another. For additional details see A.F. Mercados, 2014, "Draft Due Diligence Report, Volume I", Section 4.4

6 MCC will be performing a general equilibrium simulation of the proposed investments that will capture additional impacts throughout Ghana's economy.

7 Access in this section denotes a benefit category of additional consumer connections, which is associated with new substations and bulk supply points. This is not to be confused with the MCC access program.

Note: the values in Table 7-4are representative and were used in the P90 scenario only. In the ERR model different values were used for each of the other scenarios. The BGC varied between ECG and NEDCo, as did the customer mix, which affects the weighted average “yield” per kWh sold. Other factors, including annual rate of demand growth, and standby power costs, transmission losses will also vary by scenario.

Scenarios were created by combining a number of key attributes of each Sub-Activity (for example, cost, performance, and valuation of electricity). The financial analysis of the proposed Sub-Activity investments used prices that are, were, or will be charged to electricity consumers to value new electricity supply, lost service, and improved technical and commercial performance. The economic analysis valued the benefits differently. New service was valued according to a consumers’ willingness to pay for electricity. Technical loss reduction was valued as the resources saved by the improved performance of the system’s technical components. Outage reduction was valued as value of the lost load (VOLL), which is not the same as the cost of generation. Finally, the improvement in commercial performance was measured by the return that NEDCo can realize if the savings or additional revenues from commercial loss improvement are invested in the other three categories.

The cost of providing that new service is not the approved electricity tariff, but rather the opportunity cost of additional electricity supply. Supplying electricity for additional hours also entails a cost (for example, fuel and transmission losses) and was valued accordingly.

The values for the supply of electricity were derived from work performed for MCC on the value chain in the electricity sector, and represent the results of an electricity sector simulation model that calculates least-cost generation mixes subject to constraints and prices under a variety of conditions. The VOLL was derived from estimates made by others on the economic costs imposed by outages.

The user is allowed to vary the key parameter values with simple toggle inputs. The effects of changing parameter values can be tested either individually or as a package in one of five scenarios constructed for assessing the sensitivity of investment results to changes in operating performance, economic conditions, and valuation choices.

TABLE 7-5
Scenario Parameters

Variable	Illustrative Scenario #	Scenario Pricing and Valuation Description
Bulk Generation Charge	2	“1” is current BGC, “2” is efficient economic BGC, “3” is shadow price of additional generation, “4” is worst case
Distribution Service Charge	1	“1” is current DSC, “2” is partial adjustment for losses, “3” is full adjustment for losses, “4” is worst case
Value of Electricity to New Users	1	“1” is economic of Gx+Tx, “2” is 33% below economic cost of supply, “3” is 15% above economic cost of supply, “4” is ~ price for charged automotive batteries
VOLL	2	“1” is economic cost of Gx+Tx+Dx, “2” is cost of standby generation for 50% of customers, retail tariff for other 50%, “3” is value for choice ‘2” + 15%, “4” is value used in CGE model
Cost of Investment and Operations	3	“1” is cost below projections, “2” is planned costs, “3” is small cost overrun, “4” is larger cost overrun

7.2.1.1 Sensitivity Analyses

Scenarios were also grouped into probability “buckets” to enable the sensitivity analyses presented in Table 7-6. The scenarios are reflective of a combination of parameters that are likely to be encountered during implementation of the Sub-Activities.

TABLE 7-6
Economic Modeling Sensitivity Scenarios

Scenario	Name	Description
P90	Highly likely	A set of parameters that any other scenario must be able to accommodate with 90% certainty.
P50	Probable	A set of parameters that is likely but by no means certain.
P10	Possible	An unlikely set of parameters.
Best	Best	A combination of parameters that are favorable to Sub-Activity implementation and operation
Worst	Worst	A set of parameters that reflect either high or low end values for unfavorable Sub-Activity implementation

Table 7-7 provides the combination of parameters and values for each of the sensitivity scenarios.

TABLE 7-7
Economic Modeling Scenario Parameter Values

Scenario Parameter Values					
Parameter	P90	P50	P10	Best	Worst
Bulk Generation Charge	2	2	2	1	3
Distribution Service Charge	1	1	2	3	4
Value of Electricity to New Users	1	1	3	4	2
VOLL	2	2	3	4	1
Cost of Investment and Operations	3	3	2	1	4
Retail Fraction of Lost Load Valuation	1	2	3	4	1
Technical Efficiency Scenarios	3	2	2	1	4
Non-Technical Efficiency Scenarios	3	2	2	1	4
Access Scenarios	3	2	2	1	4
Service Continuity Scenarios	3	2	2	1	4
Variable Marginal Cost of Gx and Tx	2	2	3	4	3

7.2.2 Results

Five scenarios were created to assess the overall levels of economic returns and to evaluate how sensitive the results are to changes in key parameters and assumptions. Two variations of the five scenarios were used. In the first instance, only those individual projects that do not feature new connections ("access projects") as the main benefit were considered. Under that condition, neither the costs nor the other benefits – technical, non-technical, and outage reduction – of the access projects were considered. In the second instance, all of the projects were included.

In the NEDCo service regions, the structure of electricity exhibits limited commercial and industrial demand and many Life Line consumers. As a result, none of the scenarios show economically feasible outcomes for the proposed investment as a whole without the access projects,see Table 7-8.[8] Only seven of the proposed investments showed a positive NPV in the P_{50} scenario. In contrast, when the access projects were included, 13 of the proposed projects were feasible.

8 In the best scenario, a VOLL for commercial industrial users in excess of GH¢4.20/kWh (USD 1.77) is needed to raise the EIRR above the discount rate. VOLLs such as this are seen only in developed economies, where standby power is not common, but continuous process industries are.

Topline results for the five scenarios are summarized in Figure 7-3. Detailed results for each of the proposed investments are shown in Appendix H. Only the Best Case parameter values leads to a positive NPV without access projects and the EIRR is slightly lower than the MCC threshold.[9]

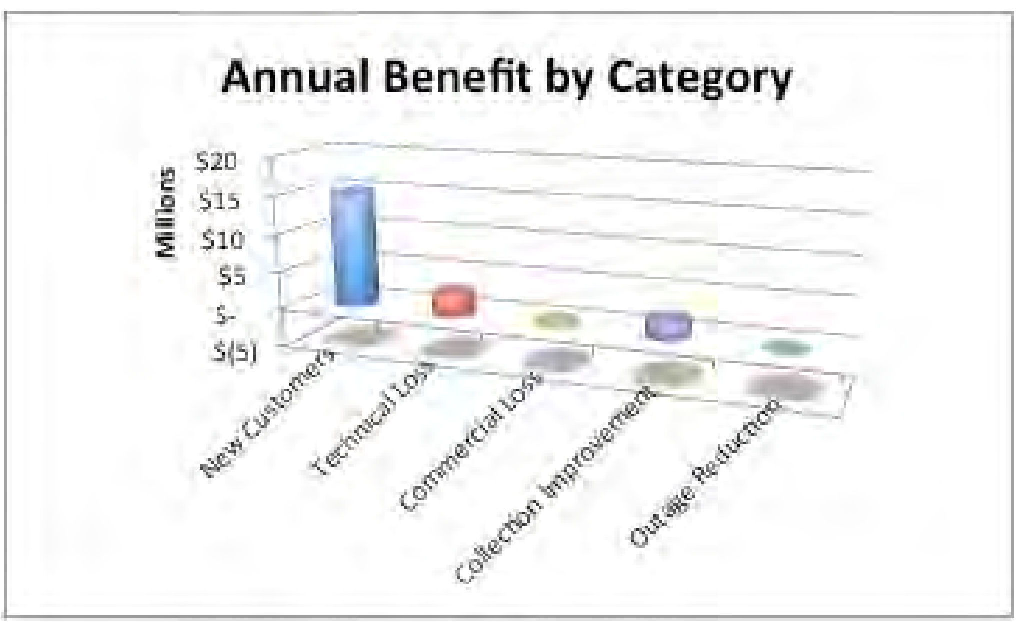
TABLE 7-8
Scenarios and Key Results - EIRR and NPV With and Without Access Projects

		P90	P50	P10	Best	Worst
With Access Projects	EIRR %	12.09%	14.32%	19.42%	52.75%	n/a
	NPV (US$)	$33,927,347	$53,330,802	$100,905,755	$637,427,982	-$300,103,846

		P90	P50	P10	Best	Worst
Without Access Projects	EIRR %	-5.31%	-1.83%	1.76%	9.38%	-10.22%
	NPV (US$)	-$51,686,676	-$41,795,891	-$26,066,675	$18,290,302	-$72,412,538

The positive results for the access projects result from the level of willingness to pay for electricity by new residential customers, which is based on the opportunity costs of currently used alternatives – kerosine, battery charging, and commercial charging centers. These opportunity costs, which represent real resource expenditures in the Ghanaian economy, are at least 50 percent higher than the lifeline electricity tariff, and more likely 2-3 times the lifeline tariff. This differential between the willingness to pay, the economic/opportunity cost price, and the liefeline tariff represents real resource use efficiency gains for the country.

FIGURE 7-3
P50 Benefits by Category (With Access Case)



In the P_{50} scenario, outage reductions do not contribute to NPV on balance. This is due almost entirely to the customer mix, which weights low-value lifeline consumers well above the small number of SLT customers. Access benefits contribute about 73 percent of total benefits for this scenario (see Figure 7-3). When access projects are

9 In the best scenario, a VOLL for commercial industrial users in excess of GH¢4.20/kWh (USD 1.77) is needed to raise the EIRR above the discount rate. VOLLs such as this are seen only in developed economies, where standby power is not common, but continuous process industries are.

removed, that same scenario shows 90 percent of the benefits assigned to technical loss reduction and collections improvements.

In most categories, the largest share of benefits comes from just a few of the proposed projects. For the P_{50} scenario, just six of the proposed investments contribute close to 90 percent of the net benefits.

7.2.3 Attributes of Scenarios Used

Key attributes of each scenario are shown in Table 7-9. Generally, both the P_{90} and P_{50} scenarios work on the assumption that the programs will be mostly, but not fully successful (normally 90 percent of the planned value); costs will be slightly higher; and the imputed valuations for new service, lost load recovery, technical losses, and improved commercial performance will be closer to current prices or costs of backup power, rather than higher survey-generated values for willingness to pay (WTP) and VOLL. For assessing the benefits of outage reduction, the customer mix was weighted more toward the residential and lifeline customers that make up the bulk of NEDCo sales.

TABLE 7-9
Key Attributes of the Five Scenarios

	Scenario Parameter Values				
Parameter	**P_{90}**	**P_{50}**	**P_{10}**	**Best**	**Worst**
Bulk Generation Charge	Current BGC	Economically efficient cost of generation	Shadow price of additional generation	Current BGC	Liquid fuels
Distribution Service Charge	Current DSC	Current DSC	DSC in IFC Report	Full incorporation of losses *with* performance improvement	Full incorporation *without* performance improvement
Value of Electricity to New Users	Economic cost of electricity supply	Economic cost of electricity supply	15% *above* economic cost of supply	Price per kWh for charged-up automotive batteries	15% *below* the economic cost of new supply
Value of Lost Load	Standby gencost for 35%, retail tariff for others	Standby gencost for 50%, retail tariff for others	15% above P_{50}	Value used in CGE Model	Economic cost of electricity supply
Cost of Investment and Operations	10% above planned	10% above planned	Planned	5% below planned	25% above planned
Retail Fraction of Lost Load Valuation	65%	50%	40%	30%	65%
Technical Efficiency Scenarios	90% of planned	100% of planned	100% of planned	105% of planned	75% of planned
Non-Technical Efficiency Scenarios	90% of planned	100% of planned	100% of planned	105% of planned	75% of planned
Access Scenarios	90% of planned	100% of planned	100% of planned	105% of planned	75% of planned
Service Continuity Scenarios	90% of planned	100% of planned	100% of planned	105% of planned	75% of planned
Variable Marginal Cost of Gx and Tx	Current liquid fuels cost in new plant	Imported LNG cost in new plant	Domestic Gas Cost	Domestic Gas cost in new plant	Liquid fuels in old plant

7.2.3.1 Key Parameters

As noted above, the NEDCo results are sensitive to just a handful of parameters. In particular, the WTP for new service is the most important parameter in the mix. Because more than 70 percent of benefits (P_{50} Scenario) are derived from access projects, anything that indicates a WTP that is lower than the cost of new supply will generate strongly negative results. Other key parameters include the performance of the investments. Implementation success must be more than 75 percent across the board. If the NEDCo investments are subject to both indifferent success (75 percent), and a 25 percent cost overrun, then the results will turn sharply negative (NPV = -\$18.3 million) in the P_{50} scenario.

In the P_{90} scenario, as in the other three with feasible EIRR values, only 2 of the 20 proposed investments showed a rate of return less than the discount rate of 11.1 percent.[10] About 75 percent of the total net benefits came from seven projects that featured increased access, even at less than full success.

In most categories, the largest share of benefits comes from just a few of the proposed projects. For the P_{50} scenario, this concentration of benefits is shown in Table 7-10.

TABLE 7-10
Concentration of Benefits by Category

Category of Benefit	Number of Projects Contributing	Number of Significant Contributors	Benefits Share of Significant Contributors
Access	7	6	98.3%
Technical Losses	11	2	90.5%
Non-Technical Losses	10	5	89.0%
Service Continuity	6	3	84.0%

7.2.4 Conclusions – Economic Modeling

Based on the economic modeling, the following conclusions were reached:

- The ILMP with access projects has a higher EIRR than without access projects.
- In almost all scenarios, the EIRR for access scenarios is higher than the MCC investment threshold of 10 percent.
- Without access projects, the EIRR is below the MCC investment threshold in all cases.

10 For the worst scenario, only nine projects are feasible. The two proposed investments that were infeasible in all five scenarios were EGC-Comm-07 and EGC-Service-03. Neither one has any access benefits or significant outage reduction benefits associated with it.

SECTION 8
Sustainability Arrangements (Task 8)

8.1 Approach

The proposed sustainability response plan considers both internal and external sustainability risks. At the same time, board of directors and management support for improved loss management is necessary to ensure that long-term staffing, tools, and practices are actively incorporated into the utilities; see Figure 8-1. Sustainability issues were identified by: 1) evaluating internal sustainability risks that relate to the direct investments which were identified in Sub-Activity risk assessments; 2) describing external sustainability considerations that include legal impacts, government bills, tariffs and social/customer considerations; and 3) describing management and governance considerations that will ensure organizational support for integrated loss management.

FIGURE 8-1
Sustainability Response Plan Requirements

8.2 Results

Sustainability arrangements for NEDCo are aligned in three broad categories: 1) Internal processes and staffing needed to ensure effective implementation and continued management of proposed investments; 2) external issues that affect or constrain the utility's ability to provide reliable service and maintain financial health; and 3) NEDCo governance and management engagement to establish long-term cultural changes that support integrated loss management. Each category is examined below and then followed by recommendations that support NEDCo sustainability.

8.2.1 NEDCo Internal Processes and Staffing Requirements

Foundational projects provide the tools and expertise to respond to key information gaps within NEDCo will need trained staff and formal processes to ensure that these systems are effectively deployed. These were identified as specific risks within the Sub-Activity risk assessment. The Risk Register in Section 4 describes a number of key internal processes and staffing requirements. Mitigation measures need to be integrated and implemented in various departments to ensure success.

8.2.2 NEDCo External Sustainability Issues

The following section will describe some of the sustainability issues that are generally outside the utility's direct control. This section describes some of the existing issues with outstanding government accounts, limitations on the existing tariff structures and the general customer perception. This section does draw attention to a lack of client service provided by NEDCo, which has an impact on client perceptions.

8.2.2.1 Clearance of MDA Arrears

NEDCo has significant arrears from government clients. Government accounts are called MDA accounts and represent a significant percentage of NEDCo's receivables. These utility bills are delivered on a monthly basis to MDAs in accordance with normal billing practice. Each MDA submits its bill to the appropriate line agency and the bills are eventually submitted to the Ministry of Finance (the Ministry) for consolidation and payment.

Formerly, the Ministry was responsible for reviewing and approving each MDA's electric bills and coordinating payment through the Cross Debt Clearing House Division (CDCHD) that was part of the Ministry. This process was changed in 2014; each MDA was instructed to budget for energy expenditures and is presently responsible for paying NEDCo directly for power bills. Some MDAs were converted to prepayment metering, but these are likely smaller consumers given the load limitations for prepayment meters. In addition a sizable payment was made by the Ministry in 2013 in an effort to reduce a large portion of the outstanding debt.

8.2.2.2 Electricity Tariffs

As they currently stand, Ghana electricity tariffs have reached a point wherein the structure may be the cause of economic harm rather than supporting economic growth. Tariffs should reflect the cost of service to most consumers. However, in Ghana there are large transfers of costs within consumer categories, from one category to another, and from one region of the country to another. The imbalance within Ghanaian electricity tariffs leads to inefficient cost recovery, inappropriate consumer pricing signals, and inefficient resource allocation based on energy prices. Without a strong relationship between the cost structure of electricity supply and the tariffs charged to consumers, NEDCo is unable to finance operations, much less expansion. The financial imbalances in the electricity sector, caused by the mismatch of costs and revenues have reached the point where they can lead to credit downgrades for the country and for private Ghanaian companies, difficulty in financing new IPPs, difficulty in securing new fuel sources at favorable prices, and a potential positive feedback between these effects and the country's ability to plan for and implement a power development plan that can reduce costs and improve service.

Electricity tariffs are typically calculated in the following manner. There is an accounting of the cost elements in bulk generation charges (BGC), transmission service charges (TSC), and distribution service charges (DSC). This accounting is additive, so a customer connected to the MV system would see attributable costs of BGC + TSC and at the low voltage would see attributable costs of BGC + TSC + DSC.

This highly simplified picture of cost allocation in power systems can be made more accurate with improved resolution through adjustments for voltage level, peak demand by customer or district, daily or seasonal patterns of peak demand, losses, and commercial issues. To plan for a future open market structure there is a need to develop a cost allocation philosophy; there is an energy charge, a transmission charge, and a variety of distribution service charges. Similarly cost of service is aligned to rate categories so that industrial, commercial and residential customers generally pay rates that compensate the utility for the cost of supplying that specific type of service. In most cases other levies are included in electricity bills that support energy policies. Such policies may allow for the transfers from one customer category to another customer category or to some favored generation source. The following example levies are from a District of Columbia (U.S.) electricity bill, including:

- Energy assistance trust fund (funds subsidies for those who cannot pay their entire bills)
- Residential aid discount surcharge (funds the "Lifeline" tariffs);
- Sustainable energy trust fund (funds the renewable portfolio standard)[11]

In contrast, in Ghana there is no rational relationship between the cost of service and the tariff structure. Although tariffs are based upon customer classifications, the rates do not align the utility's cost of service to those customer classifications. Then within each rate classification, there is no clear relationship between the cost of service and the different customer rates.

In addition to the weak relationship to the cost of service, Ghana national policy mandates uniform pricing amidst substantial regional disparities in the cost of service. This approach leads to cross-subsidization not only within customer categories, but also between categories. Special load tariff (SLT) customers (industrial customers) then become the "cash cow" for cross-subsidies, and a resulting level of tariff is well above their cost of service. In fact, prices for a small group of consumers nearly reach the cost of standby diesel generation. This cross-subsidization causes resource misallocation by the consumer and utility potentially driving some consumers to less efficient electricity sources. Furthermore, the inability to implement tariff features such as Time of Use (TOU) pricing for large consumers due to the already high tariff levels and the need to subsidize other customer categories limits any ability to use demand-side management (DSM) practices.

[11] Distribution charges also include a minimum charge and other taxes. The generation services consist of three parts: a minimum charge for the first 30 kWh, a standard charge for the remaining kWh, and an adjustment clause for purchased energy/fuel costs. Transmission services are also subject to a small fixed charge for the first 30 kWh and a standard charge for the remainder.

The first step Ghana should take before making any rate adjustments is to design and implement a willingness-to-pay analysis of electricity users and other non-users, which also addresses Ghanaian regional disparities. Furthermore, the 2012 Cost of Service Study needs to be updated based on recent changes in currency values and local costs for generation and network services. The proposed studies should clearly address the issue of regional disparities in costs and in willingness-to-pay. Based on the results of the two studies, the Energy Commission and PURC could take initial steps to move towards a tariff design that is more aligned to the cost of service, which is not entirely incompatible with current tariff levels. Such steps could include:

- All consumers at a minimum pay the BGC + TSC + distribution losses at their voltage level and ensure that the utilities recover the cost of service within each customer class. Furthermore, all consumers pay a minimum service charge per month regardless of voltage level or consumption.
- All consumers pay a generation surcharge that will equalize regional supply cost differences. This should be sufficient to cover most of the regional disparity in cost of supply.
- Lifeline tariff usage is reduced to a value that supports their needs today, which is based on lights and some basic electric items. Every commercial customer should pay a tariff that reflects the cost of service and does not require cross subsidies.
- TSC and DSC for capacity charge customers should reflect peak demand.
- Introduce TOU metering for large residential and commercial customers, and all SLT customers to support DSM under the current generation capacity constraint.
- Reform the lifeline tariff so that it is applied only to customers who need assistance (means test). If that is not possible, limit it to those customers who are very small consumers, rather than all residential consumers consuming under 50 kWh/month (as it presently benefits).

Without restructuring the tariff structure as described, the current reliance on just a small proportion of industrial, commercial, and residential consumers to support the entire cost structure of the sector will lead to decreasing industrial and commercial competitiveness and the attempt by larger consumers in all customer categories to minimize electricity payments. This can be done in the case of an individual large consumer by direct connection to GRIDCo, effectively removing the consumer, and their cross subsidy contribution, from the tariff base of the distribution utility. Even though such an interconnection is expensive, the current tariff structure provides an incentive to pursue it, with obvious consequences for NEDCo revenues.

8.2.2.3 Improvements in the NEDCo Customer Relationship

Customer care captures the overall relationship between NEDCo and its customers. Although we classify this as an external issue, this relationship is definitely in the hands of the utility. It is affected by all facets of interactions, including:

- Electric reliability (frequency and duration of electric service curtailments): Customers experiencing frequent or long curtailments in electric service are expected to be adversely affected. Even though a reliability issues are at least partly due to power supply curtailments, consumers most likely identify NEDCo as the primary culprit and blame poor performance on NEDCo.
- Ease of interaction with the utility; if it is difficult for the consumer to solicit service, pay a bill or register a complaint or inquiry, the consumer has low incentive to pay their dues.
- Consumer confidence that the metering and billing is accurate increases incentives to pay the bill.
- Electricity quality (low/High voltages, harmonics and short interruptions). Customers experiencing these irregularities in their electric service are expected to be adversely affected and therefore receive relatively poor levels of customer care.
- Electric rates (price paid for electricity): Customers may perceive the price of electricity as being excessive, especially in consideration of reliability or customer service.

- Safety: Customers may be aware of or exposed to improper service connections or other violations in standards that compromise public safety. Media coverage of such events commonly heightens such awareness and adversely affects customers' perceptions of customer care.
- Customer service: Customers may experience excessive delays in receiving responses from electric service providers. Examples include the time required to obtain a new service connection, wait times when visiting utility offices, wait times when calling the utility by telephone, time required to resolve discrepancies. Response time and accuracy in responding customer complaints may cause a lasting negative impression in the minds of customers.
- Strategic alignment between utility and customer priorities: Customers often have a set of expectations or priorities regarding electric service, such as rates, reliability, or environmental impact. Similarly, NEDCo has corporate priorities that may include profitability, safety, or reliability. If customers perceive that NEDCo's priorities are in conflict with customers' priorities, then a misalignment between what is important to customers and utilities may be in conflict and contribute to perceptions of poor customer care.
- Perceptions of electric service providers: Media coverage or special events may affect customers' perceptions of the level of customer care provided by electric service providers. Examples include television or news print coverage of NEDCo's response to weather related events or news coverage of increasing electric rates. In some instances, NEDCo may be unable to effectively correct media misrepresentations or present a more comprehensive story than that found in the media.

The preceding elements of customer care are not mutually exclusive and various elements may combine to reinforce or influence perceptions of customer care.

8.2.2.4 NEDCo Customer Care – Next Steps

Presently, the status of NEDCo's customer care is an open question. Individual drivers, such as the ones noted above, are not being monitored, assessed, or quantified on an ongoing basis. Although there is a general perception that customers are not satisfied with the level of customer care that they currently receive, there may be significant room for improvement.

Improvements in NEDCo customer care may be achieved through a carefully developed strategic plan that encompasses a qualitative and quantitative characterization of the status quo, development of actionable plans for improvement, ongoing monitoring to assess successes and failures, and a willingness to make changes in corporate-level objectives and financial investments in Customer Care.

Furthermore the consideration of a contract provides for the rule of law and the subsequent enforcement that is provided by Ghanaian governmental legal support. The establishment of "Electricity Courts," currently deployed in Accra has been an improvement by allowing simple electricity theft issues to be removed from the already overburdened court system and providing faster resolutions for the utility.

Improvements to this 'contract' can be improved by focusing on customers and customer service and public outreach on theft of electricity as a crime with support from a government awareness campaign as the program is underway. Although we did not directly analyze NEDCo's customer service practices, it is apparent that customer care receives limited attention from the utility management or staff. Furthermore, the general quality of service, including outages and power quality is poor. Consumers regularly complain about the cost and time it takes to be connected to the distribution system and the overall lack of transparency in billing. These have major impacts to customer perception and a general willingness to pay for electricity.

To respond to these issues, NEDCo should take steps to improve its overall customer service, which starts with a focus on service by the directors and senior management. The NEDCo board could consider engaging an outside consultant develop and conduct regular surveys of customer satisfaction starting with a customer service baseline. Such a survey will then establish initiatives for improvements in customer relations before a follow up survey every other year. In addition, NEDCo could actively engage in a general outreach campaign as the integrated loss management system is rolled out to respond to electricity theft and overall electricity safety.

8.2.3 Government Policy Regarding Sustainability

NEDCo is a government owned utility and as such, its future is in the hands of policy makers to a much greater extent than any private utility could be. While a private utility would be focused on profitability and efficiency, a government agency may have a different focus, one that places a higher priority on supporting the political goals of the government than on businesslike behavior. While this selection of priorities for the agency is entirely up to the government, the consequence of abandoning businesslike behavior is a requirement for explicit subsidies to cover the cost of political as opposed to financially motivated decisions.

It appears that decision-makers within Ghana's power sector have not fully embraced the idea of creating commercially-oriented distribution companies that are able to recover the full cost of service. Examples include:

- NEDCo, even though it is organized as a corporate entity, relies heavily on VRA, with staff salaries paid by VRA and accounting and project management by VRA on an uncompensated basis. This arrangement masks some tariff/cost issues and incentivizes many of the poor management practices that have resulted in acute financial distress for NEDCo.
- NEDCo focuses considerable resources on politically important investments, such as access expansion which are not financially viable. As a consequence it is therefore unable to make performance improving investments that would reduce losses and increase revenues.
- The PURC requires a uniform tariff across all regions without respect to the cost of service. This is particularly a problem for NEDCo due to its much higher cost of service, as compared with ECG. The imposition of a uniform tariff leads to practies such as the uncompensated dependence on VRA.
- The NEDCo tariff structure includes, by government policy, a large number of cross subsidies that do not contribute to the financial viability of either the company or the sector.
- Subsidies and other financial burdens are ordered without corresponding consideration of how they are to be paid for. The Minister of Finance advised that the GoG will not provide sovereign guarantees, while also stating that state-owned enterprises are expected to become financially self-sustaining.

The attitude of policy makers toward whether NEDCo is to be operated on business principles or as an extension of the government social apparatus will have a considerable impact on the sustainability of the investments undertaken under the Compact. The following will be necessary to adhere to business principles:

- Policy makers will need to expressly commit to ensuring that NEDCo operates as a business. This does not necessarily mean privatization but will require that that all investments be justified by associated revenue streams, whether these be the results of tariffs designed to recover their cost or specifically identified and reliably delivered subsidy payments.
- Efforts will be required to distance NEDCo from VRA so that the staff can focus their careers on improving the status of NEDCo rather than awaiting transfer back into VRA.
- Politically identified cross subsidies, such as lifeline tariffs, should be considered as commitments of the government, payable to NEDCo at the cost of service.
- Board participation should be based upon demonstrated competence and expertise, and board appointments should be systematized so that the board of directors reflects a cross section of constituencies rather than that of the government in power.
- The board should be made responsible for profit and loss of the corporation and should be given the authority and access to resources to enable it to make investments that improve corporate performance.
- A sovereign guarantee should be made available so long as any of the investments to be undertaken are not financially viable.

8.2.4 Governance and Management Engagement

An effective board of directors needs to exercise its duties and responsibilities of setting clear policies and direction that support the long-term financial and institutional sustainability of NEDCo. Additionally, clear boundaries and roles need to be defined between the board and the executive team, who needs authority to effectively carry out the utility's business. As a Government-owned entity, government participation on NEDCo's board is a given. At the same time, the board should operate with sufficient political autonomy to be able to put long-term targets in place that improve the financial and operational performance of the utility rather than responding to short-term political interests, which is one of the key benefits of corporatizing a utility. A major weakness of state-owned boards and management is that they are accountable to multiple objectives and stakeholders. Continual and rapidly changing interests of such stakeholders make politicians and bureaucrats poor board members, given that they typically gain no benefit from ensuring the operation is managed effectively, but are quickly blamed if things go wrong (Vagliasindi, 2008).

NEDCo is overly influenced by political imperatives, with the process of appointing and removing directors often motivated by reasons unrelated to performance. It is clear from discussions with NEDCo that the utility has maintained the political focus of expanding access rather than financial health. Furthermore, we did not find any evidence the board is providing clear direction and guidance specifically by providing metrics and targets for the utility managing director, specifically in the area of financial performance or loss management targets.

The World Bank working paper "The Effectiveness of Boards of Directors of State Owned Enterprises in Developing Countries" by Maria Vagliasindi provides a number of recommended improvements for improved governance practices meant to limit political interference and improve financial health. These recommendations include:

1. Set clear objectives and financial targets for the utility focused on ensuring financial viability. Only after the entity is financially viable, will the government introduce additional non-commercial objectives.
2. Provide a greater role for outside and independent directors, who have no management or business relationships (such as vendors or recent employees). Some countries have moved to at least 50 percent of their boards composed of such independent directors.
3. Develop a structured nomination process that focuses upon competency. Then ensure board members receive formal training in board roles, responsibilities and procedures.
4. Assemble task-specific committees with independent members comprising the majority specifically for the audit committee, the compensation committee and the nominating committees (note that none of these committees exist within the current NEDCo structure). These committees address specific areas where shareholders and manager interests conflict.

Next, effective management is founded on a clear understanding of board/executive management team roles and responsibilities. Boards engage in development of strategy, evaluation of performance, management succession, major financial decisions and approval/monitoring of the annual budgets and plans (Walton 2011). On this basis the board then empowers the NEDCo general manager to focus on implementing a program that ensures effective utility operations with minimal political interference.

Given the deteriorating financial performance of NEDCo, the most compelling issue facing the board of directors is that of ensuring financial viability. Above all, this board should develop strategy, goals and performance measures that systematically strengthening the utility's financial returns, reduces losses, and improves quality of service.

To improve interaction among shareholders (government), board members, and the executive management team, MCC/MiDA could assist the board of directors in developing a set of financial and loss management targets and performance incentive structures so that the executive management team orients their effort in improving these metrics. Additionally, MCC/MiDA could provide the board with guidance on developing/pursuing strategy and ensuring that loss metrics and system improvement evaluation is a major part of board meetings. Such practices directly engage the board with loss management and top-down support to the program.

Similarly, the board of directors and the executive management team need to actively participate in and support integrated loss management so that it is effectively adopted and implemented within the utility. Without their active approval and support, these programs will have nowhere near their effectiveness. MCC/MiDA could consider developing a formal agreement with the utility board of directors and possibly with the executive management team for its support of the integrated loss management approach. Such an agreement could include the following requirements:

1. Executive management performance based upon quantified financial and efficiency improvements (loss management specifically) and development of incentives for executive management to achieve these goals.
2. Require regular reporting on loss management indicators and performance metrics.
3. Provide mechanism for receiving issues identified by MiDA regarding implementation within the utility. Specifically confirm that staff and systems are in place to support implementation as well as general inclusion of new practices in the utility through changes in policies and procedures.

8.2.5 Utility Management Changes

Although its management should have the utmost flexibility in implementing polices. MCC/MiDA may want to consider putting some specific management practices in place to ensure investments are effectively integrated into the utilities for sustained improvements. Such mechanisms include:

1. Ensuring that NEDCo establishes a project management unit that is empowered to ensure timely implementation of the specific Sub-Activities. This unit would work directly with MiDA to ensure that projects were designed within the utility norms and requirements. It would also be responsible for ensuring effective integration of specific process changes into the utilities.
2. Ensure that NEDCo develop integrated loss reduction management units. These units should include members from Engineering, Operations, Commercial/Financial Management, and Administration. These teams will be responsible for ensuring that loss metrics and data are collected and consolidated into reports that clearly describe losses. The teams will then analyze loss data to establish where losses are most significant (including geography and type of loss) to create targeted plans to meet loss objectives. These teams also will refine management direction into executable plans that improve overall efficiency.

8.3 Conclusions

Table 8-1 presents a number of sustainability arrangements to reduce losses and sustain the proposed Activities.

TABLE 8-1
Sustainability Arrangements and Management Responsibility

Sustainability Arrangement	Type	Responsible Entity
Verify proposed employees have the appropriate computer skills before training and system deployment	Internal	Division Management
Ensure NEDCo develops procedures and corporate standards to enforce adoption, including effective data management and transparent and effective report development for management and board of directors.	Internal	Executive Management
Complete a data management integration plan and storage plan that will verify how the information will be stored, managed, and integrated into utility management reports and systems.	Internal	Administration – Information Management
Train NEDCo's employee on all new tools and procedures primarily through the institutional strengthening contractor as well as specifics on many of the sustainability arrangements (for example, ERP systems, which will include specific training and integration planning into the overall contract).	Internal	Administrative
Create job descriptions and include possible staff skills training in the system rollout of activities.	Internal	Division Management

TABLE 8-1
Sustainability Arrangements and Management Responsibility

Sustainability Arrangement	Type	Responsible Entity
Consider developing a quality assurance system that involves periodic assessments of NEDCo procedures and processes as they are is implemented by field teams. This includes records management, data quality etc.	Internal	Executive Management
For any capital projects, verify practices are in place to periodically inspect and conduct maintenance. This includes having sufficient stock of consumables and materials for emergency repairs on hand.	Internal	Operations
Ensure that nodes with high traffic are equipped with redundant links through different providers and physical infrastructure. Verify the communications back-bone has an effective O&M and repair structure in place.	Internal	Administrative – Information Management
Clearance in MDA arrears	External	GoG: Ministry of Finance
Align improved tariffs to cost of service	External	Public Utilities Regulatory Commission (PURC)
Create Board of Directors Integrated Loss Management Memorandum of Support	Management	MiDA and Utility Chairman of the Board
Development of a project management unit to support project implementation	Management	Executive Management
Create an Integrated Loss Management Unit	Management	Executive Management
Implement regular joint project reviews with MiDA and NEDCo for review of performance indicators. If results are not satisfactory, consider some projects for termination as they will not be successful without the full support of senior management as well as the implementation teams.	Management	MiDA and Executive Management

SECTION 9
Monitoring and Evaluation (Task 9)

9.1 Approach

The methodology for Task 9 consisted of evaluating proposed evaluation indicators and identifying potential gaps in existing systems and processes used by NEDCo that may affect data collection and the ability to ascertain the impact of the compact investment on targeted results. Initial findings regarding practices and procedures were provided in the Phase I situational assessment. From this evaluation, as well as new data collected as part of the feeder loss study and further system evaluation, data collection gaps in the key areas of commercial/collections, operations, and engineering were identified and evaluated. From these gaps, overarching recommendations, based on industry best practices, were provided to describe improvement in data capture and quality to support NEDCo in identifying and actively manage its priorities. The second part of this task directly responds to MCC's monitoring and evaluation framework. This section first describes some of the assumptions regarding data collection. The section then describes the set of interim targets, specifically focused on changes to regional losses. The section then provides a recommended list of overall benchmarks and targets as well as gaps/considerations regarding each of these indicators.

9.2 Results

Modern electric distribution utilities operate in a data-rich environment that includes numerous measures of power flow, metered consumption, energy losses, outages, billing and collections and other information. For the resulting information to be of value for guiding actions to reduce losses or remedy customer service problems, data must be collected, analyzed, and provided to management teams at relatively low levels within the utility. For instance, it is not useful to compute a total corporate level of losses if the loss data cannot also be disaggregated down to the consumer and feeder level, which is needed to identify specific problems and develop responses that can be deployed and effectiveness measured. Furthermore, selected performance data such as the System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) are not only needed for internal purposes, but also are provided to PURC for regulatory purposes.

9.2.1 Existing Data Collection and Reporting Gaps

NEDCo collects and aggregates power purchase and sales data from which overall energy losses and collection indices are evaluated for the purpose of preparing and presenting financial statements at the corporate level statements for decision making purposes. Technical and non-technical losses are monitored in the aggregate only (as composite energy losses) because NEDCo lacks the capability to disaggregate technical and non-technical losses.

Furthermore, traditional postpaid metering systems are read individually using manual recording and transcription methods. Meter reading is carried out by meter readers who traverse a defined route, reading meters in order and recording the data. NEDCo has not yet associated the consumer location with the transformer and feeders that serves them. This makes it impossible to monitor or assess losses on a feeder level or groups of customers.

In addition to postpaid metering systems, NEDCo has invested significantly in prepayment metering systems, installing approximately 100,000 such meters. Prepayment meters have the advantage of improving cash flow (the company receives payment before prior). However, prepayment meters introduce inconsistencies in monitoring monthly energy consumption because data collection is for anticipated rather than actual consumption. Furthermore, their design makes it difficult to accurately apply more- complex tariffs because tariffs are structured for energy usage within a fixed 30-day period. Tracking energy consumption is further complicated by the fact that NEDCo has three separate prepayment systems, each of which has its own vending and reporting mechanisms. Prepaid systems may also increase the prevalence of theft into the system due to the fact that companies no longer visit meter locations on a regular basis. Inspection allows NEDCo to identify energy theft through by-passing and tampering with meter installations.

To overcome these difficulties a two-way prepaid metering standards should be adopted and employed in concert with a meter data management (MDM) system to assist the company in correlation of monthly consumer metering location consumption to distribution transformer and feeder automatic meter reading (AMR) values. In the interim, all prepaid metering systems will require a software bridge that will allow sales records and calculated energy values to be integrated to the CIS.

Outage data collection is also quite problematic. NEDCo does not have the means to record outage data on a reliable basis; the utility does not have a trouble call center, and the service centers are poorly equipped.

9.2.1.1 Steps to Improve Overall Data Collection and Overall Data Quality

Modern distribution utilities employ digitized mapping system on either GIS or AutoCAD platforms that are integrated with network modeling software, combined with strategic metering programs to monitor technical and non-technical loss levels throughout the distribution service territory. Modeling is performed on an annual and sometimes, semi-annual basis to ensure that the distribution infrastructure can keep pace with load growth, and loss levels are kept within acceptable ranges. NEDCo does not have an up-to-date system maps or perform loss evaluations even at an enterprise level. Energy losses are evaluated as a function of power purchase and sales records, but technical and non-technical loss levels are not disaggregated. Because neither planning department has developed a discipline of system-wide modeling, investment planning cannot systematically identify how and where to optimize investments in performance improvements. The Integrated Loss management approach and proposed Sub-Activities include investments that will help capture much of this key information as describe in Table 9-1.

TABLE 9-1
Sub-Activities to support Data Collection

NEDCo	Technical	Commercial	Operations	Financial
NEDCo-Comm-03: Customer census and normalization of existing service connections		X		
NEDCo-Comm-04: Enterprise customer information system and integration with existing enterprise applications		X		X
NEDCo-Engr-24: Metering at critical nodes of the distribution system	X	X		
NEDCo-Ops-03: Installation of outage reporting and call center system			X	
NEDCo-Service-05: Technical Assistance Program	X	X	X	X

The GIS mentioned above will geographically reference NEDCo consumers, tying them to distribution transformers via low voltage circuits, and the transformers tied to medium voltage feeders. The GIS geodatabase will also allow distribution system assets attributes including substations, medium voltage feeders, transformers and low voltage feeders to be recorded in an asset data base. The GIS and asset database Sub-Activity proposed as an MCC compact investment has been designed to serve this purpose. A related Sub-Activity has been designed to install automated meter reading on all feeders and on selected distribution transformers that will greatly enhance data quality for purposes of loss analysis and reduction.

Revenue meter quality is another known issue. Replacement of legacy electromechanical meters has been a priority for NEDCo. NEDCo does not have access to sufficient funding to aggressively replace meters for legacy consumers because most of its recent investment has been focused on expanding access to new consumers. Neither does the utility have a routine of scheduled field testing or inspection of active meter locations, which would reveal defective meters.

One of foundational Sub-Activities investments consists of introducing AMR systems for distribution transformers and at other strategic points in the MV and sub-transmission lines. This will help facilitate the process of theft and loss detection. Balancing energy consumption at the consumer level with what is metered at the transformer level also will help the loss control units (LCUs) to focus on areas where consumers may be tampering with or bypassing meters.

In addition the proposed, sub activities, it is essential that NEDCo put into practice a comprehensive data collection and reporting system to integrate power purchases, sales, energy losses, collection rates, and additions to plant in a single framework on both an enterprise level as well as at the regional level. While much of this data is collected, it is not evaluated, reduced and presented in a concise and does generally exist, the utility does not effectively use the data to support management in developing investment plans or responding to key system issues. The first issue the utility needs to take is to identify how data will be collected and managed. Typically one department is responsible for consolidating such data and there is a team specifically engaged in aggregating and developing required reports.

Loss data monitoring and reporting are facilitated by of a set of standardized data reports that can be easily developed and analyzed by both technicians and managers. Such key data can be broken down by regions and down to the feeder level as needed. Such a report provides key performance indicators and a useful source of data for analysis of utility operations by planners without the need for specific data queries to the accounting department. The elements of the statistical report are standardized as to content, format, and method of calculating the summarized values using the utility's uniform system of accounts. Content is selected to provide a summary statement of operations, a balance sheet, a summary of consumer sales data, and a summary of purchased power demand and energy values. Format and terminology are specifically defined so that the meaning of each value is clear and uniform across all reporting entities. In most utilities, the development of the monthly report has been automated so that it is a standard report from the utility's enterprise accounting and operations system, to minimize both labor requirements and the data manipulation.

Most of the financial and statistical report key indicators, specifically consumer sales data, losses and ATC&C can be scaled to the regional and sub-regional level (substations) to give management and project managers the results they are looking for as Sub-Activities are rolled out. Data are generated through energy transactions, sales, and system operations and are therefore collected and entered into various data management systems, including the billing system, general ledger, and operating data management systems.

The development of disaggregated data depends on the development of protocols aimed at collecting and coordinating data from sources that reflects the behavior of an identifiable group of consumers. The following elements are required to develop such disaggregated data:

- GIS data are collected on the feeder configuration and LV networks.
- Commercial data on consumers are associated with the distribution transformers that serve the consumers. Ideally the pole from which the consumer receives service would be identified and included in the record. This would apply to both post-payment and prepayment meter consumers.
- Meter read routes are adjusted to coordinate with the physical configuration of the system so that all consumers on a particular transformer will have their meters read within a few days of each other. Ideally, all the consumers on a particular feeder would have their meters read within a single week. SLT and larger non-SLT accounts would be read during this same time period to avoid meter reading consumption errors on the AMR distribution transformer.
- Prepayment meter vending data collection is arranged to coincide with the meter read routes used on specific feeder and validation process using the meter data management (MDM) system.
- Feeder metering is read on a daily basis so that the power delivered to the feeder can be coordinated with the meter reading routes.

Development of this level of data coordination will require additional meter reading cycles, as well as a database for prepayment meter information that will combine the outputs of the various systems in place on a particular feeder in such a way that the vending history of individual consumers can be associated with their location on the feeder.

Producing and presenting key data and performance indices should be performed on a monthly basis to allow senior management to monitor operational and financial performance, and for the board of directors to make informed decisions. The monthly reports should include typical income statements, a summary of commercial data (including purchased power, sales and collections), an energy loss report, and key performance indices. In terms of loss management, the data fields that are of utmost importance and the responsible directorates/offices are shown in Table 9-2.

TABLE 9-2
Key Indicators in the Financial and Statistical Report

Indicator	Responsible Office	How is it collected	Purpose/Data Use
Purchased power	Accounting & Finance	Metering at BSPs	Required to develop overall energy inputs and key component of ATC&C loss data.
Sales	Customer Service	Billing records and prepayment metering logs disaggregated by customer category and by feeder based on its configuration during the billing month	Verify billing efficiencies and establishment of commercial and collection losses.
Energy losses	Accounting & Finance	Arithmetically calculated for purchases less sales	Identify specific areas of loss.
Technical losses	Engineering	Measured or evaluated via load flow studies	Identify high technical loss areas and identify specific feeders requiring upgrades.
Non-technical loss	Engineering	Calculated as difference from energy losses less technical losses	Identify specific areas with high commercial losses for targeted improvements. Focus areas for improvements in customer accounting, normalization and targeted electricity theft reduction.
Collection rate	Accounting & Finance	Billing and accounting records. Bills Collected/Amount Billed (down to substation/feeder level)	Identify customer categories and areas with poor collection rates possibly for changes in collection processes or metering.
ATC&C	Commercial (likely)	Calculated using above data. ATC&C = 1 – Cash Recovery Index (CRI). CRI = (1- SL) * CR SL=System Losses CR=Collection Efficiency	Key performance index for loss management. At a high level will identify regions and substation areas that require significant management engagement.
Outages	Operations		
SAIDI		Outage records – SCADA system	PURC requirement and metric on electricity service 'quality'
SAIFI		Outage records – SCADA system	PURC requirement and metric on electricity service 'quality'
Receivables (days sales)	Accounting & Finance	Accounting records	Identify key late accounts and bill collection efficiencies. Identify specific customer and regions/area with poor collection efficiencies.
Operating Margin	Accounting & Finance	Evaluated at monthly financial close	Overall utility financial performance improvements. Disaggregated will identify poorly managed areas.

Performance monitoring implies that management has established both a performance baseline point as well as performance targets for each area of utility functionality. Ideally, the board of directors and senior management should jointly decide which performance indices are of highest importance to the utility. There are dozens of performance indices that can be evaluated and tracked to characterize energy balances, commercial data, overall financial performance, human resource costs and performance, and operational effectiveness. However, given that the board of directors will have few directors who have significant experience in electric distribution utilities, it is usually of greater importance to select a small number of financial, commercial and operational data and indices that are easy to understand and that will provide the board with the information it needs to understand improvements or difficulties in performance.

9.2.2 NEDCo Monitoring and Evaluation Framework

This section discusses MCC's compact framework and program logic. This section includes.

- Key assumptions related to performance benchmarks.
- Proposed MCC compact indicators. This section presents indicators that will be used to track progress during the compact implementation period. Changes and additions from the existing indicators are noted in Red for comparison with proposed indictors. Potentail gaps in indicator collection and other data collection consideration are provided in a separated table.

9.2.2.1 Data Assumptions and Considerations

In order to effectively track energy transfers for the purpose of evaluating losses and collection efficiency, it will be necessary to implement a data collection and reporting framework that allows NEDCo to monitor performance on a regional level. Given the geographic focus on Tamale, the data collection and reporting framework should be piloted in this area. For the MCC investments, data will be collected at the regional level to evaluate technical and non-technical losses, and benefits will be further evaluated at the feeder level in synch with the performance improvement investments. This approach will enable NEDCo to track loss levels on a monthly basis with a much greater degree of geographic specificity and to make program adjustments as they are needed rather than to wait until end of year assessments can be made.

To ensure that NEDCo is able to monitor data in a timely manner and with the accuracy required, the information and engineering systems that are required – specifically, geographic information systems, the customer census, engineering modeling platforms, and strategic metering systems will be given the highest priority for immediate implementation. The implementation schedule of these and other interventions are all illustrated in Appendix D.

9.2.2.2 Interim Improvements

Table 7-3 presents performance improvement targets for the MCC compact for NEDCo. The table presents targets over a six year period beginning in 2015. As shown, impacts only start occurring after year 2 of implementation. These improvements are tied to the expected improvements that the proposed activities will have and when the different Sub-Activities are completed.

The values shown in the table represent the existing condition of NEDCo and the progression of change based on implementation of Sub-Activities. Technical loss percentages will move in a downward direction with the bifurcation and meter normalization Sub-Activities. The downward percentage in commercial losses will occur once a consumer census is completed and the MIS is populated with correct data. The critical node points are metered and data are fed into the strengthened LCU to start targeting high loss areas. Collection efficiency will improve with an aggressive disconnect policy administered by the LCU along with the replacement of legacy meters with prepaid meters. Outages will be reduced with correct data now populating the OMS database. Additional outage reduction will occur with the bifurcation of LV lines, line maintenance reports from the GIS teams and service normalization. The target values for year 6 for technical losses and commercial losses are based on the loss study analysis. The collection efficiency reduction matches the target from the PURC and is obtainable if NEDCo practices the policy of not allowing MDAs in the collection efficiency rate.

9.2.2.3 NEDCo Financial and Operational Turn-around Project Indicators

The MCC Indicators are presented in Table 9-3. Additional indicators and further information added to these indicators are shown in red. Table 9-4 describes key data gaps and issues with each of the indicators.

9.3 Conclusions

A number of actions are required for NEDCo to develop and deploy a monitoring and reporting program that will enable the board and senior management to be apprised of the progress and challenges to achieve improved financial and technical performance. As outlined earlier in this section, these activities include:

1. Customer census of all connected consumers to the NEDCo distribution system.
2. Normalization of all connections – registering consumers who are not yet included in the Customer Information System and ensuring that service connections meet NEDCo standards. This will include replacement of non-functioning meters.
3. Completing a comprehensive GIS that will geographically reference and record all asset attributes including substations, medium voltage feeders, distribution transformers, low voltage feeders and customers.
4. Via the GIS, tie customers to low voltage feeders, low voltage feeders to distribution transformers, and distribution transformers to medium voltage feeders.
5. Install AMR metering on all medium voltage feeders and distribution transformers.
6. Integrate all metering system to the new CIS to provide improved consumption and sales data.
7. Implement an outage management system and redefine the means by which outages are recorded and reported through customer service offices to the regional headquarters. Collect and process outage reports to be included in a monthly outage report at regional and enterprise levels.
8. Renovate and refurnish customer service centers, ensuring they all have NEDCo server connectivity to ensure they are able to collect and transfer electronic data to NEDCo headquarters including outage information.
9. Review and modify accounting codes to facilitate a greater level of disaggregation of operating cost data into categories that include general and administrative costs; commercial management costs (associated with billing, collections, and customer service activities); operating costs; power purchases; capital/construction costs; and other costs. Migrate accounting system from VRA to a NEDCo server.
10. Implement the financial and statistical report at the area level within NEDCo. NEDCo has recently adopted a financial and statistical reporting system presented by NRECA through a USTDA consultancy, but it is being implemented at the enterprise scale rather than a regional level.
11. In conjunction with the monthly financial and statistical report, prepare and present specific performance indices as an annex to the report. Distribute the report to all board members, senior management staff and key managers within NEDCo.

TABLE 9-3
NEDCo Financial and Operational Turn-around Project Indicators

NEDCo Financial and Operational Turnaround Project Indicators[1]							
Result Statement	**Indicator**	**Definition**	**Unit**	**Baseline**	**Year 5 Target**	**Data Source**	**Rationale and Measurement Details**
Medium Term Outcomes							
Customer satisfaction increased	Customer satisfaction	Median of satisfaction levels of electricity customers on service delivery; 1-very unsatisfied, 2-unsatisfied, 3-indifferent, 4-satisfied, 5-very satisfied	Level	TBD (prior to EIF)	TBD	Customer satisfaction module in Enterprise Survey/NEDCo Customer Service	To measure customer perceptions of NEDCo service and provide feedback to the utility, enabling customers to influence their performance.
	Customer Satisfaction	Customer care metrics including such examples as: 1) walk-in customer service time; 2) telephone customer service time, 3) customer connection response time; 4) customer complaint resolution time.	Level	TBD (prior to EIF)	TBD	Service Center Field Survey; Customer Information System (Telephone timeframe/service reports, complaint resolution and connection response time)	To measure NEDCo's improvement in responding to customer needs – this should have a direct impact on overall satisfaction
	Customer and Employee Safety	Safety lost time accidents/1,000,000 hrs worked. (serious injuries)	Hrs	Unkwn	10	NEDCo Operations	Currently NEDCo does not track lost time but tracks by event. This process should change in-line with standard practices. Tracking and improvements should be part of the Technical Assistance Scope
	Number of customers in project areas	Total number of customers on either prepayment or credit/post-paid metering system or flat rate arrangement (disaggregated by customer type, gender [for residential customers])	Number	TBD	TBD	NEDCo CIS. Further disaggregation (i.e. by gender or other social considerations) needs to be developed through customer sampling	To measure growth in grid connections and household access to electricity. An individual customer is equivalent to a household or firm. For NEDCo, all customers is 447,407 (2012). Baseline data will be taken from ERR models.
Consumption of electricity increased	Electricity consumption	Total GWh of electricity consumed by all customers (disaggregated by customer type)	GWh	658 (2012)	TBD	NEDCo CIS	Load shedding, WAGP, Jubilee delays and DSM can mask what is happening here.
Reinvestment and maintenance in capital expenditure	Capital expenditure	Total value of new equipment installed in the distribution network through projects funds and/or private sector partners	US$	TBD	TBD	NEDCo Financial Statements	All capital expenditure is money from GOG or donors. Note: baseline figure for NEDCo should be available soon (IFC/Mercados Due Diligence report – 4/15/14 or 4/16).
	Ratio of actual maintenance expenditures to planned maintenance budget	Actual maintenance expenditures divided by Planned maintenance budget	Number	TBD	TBD	NEDCo Financial Statements	Could also have an indicator for percent dollar value of assets being maintained. Relying only on planned maintenance budget may not capture changes resulting from installation of relatively new assets under the project, so it may be preferable to track maintenance expenditure based on benchmarks of international best practices. Indicator shall be harmonized with IFC model for operating expenditure.
	Ratio of actual maintenance expenditures to dollar value of total distribution assets	Actual maintenance expenditures divided by total value of distribution assets	Number	TBD	TBD	NEDCo Financial Statements	
Enhanced investment capacity	Asset turnover	Net sales divided by total assets	Ratio	0.45 (2012)	TBD	NEDCo Financial Statements	Measure of the financial security of NEDCo
Cost of electricity service delivery reduced	Cost per kWh of electricity delivered	Total cost of electricity supplied to customers divided by total electricity supplied (in kWh)	US$	TBD	TBD	~~TBD~~ Financial Statements	Measures the cost of producing 1kWh of electricity, and GoG/NEDCo attempts to reduce total operating costs.
Outcomes							
Utility Financial Health improved	Operating profit (loss)	Operating revenue minus operating expenses	$US	-24.80M (2012)	TBD	NEDCo Financial Statements	Measures the capital structure of a company. We proposed an operating margin of 2% given the rural nature of the utility and the significant change required over the next few years.
	Operating Margin	Operating Income/Net Sales	Percentage	(33.5%)*	2%	Financial Statements	
	~~Net profit~~	~~Net income divided by net sales~~	~~Number~~	~~-0.329 (2012)~~	~~TBD~~	~~NEDCo~~	
	Quick ratio	Current assets minus stock divided by current liabilities	Number	0.69 (2012)	TBD	NEDCo Financial Statements	
	Debt to equity ratio	Long-term liabilities divided by shareholders equity.	Number	N/A (2012)	TBD	NEDCo Financial Statements	

TABLE 9-3
NEDCo Financial and Operational Turn-around Project Indicators

NEDCo Financial and Operational Turnaround Project Indicators[1]							
Result Statement	**Indicator**	**Definition**	**Unit**	**Baseline**	**Year 5 Target**	**Data Source**	**Rationale and Measurement Details**
Reduced outages	SAIDI	Sum of the product of durations of consumer interruptions times the number of consumers affected by each interruption, divided by the total number of consumers in the system at the substation level."	Hours/year	106 (2012)	80	NEDCo Operations	To measure duration of outages. Outage measurements at Tx substations and Gx underestimate the magnitude of outages at the customer level. Outages due to generation shortfalls are being measured separately from outages in distribution. Benchmark is based upon reasonable improvements that will occur through bifurcation, GIS and maintenance report/response process. Note that such changes will only occur in targeted regions.
	SAIFI	Number of customer interruptions divided by Total customers in system at the sub-station level	Number	135 (2012)	101	NEDCo Operations	To measure number of outages and frequency. Outage measurements at Tx substations and Gx underestimate the magnitude of outages at the customer level. Similar indicator in Gx and overall indicators. Benchmark is based upon reasonable improvements that will occur through bifurcation, GIS and maintenance report/response process. Note that such changes will only occur in targeted regions.
Timely payments made to sector entities	Average payment period to power producers	360 times total value of accounts payable to power producers divided by annual cost of power purchased	Days purchases in payables	Unknown	NTE stated contracts (<45)	NEDCo Finance Department	Indicator shall be constructed to reflect whether the cross subsidization pass back effectively is returned to NEDCo. 45 days should be just around the contract requirements.
	Average payment period to GRIDCo	360 times total value of accounts payable to GRIDCO divided by annual cost of power purchased from GRIDCO	Days purchases in payables-GRIDCo	Unknown	NTE stated contracts (<45)	NEDCo Finance Department	
Gender employment targets met	Percentage of female employees	Number of female employees divided by number of employees time 100	Percentage	TBD	TBD	NEDCo Human Resources	
Commercial losses reduced	Commercial losses	System losses minus technical losses.	Percentage	9.32 (2012)	7.3%	NEDCo MIS	Represents MWhs of unmetered and unbilled consumption, including consumption through illegal connections and incorrect estimation of legal consumption due to tampering with meters and inadequate fixed billing (expressed as a percentage of net purchases of electricity)
Billing and Collections improved	Billing and collection ratio	Revenue collected divided by total electricity billed.	Percentage	67.6% (2012)	77.6%	NEDCo MIS	Shows the effectiveness of the utility in bill collection Percentage of the revenue that's actually collected in a given year. Dollars collected over dollars billed. This is the PURC's stated target. 120 days recognizes some of the greater challenges with collections in the Tamale area.
	Average collection period (accounts receivable)	Receivables divided by credit sales times 360 days	Days	325 (2012)	120	NEDCo Financial Statements	
Distribution technical losses reduced	Total System Losses	(Total MWh of energy delivered to the distribution system as BSP meters, less MWh of sales to consumers)/(Total MWh delivered)	Percentage	20% ~~10.62~~ (2012)	16%	NEDCo MIS	Total Purchases less Total Sales in kWH, updated monthly
	Technical Losses	Estimated MWh of energy dissipated in electricity system components such as distribution lines, transformers, expressed as a percentage of all MWh of energy delivered to the distribution system, as determined by modeling of the system	Percentage	10.9% ~~19.1%~~ (2012)	8.9%	NEDCo MIS	To be updated during loss characterization study planned for CIF. This is based upon the technical improvements and will only impact that Tamale area.

[1] The Financial and Operational Turnaround Indicators were provided by MCC to CH2M HILL in April 2014. The text in red or ~~stricken~~ is text provided by CH2M HILL.

[a] Not applicable to NEDCo because VRA absorbs all NEDCo long-term liabilities. Thus, long-term liabilities do not appear on NEDCo books.

TABLE 9-4
Recommended Data Collection Frequency, Considerations and Existing Gaps

NEDCo Financial and Operational Turnaround Project Indicators					
Result Statement	Indicator	Definition	Frequency	Data Collection Considerations	Measurement Gaps
Medium Term Outcomes					
Customer satisfaction increased	Customer satisfaction	Median of satisfaction levels of electricity customers on service delivery; 1-very unsatisfied, 2-unsatisfied, 3-indifferent, 4-satisfied, 5-very satisfied	TBD	Customer satisfaction module in Enterprise Survey	To measure customer perceptions of ESCOM service, and to provide feedback to utility and thus enabling customers to influence their performance.
	Customer Satisfaction	Customer Care metrics including such examples as: 1) Walk-in customer service time; 2) Telephone customer service time, 3) customer connection response time; 4) Customer complaint resolution time.	Yearly	Walk-in assessments are completed by field surveys.	It is unknown if NEDCo's telephone system tracks response times – most systems will include this metric. Currently the NEDCo operations team does not collect response time data and there is no way to track customer complaint to response or customer connection response time. The proposed INDRA CIS should have the ability to track such information.
	Customer and Employee Safety	Safety lost time accidents/1,000,000 hrs worked. (serious injuries)	Quarterly	N/A	NEDCo does not track safety incidences and there is no tracking system in place. Its safety and environmental team is extremely understaffed and would have difficulty tracking/managing such data.
	Number of customers in project areas	Total number of customers on either prepayment or credit/post-paid metering system or flat rate arrangement (disaggregated by customer type, gender [for residential customers])	Quarterly	N/A	NEDCo does not disaggregate by gender. To develop such data, the information would need to collect though some type of customer sampling.
Consumption of electricity increased	Electricity consumption	Total Gwh of electricity consumed by all customers (disaggregated by customer type)	Quarterly	N/A	N/A
Reinvestment and maintenance in capital expenditure	Capital expenditure (Capex)	Total value of new equipment installed in the distribution network through projects funds and/or private sector partners	Monthly	Capital expenditure amount is important, but should b based upon an investment plan developed through system model and long-range plan.	This will require NEDCo to develop more regular financial statements as such statements are normally considered only once per year. More detail into these practices should be considered.
	Ratio of actual maintenance expenditures to planned maintenance budget	Actual maintenance expenditures divided by Planned maintenance budget	Monthly		The lack of disaggregated financial data makes getting many of these financial indicators problematic. It may be necessary to understand what these numbers consist of and work with the utility to further disaggregate the required information. Furthermore, current expenditures seem very low in comparison to other utilities.
	Ratio of actual maintenance expenditures to dollar value of total distribution assets	Actual maintenance expenditures divided by total value of distribution assets	Monthly		
Enhanced investment capacity	Asset turnover	Net sales divided by total assets	Monthly		
Cost of electricity service delivery reduced	Cost per kWh of electricity delivered	Total cost of electricity supplied to customers divided by total electricity supplied (in kWh)	Monthly		
Outcomes					
Utility Financial Health improved	Operating profit (loss)	Operating revenue minus operating expenses	Quarterly		
	Operating Margin	Operating Income/Net Sales	Monthly		
	Net profit	Net income divided by net sales	Monthly		
	Quick ratio	Current assets minus stock divided by current liabilities	Monthly		
	Debt to equity ratio	Long-term liabilities divided by shareholders equity.	Monthly		
Reduced outages	SAIDI	Sum of durations of all customer interruptions divided by Total customers in system at the sub-station level	Monthly		Currently customers affected are an estimate. The GIS system tied to the customer information system will ensure more accurate readings.
	SAIFI	Number of customer interruptions divided by Total customers in system at the sub-station level	Quarterly		Currently customers affected are an estimate. The GIS system tied to the customer information system will ensure more accurate readings.
Timely payments made to sector entities	Average payment period to power producers	Total accounts payable to power producers divided by total credit purchases times 360	Quarterly		
	Average payment period to GRIDCo	Total accounts payable to GRIDCo divided by total credit purchases times 360	Quarterly		

TABLE 9-4
Recommended Data Collection Frequency, Considerations and Existing Gaps

NEDCo Financial and Operational Turnaround Project Indicators					
Result Statement	**Indicator**	**Definition**	**Frequency**	**Data Collection Considerations**	**Measurement Gaps**
Gender employment targets met	Percentage of female employees	Number of female employees divided by number of employees time 100	Quarterly		
Billing and Collections improved	Billing and collection ratio	Revenue collected divided by total electricity billed.	Quarterly		
	Average collection period (accounts receivable)	Receivables divided by credit sales times 360 days	Monthly		
Distribution losses reduced	Technical losses	Estimated MW of power dissipated in electricity system components such as distribution lines, transformers using the Power System Analysis Software	Yearly		
			Monthly		Requires NEDCo develop greater detail of its loss data. Will require installation of appropriate meters. Will require 1) GIS, 2) Modeling of Technical losses and 3) disaggregation of technical, non-technical and collection efficiency.
	Commercial losses reduced	System losses minus technical losses.	Yearly		
	Energy Losses	System losses.	Monthly		
Distribution system losses (ATC&C)	Distribution system losses (ATC&C)	~~Total electricity purchased by distributors minus total electricity sold (or billed) as a percentage of total electricity purchased~~ ATC&C is (1-energy losses)*collection efficiency	Monthly		Requires NEDCo develop greater detail of its loss data. Will require installation of appropriate meters. Will require 1) GIS, 2) Modeling of Technical losses and 3) disaggregation of technical, non-technical and collection efficiency.

SECTION 10

Observations, Conclusions, and Recommendations

10.1 Introduction

This section presents the observations, conclusions, and recommendations of the project team, based on more than five months of working with NEDCo. The intent of the observations is to frame the context for the conclusions and recommendations.

During Phase I, the ATC&C index was identified as the unifying metric to focus attention on the magnitude and type of losses (technical, commercial, and collection). The ATC&C index was calculated to characterize overall NEDCo losses and provide a relative basis for comparison with other distribution utilities. The ATC&C metric was subsequently employed to evaluate specific Sub-Activities for improvement. Moving forward, measuring changes in ATC&C provides an objective means of evaluating progress over time.

Also during Phase I, an integrated loss management program (ILMP) with a geographic focus was introduced as a means to address ATC&C challenges. The coupling of ATC&C with ILMP provides a unifying theme for the conclusions and recommendations.

10.2 Summary Observations and Challenges

Power sector decision makers in Ghana have not fully embraced the challenge of creating the conditions to support financially viable distribution companies. The Minister of Finance said that the GoG will not provide sovereign guarantees, while also stating that state-owned enterprises are expected to become financially self-sustaining. Concurrently, the GoG appears to be reluctant to make important reforms in how NEDCo is governed, changes that would provide the necessary incentives for making more-effective investment and operational decisions that would reduce losses. NEDCo focuses significant resources on politically important investments, such as access expansion, and is unable to invest in essential performance improvements that would result in significant cost savings and revenue collection improvements.

High annual growth in demand is occurring. Electricity demand is projected to grow at an approximate 6 percent compound annual growth rate. Peak capacity is estimated to grow at a compound annual growth rate of about 9 percent. High ATC&C losses place NEDCo in a negative annual income position with poor cash flow. The GoG policy to achieve universal electricity access by 2030, coupled with tariffs that do not allow full cost recovery, exacerbates a weak financial position by adding tens of thousands of highly subsidized consumers each year.

Data are available but are not used. NEDCo collects essential financial and technical data but lacks the organizational framework to use the data effectively for decision-making. Data are collected but are not systematically evaluated, shared, or employed to result in informed decision making. For instance, NEDCo has the capacity to develop enterprise financial-technical performance reports and information regarding losses every month, but this information is not regularly developed or disseminated.

Reliance upon VRA is unbalanced and uncertain. NEDCo continues to rely upon VRA for payment of salaries, purchases of electricity, and a variety of project management activities. The VRA-NEDCo assistance agreement is vague on the issue of NEDCo graduation, so it is difficult to determine when VRA will likely divest itself of NEDCo. This dependence limits NEDCo’s control over key performance information and ability to fully manage and respond to its performance issues.

Planning department lacks focus and resources. At present, the NEDCo planning department focuses on issues of urgent and immediate import rather than addressing the long-term needs of the organization. The department lacks the basic and essential data, information, and methodologies needed to systematically address expansion and performance improvement for short-, medium-, and long-term planning. Distribution planning cannot be accomplished without up-to-date system maps, single- line diagrams, and system models to evaluate load flows, losses, and expansion needs. With these resources, expansion planning can be accomplished for short-term (1-2 years), medium-term (5 years), and long-term expansion planning. Without planning it is especially difficult to set priorities and allocate resources to prepare for growth.

Customer knowledge is limited. NEDCo has a limited understanding of its customers, which indicates a lack of customer orientation. Customer service departments are typically organized with a key accounts group that focuses on the needs of strategically important customer accounts, and a larger group that caters to the needs of a large number of smaller consumers, including residential and small commercial consumers. Finding the means to be responsive to all consumers can be challenging for a modern electric utility, and is even more difficult for a small distribution utility like NEDCo. At this point, the basic building blocks of understanding customer behaviors and needs have not been addressed because NEDCo has not yet conducted focus group or consumer surveys to gather data and insight. Developing and employing such practices, along with effective use of a CIS platform, are needed to better respond to customer needs and desires.

Key performance indicators, **including ATC&C, are not employed to support management solutions.** Similarly, reporting important operational information such as disaggregation of O&M costs is not practiced even though the data can be readily evaluated from accounting records. NEDCo has the capability, but it has not developed a format in which performance data can be presented and used by the NEDCo board of directors and senior management for decision making, particularly strategic investment decisions.

10.3 Conclusions

ATC&C has to be reduced. NEDCo meets most of the metrics required by PURC regulations, with the exception of overall loss levels and collection efficiency. Despite recent interventions specifically designed to reduce losses, ATC&C losses have actually increased in the past 2 years. As demonstrated in the financial analysis, without a significant improvement in loss reduction, NEDCo will continue to experience significant financial losses. Two areas, collection and commercial losses, are of particular concern. The GoG arrears to NEDCo represent 62 percent of all outstanding arrears. Simply put, government consumers need to pay their electricity bills either directly or through the Ministry of Finance in a timely manner. The method used to reconcile bill payment needs to be streamlined such that each government consumer will be empowered to complete payment in a timely manner without harming NEDCo’s financial position. NEDCo has started implementing prepaid meters for non-critical government customers to try to mitigate this problem.

An ILMP needs to be implemented. NEDCo addresses ATC&C losses in a disjointed manner. An ILMP will integrate the key functions of engineering, operations, commercial, and administration to systematically identify, evaluate, and implement loss reduction solutions. The ILMP will be the implementation force for both foundational projects and high value Sub-activities. Furthermore, monitoring and evaluating measures will be tied to the ILMP on an ongoing basis to measure success of the program.

Growth in demand growth needs to be controlled. High growth in demand is challenging even for well-managed and financially healthy organizations. NEDCo will be hard-pressed to keep up with growth in demand, which will include increased pressure for new customer connections. Without demand management, there will likely be an increase in the number and duration of outages as the distribution system is stressed. The focus access projects divert attention from loss reduction and lead to increases in demand without the infrastructure required to serve the new customers.

Information flow needs to change. Without timely and accurate information, the NEDCo board of directors cannot make informed decisions or prioritize investments to those that will yield highest performance improvements. A reporting framework, similar to the financial and statistical report presented in the Monitoring and Evaluation section of this report, provides a concise and accepted reporting format for electric utilities.

Modeling indicates positive returns to the Ghanaian economy. The financial health and stability of NEDCo requires reduction of ATC&C losses to improve revenue collection and cash flow. The project’s financial modeling demonstrated that implementation of the multiple Sub-Activities, coupled with modest tariff increases, results in positive cash flow. The internal rate of return for the utility is positive and the overall EIRR for the ILMP for NEDCo is 14.7 percent. Economic modeling demonstrates that the proposed Sub-Activities will provide significant positive economic impacts by improving fuel management and reducing outages.

Planning. NEDCo needs to develop the tools, discipline, and methodologies to engage in system planning, especially system-wide performance modeling and long-term expansion planning. Expansion planning will rely on developing load forecasting that is derived from geographically specific sales data generated from a CIS that is directly linked to GIS and load flow modeling software. Short-, medium-, and long-term expansion plans provide a roadmap for capital investments that address load requirements for NEDCo's distribution network. Over the past years, NEDCo has made significant investments in infrastructure, but these investments have emphasized access rather than improving revenue recovery. In addition, these investments have not been targeted to reduce losses and increase collections, as evidenced by increasing ATC&C losses. Although NEDCo has purchased and installed more than 200,000 pre-paid meters that have the capacity to improve revenue recovery, it has not evaluated investment options to reduce losses with a comprehensive strategy to systematically improve its financial position.

NEDCo needs to change the institutional culture. NEDCo needs to engage in an initiative to bring about a sweeping change in its institutional culture. Senior management needs engage in a process to define immediate and long-term goals, and to align staff with these corporate goals so that long-term performance improvements are achieved. The NEDCo staff is experienced and talented but lacks the proper incentives to focus its abilities on improving NEDCo performance. For initiatives to succeed, such as the ILMP, NEDCo management needs to invest in information sharing at all levels of the corporate structure and to demonstrate how employees will benefit from improved performance.

Environmental, social, and resettlement impacts must be minimized. Of the 21 NEDCo Sub-Activities located in the Northern and Brong Ahafo Regions of Ghana, 15 will have little or no environmental or social impacts and will not require resettlement. The 6 Sub-Activities that have the potential for environmental and social impacts as well as resettlement involve the construction of substations and various distribution line construction and modifications. There is inherent flexibility in the location and design of both proposed substations and distribution lines that will enable potential environmental and social impacts to be minimized. The greatest potential for resettlement is with the numerous informal businesses that locate within the utility corridors along busy roads. Although the GoG does not compensate vendors who must move out of the utility corridors, it is the standing policy of the MCC that all resettlement activities must be appropriately compensated. It will be important for NEDCo to take advantage of the flexibility in routing and designing most distribution lines to minimize the overall need for resettlement.

10.4 Recommendations

An ILMP with a geographic focus. In order to incubate an effective loss management program, the program needs to be integrated between several directorates in NEDCo. Towards this end, we recommend that the MCC loss reduction program focus on a specific geographic area to integrate customer service, engineering, and operations activities, and to measure performance improvement metrics in a timely manner and on a comprehensive basis. A team should be created with the mandate to integrate key functions from various directorates that will directly support MCC investment objectives. The ILMP will provide detailed granularity to help focus decision making, and the Technical Assistance Program (NEDCo-Service-05) will be able to support NEDCo in developing appropriate management reports and then using such reports for decision-making.

Organizational change. Organizational cultural change is sensitive and can be challenging to implement NEDCo leadership, and perhaps the technical advisors who support the MCC investment, will need to identify and engage with personnel who have the capacity to model behavior and to encourage peers to effect positive change within the organization. These key leaders need to be committed to change, specifically the focus on loss management with the concurrent alignment of information flow tied to performance metrics. The NEDCo leadership will need to "walk the talk," meaning to lead by example to improve performance and to address customer concerns. Spending time fielding customer complaints, accompanying the LCUs on a daily round, or preparing informational brochures are ways for the leadership to stay connected with NEDCo customers.

Internal staff and funds resource allocation. NEDCo also needs to understand how to redistribute resources to the ILMP and away from non-productive or “cold spot” activities. All firms have limited resources and NEDCo needs to prioritize staff resources to address the high returns with loss reductions.

Internal liaison. The NEDCo board of directors and senior management need to be attuned to personnel issues and needs. Staff liaisons should be created that assign key personnel to keeping the leadership informed of how changes are received within the organization. Key liaison personnel need to be highly respected and capable of building coalitions and devising strategies to execute the organization changes.

Employee engagement. As part of the organizational change, NEDCo needs to engage employees and to capture their ideas, as well as to motivate improved behaviors. Employee recognition and compensation will need to include recognition and reward for achieving performance improvement metrics such as reducing ATC&C losses. Employee training with a focus on loss reduction is an important tool for both increasing the corporate skill set as well as communicating common goals such as loss reduction. Employee engagement needs to be aligned with the Sub-Activities, especially for commercial and collection losses. These personnel must have appropriate training and compensation. At the same time, much of the non-technical loss is due to employee involvement, and NEDCo will need to develop procedures for identifying and dealing with employees who continue to pursue such activities through legal action.

Customer knowledge. NEDCo needs to capture information to understand customer behavior and usage patterns. Customer surveys (differentiated by customer class), town meetings, and one-on-one meetings with key accounts are methods for capturing customer information. Over time, as the NEDCo systems and staff become better acquainted with all of the data (CIS, CMO, GIS) that the various Sub-Activities will provide, “big data” mining will be possible to provide further understanding of NEDCo’s customers and their behaviors.

Uniform tariff. A major challenge is the insistence by the PURC on a uniform national tariff. An explicit tariff/subsidy structure that considers cost of service separately for NEDCo will be necessary before there can be any reduction in dependence on VRA. This is a policy issue, and it appears that current policy makers are satisfied with the status quo, that is one in which subsidies are hidden and implicit.

Long term planning. The lack of a clear definition of a long term strategy for NEDCo is of concern and a priority should be given to creating a master plan that captures both the technical aspects of running the organization but also with great consideration to funding NEDCo for the long term as part of the tariff structure. VRA is perhaps the key organization for which consultations will be required to forge a long term strategy

SECTION 11

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Appendix A
Consolidated Sub-Activity List and Results

Area(s)	Foundational	Sub-Activity Name	Activity	Cost	Start Year	Duration (months)	Precedents	NPV
All	No	NEDCo-Comm-01: Service connection materials	Commercial Losses Reduction and Collection Efficiency Improvement	$ 3,933,000	1	18	NEDCo-Engr-22	$ (1,098,000)
All	Yes	NEDCo-Comm-03: Customer census and normalization of existing service connections	Commercial Losses Reduction and Collection Efficiency Improvement	$ 7,836,000	0	26	NEDCo-Comm-04	$ 8,051,000
All	Yes	NEDCo-Comm-04: Enterprise customer information system and integration with existing enterprise applications	Institutional Support	$ 4,838,000	0	26	None	$ 31,551,000
Northern; Sunyani	Yes	NEDCo-Service-02A: Procurement of vehicles, tools and equipment	Commercial Losses Reduction and Collection Efficiency Improvement	$ 4,506,000	1	22	NEDCo-Engr-22	$ 12,949,000
Tamale; Sunyani	No	NEDCo-Engr-03A: Replace faulty and aging underground conductors	Outages Reduction	$ 4,888,000	0	10	NEDCo-Engr-22	$ 18,050,000
Techniman	No	NEDCo-Engr-07: Shield wire conversion to 34.5 kV system Techniman-Ahafour	Technical Losses Reduction	$ 4,420,000	2	37	NEDCo-Engr-22	$ 12,615,000
Tamale	No	NEDCo-Engr-08: Install Banvim primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	Technical Losses Reduction	$ 3,386,000	2	39	NEDCo-Service-06	$ 17,619,000
Tamale	No	NEDCo-Engr-09: Install Islamic primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	Technical Losses Reduction	$ 3,338,000	2	39	NEDCo-Service-06	$ 17,111,000
Sunyani	No	NEDCo-Engr-11: Install Fiapre primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	Technical Losses Reduction	$ 3,105,000	2	39	NEDCo-Service-06	$ 17,392,000
All	No	NEDCo-Engr-18: Reactive power compensation for primary substations and MV lines	Technical Losses Reduction	$ 1,822,000	2	31	None	$ 537,000
Tamale; Sunyani	Yes	NEDCo-Engr-19A: Low voltage feeder bifurcation with medium voltage upgrade	Technical Losses Reduction	$ 6,652,000	1	37	NEDCo-Engr-22	$ 887,000
All	Yes	NEDCo-Engr-22: Update distribution construction standards based on current low loss practices	Technical Losses Reduction	$ 314,000	0	10	None	$ 795,000
Tamale	Yes	NEDCo-Engr-24: Metering at critical nodes of the distribution system	Commercial Losses Reduction and Collection Efficiency Improvement	$ 1,377,000	1	30.5	NEDCo-Engr-22	$ 1,314,000
All	Yes	NEDCo-Engr-29: Sectionalizing study of MV networks within NEDCo's territory	Outages Reduction	$ 498,000	2	23	NEDCo-Engr-22	$ 533,000
All	No	NEDCo-Ops-02: Procure operations and maintenance materials	Outages Reduction	$ 1,800,000	2	31	NEDCo-Engr-22	$ (933,000)
All	Yes	NEDCo-Ops-03: Installation of outage reporting and call center system	Outages Reduction	$ 194,000	4	14	NEDCo-Comm-04	$ 543,000
Northern; Sunyani	Yes	NEDCo-Ict-01: Communication network	Institutional Support	$ 315,000	0	27	None	$ 3,823,000
All	Yes	NEDCo-Ict-04: Data center at VRA or Sunyani	Institutional Support	$ 981,000	0	22	None	$ 1,492,000
Northern; Sunyani	No	NEDCo-Service-01A: Construction of customer service centers	Institutional Support	$ 3,670,000	1	22	None	$ 15,771,000
All	Yes	NEDCo-Service-05: Technical Assistance Program	Institutional Support	$ 4,950,000	0	54	None	$ 2,280,000
All	No	NEDCo-Service-06: Distribution System Master Plan	Institutional Support	$ 437,000	0	28	None	$ 923,000

Appendix B
Loss Study Results

Tamale Grid Substation Feeder Data (From Hasibur)								Load Flow Analysis Result										
Fdr Name	Voltage	Line Length (kM)	No. of Dist.Trafo	Connected kVA	Peak Load (kW)		Av. Loading of Trafo (%)	**Load (kW)**	**HT Length (km)**	**34.5kV Loss (kW)**	**11kV Loss (kW)**	**LT Length (km)**	**LT Loss (kW)**	**Trans FL Loss (kW)**	**Trans NL Loss (kW)**	**Trans Load Loss**	**Allocated Load (kW)**	**% Loss**
Under 28T2											Estimated		Estimated					
28F1Y	34.5kV	346.99	127	26,700	7,500		30%	5,298	337.00	82.25	502.27		390.11	78.20	56.86	21.34	6,351	16.58%
Under 28T1											Measured		Estimated					
28F2B	11kV	5.71	8	2,830	1,935		72%	1,878	5.71		26.40		138.41	32.22	5.74	26.48	2,075	9.50%
28F3B	11kV	78.18	70	11,895	4,448		39%	3,741	78.18		655.15		319.12	68.97	29.47	39.50	4,784	21.81%
28F4B	11kV	47.77	65	11,155	4,718		45%	3,840	47.78		808.42		337.47	73.46	28.87	44.59	5,059	24.10%
28F6B	11kV	67.35	68	12,105	4,698		41%	4,291	67.36		334.71		335.67	71.00	31.54	39.46	5,032	14.73%
Under 28T2																		
28F7B	11kV	41.20	53	12,315	5,582		48%	5,251	41.20		262.39		400.01	83.60	29.57	54.03	5,997	12.44%
28F8B	11kV	4.38	9	2,830	1,766		66%	1,708	4.38		21.22		126.25	37.32	4.32	33.00	1,893	9.76%
28F9B	11kV	45.82	53	12,795	5,435		45%	4,852	45.82		502.15		388.30	79.04	31.96	47.08	5,821	16.65%
28F11B	11kV	10.81	20	5,800	3,955		72%	3,447	10.81		162.94	55.65	264	77.40	14.28	63.12	3,951	12.75%
											0.08						34,613	
													Measured					
28F11B	11kV	10.81	20	5,800	3,955		72%	3,447	10.81		162.94	55.65	264	77.40	14.28	63.12	3,951	12.75%

Appendix C
Sub-Activity Descriptions

Identification

Sub-Activity Name	Service connection materials
Activity	Commercial Losses Reduction and Collection Efficiency Improvement
Area(s)	All
Foundational	No
Sub-Activity Dependency	NEDCo-Engr-22: Update distribution construction standards based on current low loss practices
Project Source	NEDCo

Problem Statement

Commercial losses represent the energy that is not billed to the customer due to illegalities. The causes of commercial losses are many and some of the most common are: (a) Illegal connection to the LV system; (b) Bypass of the Meter; (c) Tampering of the meter and/or meter instruments (Potential and Current transformers); (d) Inaccurate or dysfunctional meter and (e) any other situation causing inaccurate count of the energy used by a consumer.
Collection inefficiency is another type of losses that occur when the energy registered as used by a consumer is not paid for. The causes of these losses are many and some of the most common are: (a) undelivered, lost or non-printed bills, (b) inability of consumer to pay bill in full (c) inability of utility to disconnect delinquent accounts. Commercial and Collection losses are the most costly to the utility. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. In recent years the annual connection rate of new consumers in the NEDCo service territory has been approximately 10 percent of its customer base, or about 40,000 new customers per year. The connection process includes payment of a connection fee by the consumer to NEDCo. In practice, NEDCo-supplied connection materials— wires, connectors, meter boxes and other accessories—are in limited supply and an inventory is not maintained. NEDCo often is unable to fulfill a new connection for its customers.
Therefore customers resort to the open market to purchase and install connection material. The open market material is not always consistent with NEDCo standards and leads to implementation challenges, including unsafe practices, non-reliable wiring, and connections that are susceptible to tampering.
This sub-activity will provide a connection inventory to facilitate timely and standardized connections (sub-activity Engr-22) to the electric service. It also enables NEDCo to fulfill new customer connection demands while maintaining control over the most important portion of the distribution network in limiting commercial losses.

Implementation. Service materials will be procured by NEDCo according to the new service specifications (sub-activity Engr-22). The new service materials will be hardened against tampering and theft and will be stocked in the area warehouse. The project budget is to provide sufficient funding to purchase service connections. In future years, it is anticipated NEDCo will be able to self-finance the services supported by revenues from new consumer payments.

Metrics

Investment	$ 3,933,000	**Financial Rate of Return (IRR)**		6%
Net Present Value (NPV)	$ (1,098,000)	**Economic Rate of Return (ERR)**		57%
Yearly Operations and Maintenace	$ 129,000	**Yearly revenue from new cust.**	$	740,000

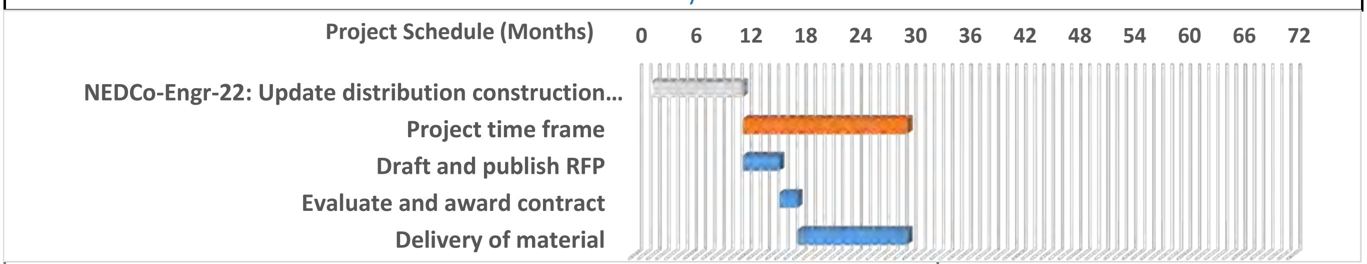
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Service Material	*Services*	35,000	$ -	$ 3,745,000	$ 3,745,000
Contingency on labor	*Percentage*	10	$ -	$ -	$ -
Contingency on material	*Percentage*	5	$ -	$ 188,000	$ 188,000
PMC, Design & Supervision	*Percentage*	-	$ -	$ -	$ -
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ -	$ 3,933,000	$ 3,933,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the updated work procedures

Identification

Sub-Activity Name	Customer census and normalization of existing service connections
Activity	Commercial Losses Reduction and Collection Efficiency Improvement
Area(s)	All
Foundational	Yes
Sub-Activity Dependency	NEDCo-Comm-04: Enterprise customer information system and integration with existing enterprise applications
Project Source	NEDCo

Problem Statement

Commercial losses represent the energy that is not billed to the customer due to illegalities. The causes of commercial losses are many and some of the most common are: (a) Illegal connection to the LV system; (b) Bypass of the Meter; (c) Tampering of the meter and/or meter instruments (Potential and Current transformers); (d) Inaccurate or dysfunctional meter and (e) any other situation causing inaccurate count of the energy used by a consumer.
Collection inefficiency is another type of losses that occur when the energy registered as used by a consumer is not paid for. The causes of these losses are many and some of the most common are: (a) undelivered, lost or non-printed bills, (b) inability of consumer to pay bill in full (c) inability of utility to disconnect delinquent accounts. Commercial and Collection losses are the most costly to the utility. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. NEDCo has served consumers in the legacy business system for more than three decades. The customer information system has numerous errors regarding customer identification, particularly missing data, duplicates, and / or wrong locations. As new business systems (sub activity Comm-04) are brought on line, it will important to check that customer information has been updated.
Furthermore, services and meter installations in the utility's service territory have been historically non-compliant with published standards. Contractors hired to install new services do not consistently follow construction standards and have not been subject to routine inspection of proper installation of services and meters. This leads to service installations that are easily tampered with, which is the leading cause of the commercial losses from illegalities (meter by-pass, meter tampering, paralleling the meter with jumpers).

Implementation. A contractor will be hired to conduct a census of all connected consumers. The census activity will also include an audit of the customer's service connection(s). For those consumers whose meter installations are improperly installed or located, the contractor will normalize the connection to restore integrity of the services per sub activity Engr-22. The contractor will perform the normalization task.

Metrics

Investment	$	7,836,000	**Financial Rate of Return (IRR)**	24%
Net Present Value (NPV)	$	8,051,000	**Economic Rate of Return (ERR)**	-12%
Yearly Operations and Maintenace	$	256,000		

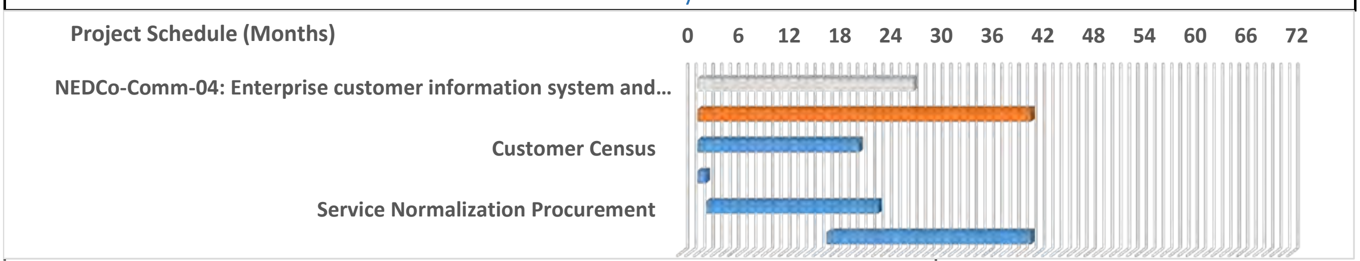
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Customer Census	*Services*	591,700	$ 888,000	$ -	$ 888,000
Service connection upgrades	*Services*	54,200	$ 1,301,000	$ 4,174,000	$ 5,475,000
Training NEDCo inspectors	*work days*	15	$ 19,000	$ -	$ 19,000
Contingency on labor	*Percentage*	10	$ 221,000	$ -	$ 221,000
Contingency on material	*Percentage*	5	$ -	$ 209,000	$ 209,000
PMC, Design & Supervision	*Percentage*	15	$ 332,000	$ 627,000	$ 959,000
Env/Social Mitigation	*Percentage*	1	$ 23,000	$ 42,000	$ 65,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 2,784,000	$ 5,052,000	$ 7,836,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.5%	82,000	$ 8,000
Commercial loss	38.0%	6,244,000	$ 1,228,000
Collection efficiency	10.0%	6,557,000	$ 1,289,000
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the updated work procedures
Selecting a qualified consultant who is capable of delivering the scope of the project, on time, and within budget.	Institutional	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with there accommodations and other fringes
Selecting a skilled local contractor who is capable of delivering the scope of	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work
NEDCo completing GIS system	Financial	Coordinate with Swiss donors to ensure that funds available for GIS are released in time. Follow Closely current progress of GIS implementation and adjust course accordingly.
Access to consumer premises	Technical	Ensure that all required documentation to access premises are procured and put in place procedure to send inaccessible premises location to the LCU fro further action and escalation
Customers lose electrical service as a result of sub-activity	Social	MCC/MiDA to develop a means test and mitigation approach with utility

Identification

Sub-Activity Name	Enterprise customer information system and integration with existing enterprise applications
Activity	Institutional Support
Area(s)	All
Foundational	Yes
Sub-Activity Dependency	None
Project Source	E-solutions IT Transformation Study

Problem Statement

The utility has an inadequate level of support (both systems and expert personnel) to execute the sub-activities under the loss and outage reduction activities funded by the MCC compact II. The problems facing the organization are lack of updated master plan, lack of a strong IT infrastructure to support the installation and integration of many of the business application and an inefficient organizational structure.

Sub-Activity Description

Intervention. Enterprise resource planning (ERP) generally comprises an integrated suite of business software applications using a common database. Enterprise solutions integrate internal and external management information across an entire organization, embracing processes spanning finance/accounting, asset management, customer relationship management and energy capital management. The purpose of an integrated enterprise application solution suite is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders.
NEDCo currently uses individual applications with disconnected regional databases in many of its business applications. The current practice leads to inefficiencies and poor data availability and quality, which can result in compromised decision making.

Implementation. A contactor will be hired to finalize the ERP specification based upon the approach that has been initially developed by E-solutions in 2012. NEDCo plans to implement an enterprise resource planning application via a customer information system (CIS) that will integrate general ledger & accounting, customer billing, warehouse control, work order, asset management, human resource, payroll, and other business applications with which NEDCo will manage its core business functions. This project will finance the procurement of the hardware, software licenses and implementation / customization costs for the enterprise CIS for the NEDCo ERP system according to specifications.

Metrics

Investment	$	4,838,000	**Financial Rate of Return (IRR)**	79%
Net Present Value (NPV)	$	31,551,000	**Economic Rate of Return (ERR)**	20%
Yearly Operations and Maintenace	$	184,000		

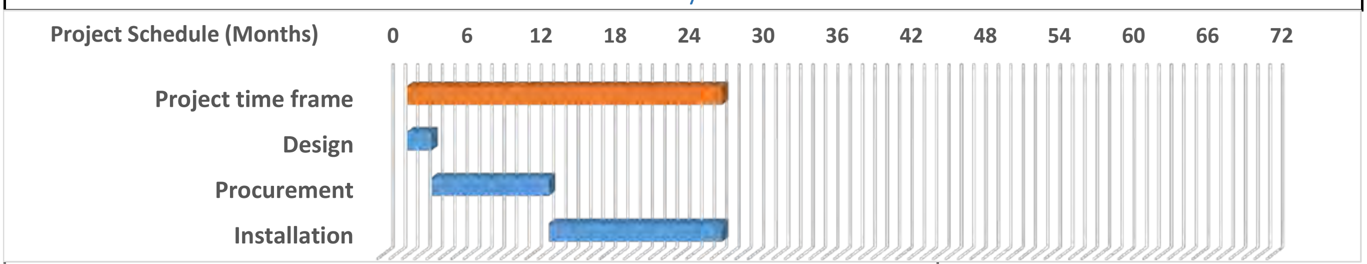
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
ERP System	*System*	1	$ -	$ 3,000,000	$ 3,000,000
ERP System integration	*Worked Days*	792	$ 990,000	$ -	$ 990,000
Contingency on labor	*Percentage*	10	$ 99,000	$ -	$ 99,000
Contingency on material	*Percentage*	5	$ -	$ 150,000	$ 150,000
PMC, Design & Supervision	*Percentage*	15	$ 149,000	$ 450,000	$ 599,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 1,238,000	$ 3,600,000	$ 4,838,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	20.0%	3,286,000	$ 646,000
Collection efficiency	33.0%	21,639,000	$ 4,255,000
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Employee capacity to use software efficiently	Institutional	Ensure appropriate number of training sessions are budgeted with each software deployment and require that participants pass basic computer skill test before attending training
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the
Integration between new and existing systems	Technical	Ensure enough resources are allocated to the debugging and programing of the interfaces between the different systems
Wide area network communication	Technical	Ensure that nodes with high traffic are equipped with redundant links through different provider and physical infrastructure.
NEDCo completing GIS system	Financial	Coordinate with Swiss donors to ensure that funds available for GIS are released in time. Follow Closely current progress of GIS implementation and adjust course accordingly.
Selecting a qualified consultant who is capable of delivering the scope of the project, on time, and within budget.	Institutional	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with there accommodations and other fringes

Identification

Sub-Activity Name	Replace faulty and aging underground conductors
Activity	Outages Reduction
Area(s)	Tamale; Sunyani
Foundational	No
Sub-Activity Dependency	NEDCo-Engr-22: Update distribution construction standards based on current low loss practices
Project Source	NEDCo

Problem Statement

In areas where outages are frequent or have long durations large industrial and commercial customers, who require reliable power, may decide to reduce their reliance on the utility by utilizing self-generation (part time or full time.) In extreme cases these customers my decide to relocate their facility to another area/country that offers a service standard that meets their needs. By reducing outages these consequences can be avoided and severely reduce the amount of unrealized or lost revenue.

Sub-Activity Description

Intervention. The underground conductor (cable) employed in several population centers is aging and is subject to frequent faults. When a fault occurs, a team from NEDCo is dispatched to locate it using specialized equipment. Once the fault is located, the area is excavated and a section of the cable is replaced with two splices. This process is time- consuming and leaves the cable de-energized for a long duration. In addition, each fault on the cable weakens the insulation at another location, which leads to increased probability of faults. There is usually a limit to the number of repaired faults on the cable before the entire cable must be replaced, and many of the existing conductors should be replaced.

Implementation. A contractor will be hired to conduct a detailed evaluation of the NEDCo underground system in Tamale and Sunyani, and from the results of the evaluation, to replace the MV underground conductors that are causing the outages. The contractor's scope of work includes a detailed design with an operational plan to keep the affected areas energized while the cables are being replaced. The physical work will include procurement, excavation, installation of the new cable, and restoration of the area to previous condition.

Metrics

Investment	$ 4,888,000	**Financial Rate of Return (IRR)**	43%
Net Present Value (NPV)	$ 18,050,000	**Economic Rate of Return (ERR)**	29%
Yearly Operations and Maintenace	$ 160,000	**Yearly revenue from new cust.**	$ 3,788,000

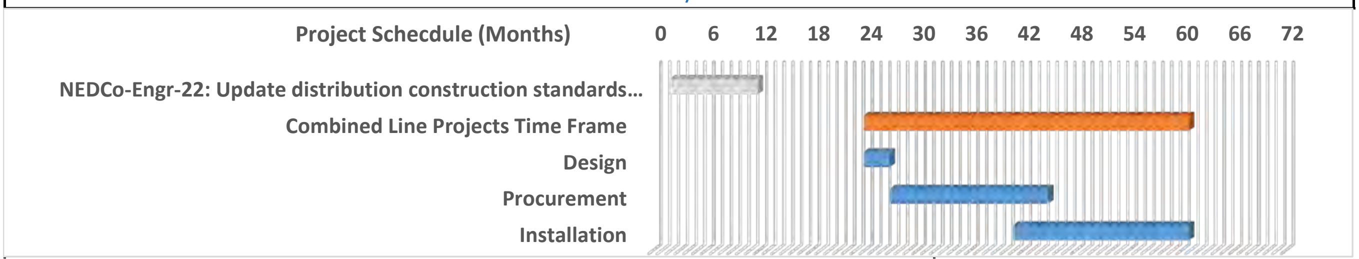
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Replace and upgrade 11 kV cable	*km*	33	$ 1,432,000	$ 2,387,000	$ 3,819,000
Contingency on labor	*Percentage*	10	$ 144,000	$ -	$ 144,000
Contingency on material	*Percentage*	5	$ -	$ 120,000	$ 120,000
PMC, Design & Supervision	*Percentage*	15	$ 215,000	$ 359,000	$ 574,000
Env/Social Mitigation	*Percentage*	1	$ 15,000	$ 24,000	$ 39,000
Resettlement	*Percentage*	5	$ 72,000	$ 120,000	$ 192,000
		Total	$ 1,878,000	$ 3,010,000	$ 4,888,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.5%	82,000	$ 8,000
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the
Clearance from electrical equipment	Technical	Reroute lines away from structure and there original path when possible and include a contingency to use pricier designs that do not require clearance or remove structures causing clearance issues
Selecting a skilled local contractor who is capable of delivering the scope of the project, on time, and within	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement cannot be avoided.

Identification

Sub-Activity Name	Shield wire conversion to 34.5 kV system Techniman-Ahafour
Activity	Technical Losses Reduction
Area(s)	Techniman
Foundational	No
Sub-Activity Dependency	NEDCo-Engr-22: Update distribution construction standards based on current low loss practices
Project Source	GEDAP III

Problem Statement

Technical losses, the second most costly type of loss to utilities, represent the energy lost in the wires and electrical equipment. The principal cause of technical losses is often high current on inadequately sized conductors. Another cause is the use of high loss transformers because of their lower initial capital cost. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. NEDCo presently serves some rural villages that are adjacent to transmission corridors with single-phase power supplied via the shield wire on the transmission circuits. GRIDCo no longer allows this practice. The existing shield wire has exceeded its designed capacity leading to outages at peak hours due to the protection relay on the line tripping the breaker. This project will convert the single-phase shield wire distribution service to three-phase distribution on wooden poles. This conversion will energize communities in and around Techiman to Abofour via the existing BSP substation in Techiman.

Implementation. A contractor will be hired to prepare the detailed design of the new line, which will be built in the same corridor as the current transmission line. The existing side tap currently connected to the shield wire will be moved to be energized by the new line. This project also includes the procurement of poles, wires, insulators, and other electrical material to construct the new line. A separate contractor will be hired for procurement and installation of the new line.

Metrics

Investment	$ 4,420,000	**Financial Rate of Return (IRR)**	40%
Net Present Value (NPV)	$ 12,615,000	**Economic Rate of Return (ERR)**	26%
Yearly Operations and Maintenace	$ 145,000	**Yearly revenue from new cust.**	$ 2,874,000

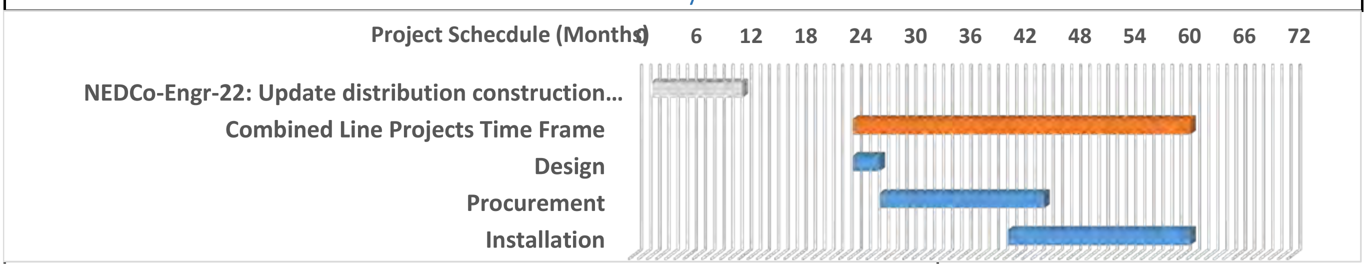
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Install MV lines	*km*	50	$ 220,000	$ 731,000	$ 951,000
Upgrade MV lines	*km*	120	$ 132,000	$ 439,000	$ 571,000
Install LV lines	*km*	50	$ 174,000	$ 577,000	$ 751,000
Update LV Lines	*km*	150	$ 130,000	$ 433,000	$ 563,000
Install Distribution Transtomers	*Transformers*	55	$ 127,000	$ 424,000	$ 551,000
Install New Services	*Services*	600.0	$ 20,000	$ 65,000	$ 85,000
Contingency on labor	*Percentage*	10	$ 81,000	$ -	$ 81,000
Contingency on material	*Percentage*	5	$ -	$ 134,000	$ 134,000
PMC, Design & Supervision	*Percentage*	15	$ 121,000	$ 401,000	$ 522,000
Env/Social Mitigation	*Percentage*	1	$ 9,000	$ 27,000	$ 36,000
Resettlement	*Percentage*	5	$ 41,000	$ 134,000	$ 175,000
		Total	$ 1,055,000	$ 3,365,000	$ 4,420,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the
Clearance from electrical equipment	Technical	Reroute lines away from structure and there original path when possible and include a contingency to use pricier designs that do not require clearance or remove structures causing clearance issues
Selecting a skilled local contractor who is capable of delivering the scope of the	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement cannot be avoided.

Identification

Sub-Activity Name	Install Banvim primary substation with interconnecting sub-T lines, MV offloading circuits and LV network
Activity	Technical Losses Reduction
Area(s)	Tamale
Foundational	No
Sub-Activity Dependency	NEDCo-Service-06: Distribution System Master Plan
Project Source	GEDAP III

Problem Statement

Technical losses, the second most costly type of loss to utilities, represent the energy lost in the wires and electrical equipment. The principal cause of technical losses is often high current on inadequately sized conductors. Another cause is the use of high loss transformers because of their lower initial capital cost. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. Some of the NEDCo distribution feeders have been extended beyond their design limits, leading to deteriorating power quality, higher losses, and reduced capacity to meet load. The primary substations currently serving the Banvim area will soon become overloaded, based on the current demand forecast. To avoid rolling blackouts and improve power quality, a primary substation will be installed.

Implementation. A contractor will be hired to procure and build a substation that conforms to the NEDCo's standard substation design. This activity includes installation of the following items: (1) a new primary substation, including transformer, switchyard, and control house on a fenced-in plot; (2) sub-transmission lines and interconnections to/from the new substation to the existing grid substation; (3) medium voltage lines, and; (4) low voltage distribution line and distribution transformers.

Metrics

Investment	$ 3,386,000	**Financial Rate of Return (IRR)**	57%
Net Present Value (NPV)	$ 17,619,000	**Economic Rate of Return (ERR)**	39%
Yearly Operations and Maintenace	$ 111,000	**Yearly revenue from new cust.**	$ 3,396,000

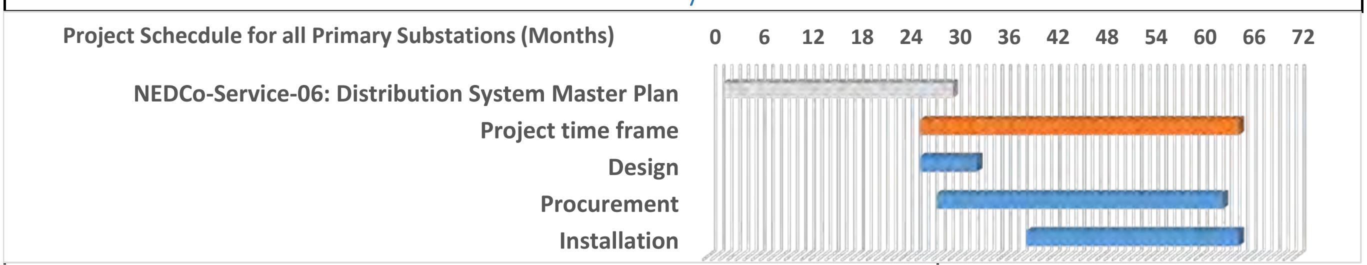
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Primary Substation	*Substation*	1	$ 462,000	$ 1,539,000	$ 2,001,000
Sub-Transmission Lines	*km*	10	$ 44,000	$ 147,000	$ 191,000
Medium Voltage Lines	*km*	6	$ 27,000	$ 88,000	$ 115,000
Distribution Transformers	*Transformers*	20	$ 47,000	$ 154,000	$ 201,000
LV Lines	*km*	10	$ 35,000	$ 116,000	$ 151,000
Contingency on labor	*Percentage*	10	$ 62,000	$ -	$ 62,000
Contingency on material	*Percentage*	5	$ -	$ 103,000	$ 103,000
PMC, Design & Supervision	*Percentage*	15	$ 93,000	$ 307,000	$ 400,000
Env/Social Mitigation	*Percentage*	1	$ 7,000	$ 21,000	$ 28,000
Resettlement	*Percentage*	5	$ 31,000	$ 103,000	$ 134,000
		Total	$ 808,000	$ 2,578,000	$ 3,386,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	5.0%	822,000	$ 79,000
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Clearance from electrical equipment	Technical	Reroute lines away from structure and there original path when possible and include a contingency to use pricier designs that do not require clearance or remove structures causing clearance issues
Real estate and right of way availability for substations	Technical	Include multiple sites location alternative for the substation location and plan for a higher contingency
Selecting a skilled local contractor who is capable of delivering the scope of the	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement cannot be avoided.

Identification

Sub-Activity Name	Install Islamic primary substation with interconnecting sub-T lines, MV offloading circuits and LV network
Activity	Technical Losses Reduction
Area(s)	Tamale
Foundational	No
Sub-Activity Dependency	NEDCo-Service-06: Distribution System Master Plan
Project Source	GEDAP III

Problem Statement

Technical losses, the second most costly type of loss to utilities, represent the energy lost in the wires and electrical equipment. The principal cause of technical losses is often high current on inadequately sized conductors. Another cause is the use of high loss transformers because of their lower initial capital cost. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. Some of the NEDCo distribution feeders have been extended beyond their design limits, leading to deteriorating power quality, higher losses, and reduced capacity to meet load. The primary substations currently serving the Islamic area will soon become overloaded, based on current demand forecast. To avoid rolling blackouts, a primary substation will be installed.

Implementation. A contractor will be hired to procure and build a substation that conforms to the NEDCo's standard substation design. This activity includes installation of the following items: (1) a new primary substation, including transformer, switchyard, and control house on a fenced-in plot; (2) sub-transmission lines and interconnections to/from the new substation to the existing grid substation; (3) medium voltage lines, and; (4) low voltage distribution line and distribution transformers.

Metrics

Investment	$ 3,338,000	**Financial Rate of Return (IRR)**	58%
Net Present Value (NPV)	$ 17,111,000	**Economic Rate of Return (ERR)**	39%
Yearly Operations and Maintenace	$ 110,000	**Yearly revenue from new cust.**	$ 3,396,000

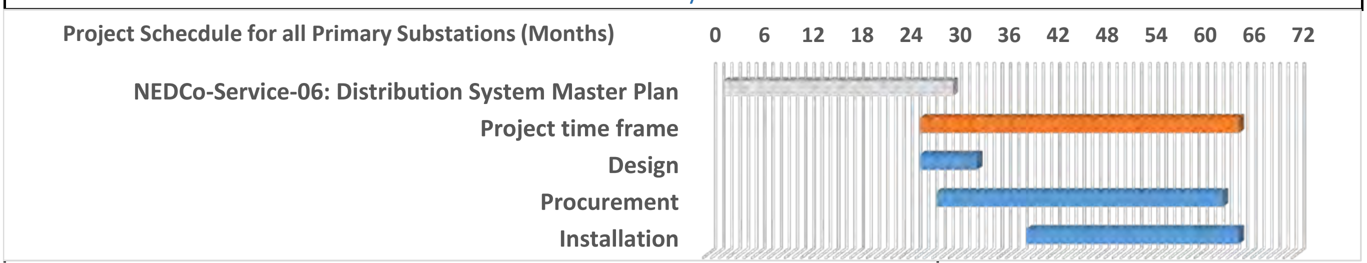
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Primary Substation	*Substation*	1	$ 462,000	$ 1,539,000	$ 2,001,000
Sub-Transmission Lines	*km*	6	$ 27,000	$ 88,000	$ 115,000
Medium Voltage Lines	*km*	8	$ 36,000	$ 117,000	$ 153,000
Distribution Transformers	*Transformers*	20	$ 47,000	$ 154,000	$ 201,000
LV Lines	*km*	10	$ 35,000	$ 116,000	$ 151,000
Contingency on labor	*Percentage*	10	$ 61,000	$ -	$ 61,000
Contingency on material	*Percentage*	5	$ -	$ 101,000	$ 101,000
PMC, Design & Supervision	*Percentage*	15	$ 92,000	$ 303,000	$ 395,000
Env/Social Mitigation	*Percentage*	1	$ 7,000	$ 21,000	$ 28,000
Resettlement	*Percentage*	5	$ 31,000	$ 101,000	$ 132,000
		Total	$ 798,000	$ 2,540,000	$ 3,338,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	5.0%	822,000	$ 79,000
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Clearance from electrical equipment	Technical	Reroute lines away from structure and there original path when possible and include a contingency to use pricier designs that do not require clearance or remove structures causing clearance issues
Real estate and right of way availability for substations	Technical	Include multiple sites location alternative for the substation location and plan for a higher contingency
Selecting a skilled local contractor who is capable of delivering the scope of the	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement cannot be avoided.

Identification

Sub-Activity Name	Install Fiapre primary substation with interconnecting sub-T lines, MV offloading circuits and LV network
Activity	Technical Losses Reduction
Area(s)	Sunyani
Foundational	No
Sub-Activity Dependency	NEDCo-Service-06: Distribution System Master Plan
Project Source	GEDAP III

Problem Statement

Technical losses, the second most costly type of loss to utilities, represent the energy lost in the wires and electrical equipment. The principal cause of technical losses is often high current on inadequately sized conductors. Another cause is the use of high loss transformers because of their lower initial capital cost. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. Some of the NEDCo distribution feeders have been extended beyond their design limits, leading to deteriorating power quality, higher losses, and reduced capacity to meet load. The primary substations currently serving the region will soon become overloaded, based on current demand forecast. To avoid rolling blackouts, a primary substation will be installed.

Implementation. A contractor will be hired to procure and build a substation that conforms to the NEDCo's standard substation design. This activity includes installation of the following items: (1) a new primary substation, including transformer, switchyard, and control house on a fenced-in plot; (2) sub-transmission lines and interconnections to/from the new substation to the existing grid substation; (3) medium voltage lines, and; (4) low voltage distribution line and distribution transformers.

Metrics

Investment	$ 3,105,000	**Financial Rate of Return (IRR)**	61%
Net Present Value (NPV)	$ 17,392,000	**Economic Rate of Return (ERR)**	41%
Yearly Operations and Maintenace	$ 102,000	**Yearly revenue from new cust.**	$ 3,396,000

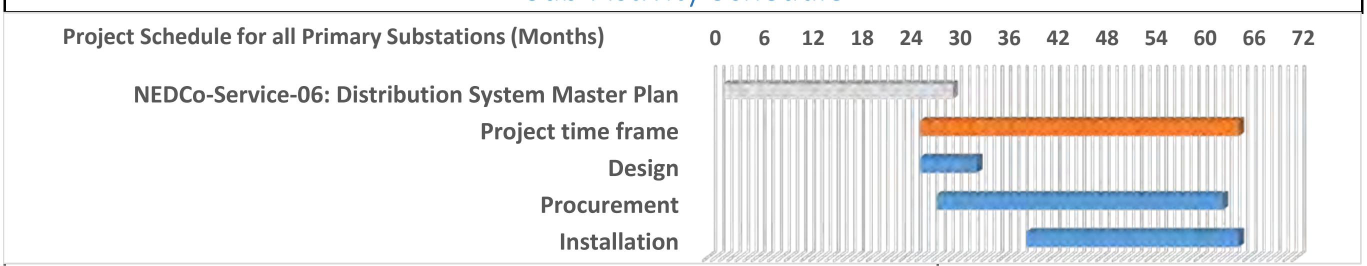
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Primary Substation	*Substation*	1	$ 462,000	$ 1,539,000	$ 2,001,000
Sub-Transmission Lines	*km*	8	$ 36,000	$ 117,000	$ 153,000
Medium Voltage Lines	*km*	3	$ 14,000	$ 44,000	$ 58,000
Distribution Transformers	*Transformers*	15	$ 35,000	$ 116,000	$ 151,000
LV Lines	*km*	5	$ 18,000	$ 58,000	$ 76,000
Contingency on labor	*Percentage*	10	$ 57,000	$ -	$ 57,000
Contingency on material	*Percentage*	5	$ -	$ 94,000	$ 94,000
PMC, Design & Supervision	*Percentage*	15	$ 85,000	$ 282,000	$ 367,000
Env/Social Mitigation	*Percentage*	1	$ 6,000	$ 19,000	$ 25,000
Resettlement	*Percentage*	5	$ 29,000	$ 94,000	$ 123,000
		Total	$ 742,000	$ 2,363,000	$ 3,105,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	5.0%	822,000	$ 79,000
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Clearance from electrical equipment	Technical	Reroute lines away from structure and there original path when possible and include a contingency to use pricier designs that do not require clearance or remove structures causing clearance issues
Real estate and right of way availability for substations	Technical	Include multiple sites location alternative for the substation location and plan for a higher contingency
Selecting a skilled local contractor who is capable of delivering the scope of the	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement cannot be avoided.

Identification

Sub-Activity Name	Reactive power compensation for primary substations and MV lines
Activity	Technical Losses Reduction
Area(s)	All
Foundational	No
Sub-Activity Dependency	None
Project Source	NEDCo

Problem Statement

Technical losses, the second most costly type of loss to utilities, represent the energy lost in the wires and electrical equipment. The principal cause of technical losses is often high current on inadequately sized conductors. Another cause is the use of high loss transformers because of their lower initial capital cost. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. Reactive power (defined as “var”) takes place on every alternating current power system where motors, inductors, and diodes shift the working or measured real power (watts) and creates a third component known as total power consumed (“va”); this imbalance is known as the power factor. By installing capacitors along the power system, this imbalance can be reduced so that watts and va become equal, thus reducing losses on the power system. Because power system daily loads fluctuate, the installed capacitors will need to be both fixed and switched installations.

Implementation. Once the Distribution Master Plan (Sub-Activity Service-04) and the engineering analysis has been completed, capacitor bank locations can be identified. The capacitor bank locations can be within a substation lot or placed along the 11 kV network.

Metrics

Investment	$	1,822,000	**Financial Rate of Return (IRR)**	15%
Net Present Value (NPV)	$	537,000	**Economic Rate of Return (ERR)**	21%
Yearly Operations and Maintenace	$	60,000		

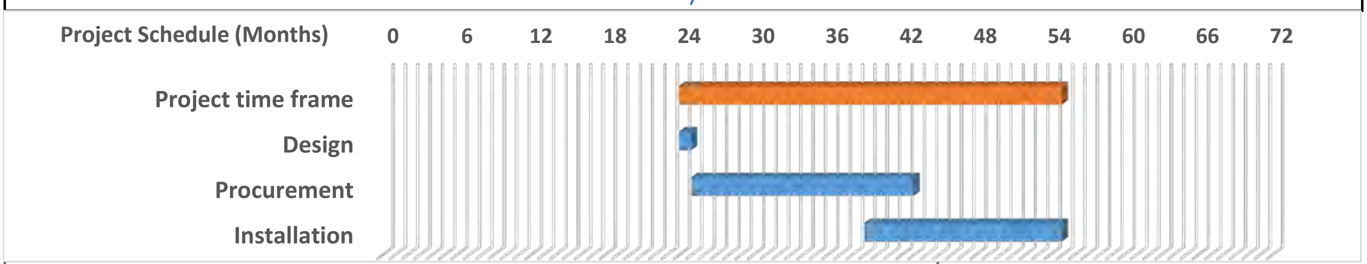
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Fix and switched capacitor banks	*kVAR*	45,000	$ 120,000	$ 1,380,000	$ 1,500,000
Contingency on labor	*Percentage*	10	$ 12,000	$ -	$ 12,000
Contingency on material	*Percentage*	5	$ -	$ 69,000	$ 69,000
PMC, Design & Supervision	*Percentage*	15	$ 18,000	$ 207,000	$ 225,000
Env/Social Mitigation	*Percentage*	1	$ 2,000	$ 14,000	$ 16,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 152,000	$ 1,670,000	$ 1,822,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	25.0%	4,108,000	$ 397,000
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Clearance from electrical equipment	Technical	Reroute lines away from structure and there original path when possible and include a contingency to use pricier designs that do not require clearance or remove structures causing clearance issues
Selecting a skilled local contractor who is capable of delivering the scope of the	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work

Identification

Sub-Activity Name	Low voltage feeder bifurcation with medium voltage upgrade
Activity	Technical Losses Reduction
Area(s)	Tamale; Sunyani
Foundational	Yes
Sub-Activity Dependency	NEDCo-Engr-22: Update distribution construction standards based on current low loss practices
Project Source	NEDCo

Problem Statement

Technical losses, the second most costly type of loss to utilities, represent the energy lost in the wires and electrical equipment. The principal cause of technical losses is often high current on inadequately sized conductors. Another cause is the use of high loss transformers because of their lower initial capital cost. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. The purpose of this project is to reduce the length of the LV circuits (segmenting a large circuit into multiple smaller ones) to ensure that the LV trunk lines do not exceed a length that affects the quality of service to the customer and a technical loss threshold on the distribution system.
Technical losses on the distribution lines have an inverse exponential relationship with the voltage—that is, the higher the voltage the lower the losses. The ratio of medium voltage to low voltage (MV:LV) in the NEDCo system has been reported to be around 1:5 (GEC 2012). There are no firm guidelines or standards for the MV:LV ratio, rather indicative targets are in the range of 1:2 or 1:3, largely dependent upon the individual circumstances of each network.
LV lengths will be customized for NEDCo from the sub activity (Engr-22) to improve service quality and reliability while lowering technical losses. When LV lines are long and heavily loaded, their thermal losses become a large portion of the technical losses on the system. Moreover, the voltage level at the end of the long LV networks drops below allowable levels, which subsequently causes electric equipment to malfunction and/or degrade at an accelerated rate.

Implementation. A consultant will evaluate and design the line bifurcation upgrades. A contractor will be hired to execute on the design following the updated NEDCo construction standards (sub activity Engr-22). The scope of work includes extension of 11 kV overhead (MV) lines, replacement of the short pole currently carrying LV lines with taller poles, and installing additional transformers.

Metrics

Investment	$ 6,652,000	**Financial Rate of Return (IRR)**	13%
Net Present Value (NPV)	$ 887,000	**Economic Rate of Return (ERR)**	11%
Yearly Operations and Maintenace	$ 218,000		

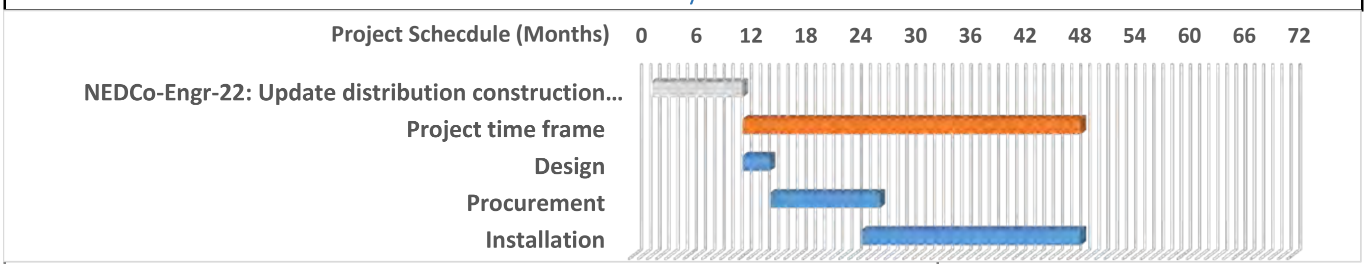
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Medium Voltage Lines	*km*	55	$ 242,000	$ 804,000	$ 1,046,000
Transformers structures	*Transfromers*	380	$ 877,000	$ 2,924,000	$ 3,801,000
Contingency on labor	*Percentage*	10	$ 112,000	$ -	$ 112,000
Contingency on material	*Percentage*	5	$ -	$ 187,000	$ 187,000
PMC, Design & Supervision	*Percentage*	15	$ 168,000	$ 560,000	$ 728,000
Env/Social Mitigation	*Percentage*	1	$ 12,000	$ 38,000	$ 50,000
Resettlement	*Percentage*	15	$ 168,000	$ 560,000	$ 728,000
		Total	$ 1,579,000	$ 5,073,000	$ 6,652,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	57.5%	9,448,000	$ 913,000
Commercial loss	15.0%	2,465,000	$ 485,000
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Clearance from electrical equipment	Technical	Reroute lines away from structure and there original path when possible and include a contingency to use pricier designs that do not require clearance or remove structures causing clearance issues
Real estate and right of way availability for substations	Technical	Include multiple sites location alternative for the substation location and plan for a higher contingency
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the updated work procedures
Selecting a skilled local contractor who is capable of delivering the scope of the	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement cannot be avoided.

Identification

Sub-Activity Name	Update distribution construction standards based on current low loss practices
Activity	Technical Losses Reduction
Area(s)	All
Foundational	Yes
Sub-Activity Dependency	None
Project Source	NEDCo

Problem Statement

Technical losses, the second most costly type of loss to utilities, represent the energy lost in the wires and electrical equipment. The principal cause of technical losses is often high current on inadequately sized conductors. Another cause is the use of high loss transformers because of their lower initial capital cost. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. NEDCo currently has an engineering and construction standard that was inherited from VRA. Some of the standard specifications need to be updated (for example, move from open wire LV to multiplex LV cable to reduce illegal connections, or specification of lower cost, new materials such as pre-form wire dead-ends). Other parts of the standard are not used or applied—for example, location of service connection, the single phase transformer installations, and the smaller transformers installation—when they should be.

Implementation. A contractor will be hired to review and update the engineering and construction standards in consultation with NEDCo. It also will be necessary to update NEDCo's service connections standards with a tamper- resistant, safe and economic design, for each customer category. To complete this task, the contractor will collect field information regarding the various structure types that require electric services (for example, mud huts, apartment complex, or mines). In consultation with NEDCo, the consultant will update the existing standards with a new design

The contractor will conduct training for NEDCo designers, planners and service inspectors on the updated material. Implementation and enforcement is anticipated to be the responsibility of NEDCo's management.

Metrics

Investment	$ 314,000	**Financial Rate of Return (IRR)**	40%
Net Present Value (NPV)	$ 795,000	**Economic Rate of Return (ERR)**	2%
Yearly Operations and Maintenace	$ 11,000		

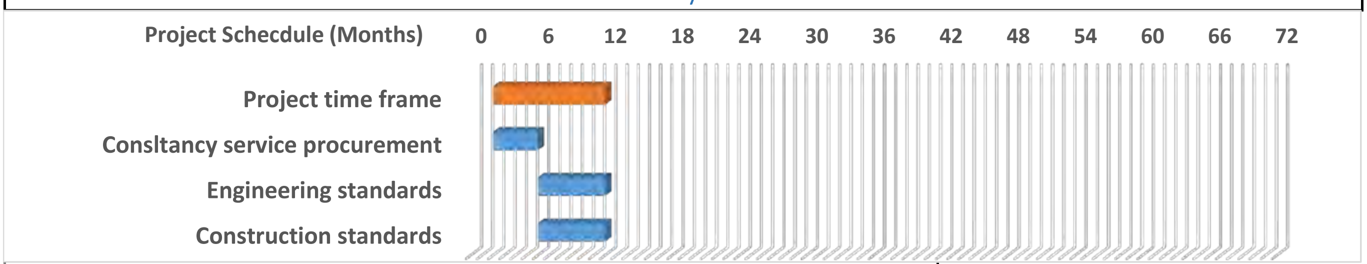
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Engineering standards	*Work Days*	182	$ 51,000	$ -	$ 51,000
Service Standard	*Study*	1	$ 61,000	$ -	$ 61,000
Service Standard Books	*Books*	30,000	$ -	$ 90,000	$ 90,000
Construction standards	*Work Days*	182	$ 51,000	$ -	$ 51,000
Contingency on labor	*Percentage*	10	$ 17,000	$ -	$ 17,000
Contingency on material	*Percentage*	5	$ -	$ 5,000	$ 5,000
PMC, Design & Supervision	*Percentage*	15	$ 25,000	$ 14,000	$ 39,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 205,000	$ 109,000	$ 314,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.5%	82,000	$ 8,000
Commercial loss	5.0%	822,000	$ 162,000
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the
Selecting a skilled local contractor who is capable of delivering the scope of the project, on time, and within budget.	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work

Identification

Sub-Activity Name	Metering at critical nodes of the distribution system
Activity	Commercial Losses Reduction and Collection Efficiency Improvement
Area(s)	Tamale
Foundational	Yes
Sub-Activity Dependency	NEDCo-Comm-04: Enterprise customer information system and integration with existing enterprise applications
Project Source	GEDAP III

Problem Statement

Commercial losses represent the energy that is not billed to the customer due to illegalities. The causes of commercial losses are many and some of the most common are: (a) Illegal connection to the LV system; (b) Bypass of the Meter; (c) Tampering of the meter and/or meter instruments (Potential and Current transformers); (d) Inaccurate or dysfunctional meter and (e) any other situation causing inaccurate count of the energy used by a consumer.
Collection inefficiency is another type of losses that occur when the energy registered as used by a consumer is not paid for. The causes of these losses are many and some of the most common are: (a) undelivered, lost or non-printed bills, (b) inability of consumer to pay bill in full (c) inability of utility to disconnect delinquent accounts. Commercial and Collection losses are the most costly to the utility. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. Metering of critical nodes will allow NEDCo to identify and monitor where technical and commercial losses are occurring. The critical nodes are:

- The bulk supply point incoming feeders.
- The primary substation outgoing feeders
- The distribution transformers that serve more than one customer

This sub-activity is predicated on the implementation of proposed CIS sub-activity (comm-03) and a GIS system that is currently implemented, which will help provide the foundation for an electrical model of the system to calculate technical losses. Given a value for the technical losses, metering will enable NEDCo to establish the balance of energy between what is bought at the bulk supply points and the energy billed to NEDCo's customers and to identify commercial losses.

Implementation. An engineering expert who will part of a multi-disciplinary technical assistance team will evaluate and specify meters and locations for metering. Meters with communication capability will be purchased and installed at all the critical nodes in Tamale and information relayed to the newly installed CIS system (sub activity comm-04). The CIS system will have a module capable of accounting for all the energy recorded by the meters and then computing the losses in each network segment. These losses can then be compared to the anticipated technical loss and the calculated commercial losses. This information will be used by the loss control unit personnel to prioritize areas of the network with the highest energy commercial energy losses.

Metrics

Investment	$ 1,377,000	**Financial Rate of Return (IRR)**	23%
Net Present Value (NPV)	$ 1,314,000	**Economic Rate of Return (ERR)**	3%
Yearly Operations and Maintenace	$ 45,000		

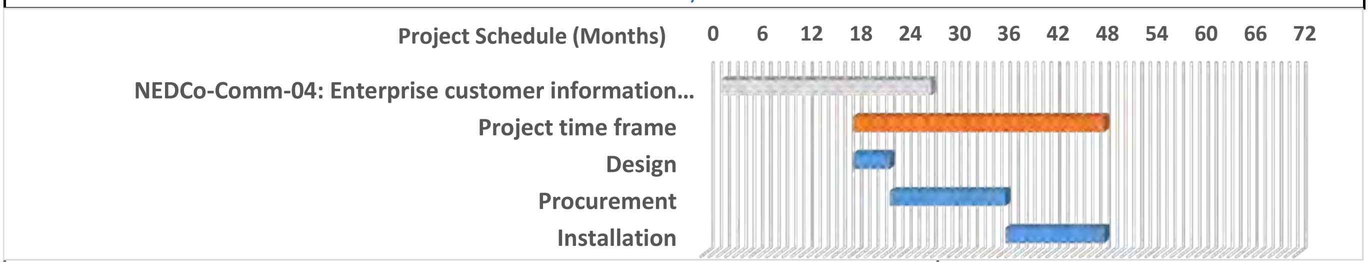
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
BSP outgower feeders meters	*Meters*	2	$ 1,000	$ 2,000	$ 3,000
Primary substation feeders metering instruments	*3Ph Metering instruments*	6	$ 19,000	$ 62,000	$ 81,000
Primary substation feeders meter	*Meters*	6	$ -	$ 4,000	$ 4,000
Distribution transformer meters and metering instruments	*DT Meter Assembly*	600	$ 198,000	$ 840,000	$ 1,038,000
Contingency on labor	*Percentage*	10	$ 22,000	$ -	$ 22,000
Contingency on material	*Percentage*	5	$ -	$ 46,000	$ 46,000
PMC, Design & Supervision	*Percentage*	15	$ 33,000	$ 137,000	$ 170,000
Env/Social Mitigation	*Percentage*	1	$ 3,000	$ 10,000	$ 13,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 276,000	$ 1,101,000	$ 1,377,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	10.0%	1,643,000	$ 323,000
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration between new and existing systems	Technical	Ensure enough resources are allocated to the debugging and programing of the interfaces between the different systems
Selecting a qualified consultant who is capable of delivering the scope of the project, on time, and within budget.	Institutional	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with there accommodations and other fringes
Wide area network communication	Technical	Ensure that nodes with high traffic are equipped with redundant links through different provider and physical infrastructure.
Selecting a skilled local contractor who is capable of delivering the scope of the	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work

Identification

Sub-Activity Name	Sectionalizing study of MV networks within NEDCo's territory
Activity	Outages Reduction
Area(s)	All
Foundational	Yes
Sub-Activity Dependency	NEDCo-Engr-22: Update distribution construction standards based on current low loss practices
Project Source	NEDCo

Problem Statement

In areas where outages are frequent or have long durations large industrial and commercial customers, who require reliable power, may decide to reduce their reliance on the utility by utilizing self-generation (part time or full time.) In extreme cases these customers my decide to relocate their facility to another area/country that offers a service standard that meets their needs. By reducing outages these consequences can be avoided and severely reduce the amount of unrealized or lost revenue.

Sub-Activity Description

Intervention. System outages are affecting larger areas and more and more consumers. Frequent interruption on the lines affects all customers, who require a stable source of electricity. Historically, NEDCo has employed limited sectionalizing on its MV lines; rather, the approach has been to install costly switching stations to split 33 kV sub-transmission lines into 33 kV distribute
A properly sectionalized distribution network will ensure that outages at the end of the lines and on side tap do not trip the breaker at the substation and take out the entire line, cutting power to customers who otherwise could have remained energized. Improved sectionalizing will reduce outage frequency (and duration as seen by customers) and improve overall service quality.

Implementation. This sub-activity is linked to the completion of the GIS. The GIS data will be used by a consultant to conduct a sectionalizing study of the NEDCo's network. The study results will be used to locate reclosers, switches, and other sectionalizing devices in the MV network.
A contractor will be hired to implement the recommendations of the sectionalizing study (in a limited pilot at one substation) in accordance with NEDCo's specifications and standards. We assume that each feeder will require one recloser and four sectionalizers. All reclosers and sectionalizers will then be monitored and operated remotely. In addition, inline fuses will be installed as indicated by the study.

Metrics

Investment	$	498,000	**Financial Rate of Return (IRR)**	0%
Net Present Value (NPV)	$	533,000	**Economic Rate of Return (ERR)**	n/a
Yearly Operations and Maintenace	$	17,000		

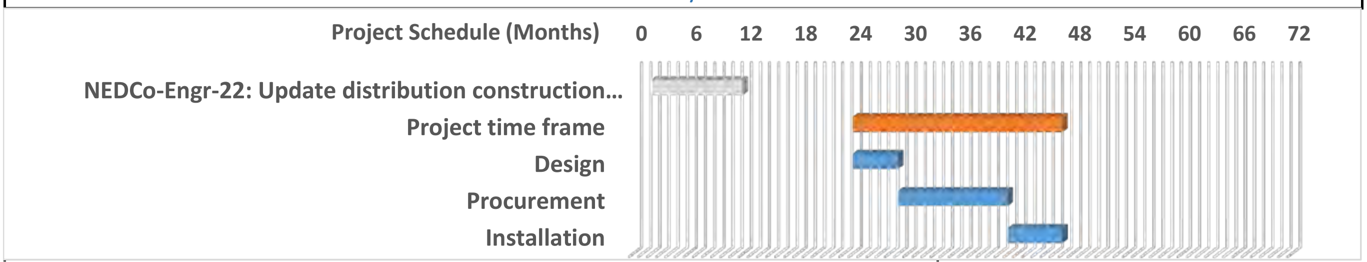
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Accra Sectionalizing study	*Work Days*	33	$ 42,000	$ -	$ 42,000
Feeder sectionalizing and automation	*Feeders*	6	$ 84,000	$ 279,000	$ 363,000
Contingency on labor	*Percentage*	10	$ 13,000	$ -	$ 13,000
Contingency on material	*Percentage*	5	$ -	$ 14,000	$ 14,000
PMC, Design & Supervision	*Percentage*	15	$ 19,000	$ 42,000	$ 61,000
Env/Social Mitigation	*Percentage*	1	$ 2,000	$ 3,000	$ 5,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 160,000	$ 338,000	$ 498,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	43.5%		$ 60,000

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the updated work procedures
NEDCo completing GIS system	Financial	Coordinate with Swiss donors to ensure that funds available for GIS are released in time. Follow Closely current progress of GIS implementation and adjust course accordingly.
Selecting a skilled local contractor who is capable of delivering the scope of the	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work

Identification	
Sub-Activity Name	Communication network
Activity	Institutional Support
Area(s)	Northern; Sunyani
Foundational	Yes
Sub-Activity Dependency	None
Project Source	NEDCo

Problem Statement

The utility has an inadequate level of support (both systems and expert personnel) to execute the sub-activities under the loss and outage reduction activities funded by the MCC compact II. The problems facing the organization are lack of updated master plan, lack of a strong IT infrastructure to support the installation and integration of many of the business application and an inefficient organizational structure.

Sub-Activity Description

Intervention. NEDCO requires new business applications including an enterprise information system (sub activity Comm-04). These systems will require a network communication backbone on which the software will run. Furthermore, the ERP must also be networked throughout the regional, area, and customer service offices to provide the information required to manage billing and collections and to resolve customer issues as they arise. NEDCo will access fiber optic lines from a private communication provider who is presently installing its fiber optic system on NEDCo poles. NEDCo will use the private provider's system to connect field offices on the WAN. In the areas where the private system is unavailable, NEDCo will use 4G wireless providers.

Implementation. A contractor will be hired to update a detailed design based on the NEDCo ICT department technology roadmap and the 2012 eSolution report. This sub-activity will connect the data center to the network and upgrade the LAN in all the offices. The currently used WAN connections will also be evaluated during detailed design. For high-priority nodes such as regional offices, a redundant connection will need to be installed if one does not exist.

Metrics

Investment	$ 315,000	**Financial Rate of Return (IRR)**	148%
Net Present Value (NPV)	$ 3,823,000	**Economic Rate of Return (ERR)**	108%
Yearly Operations and Maintenace	$ 11,000		

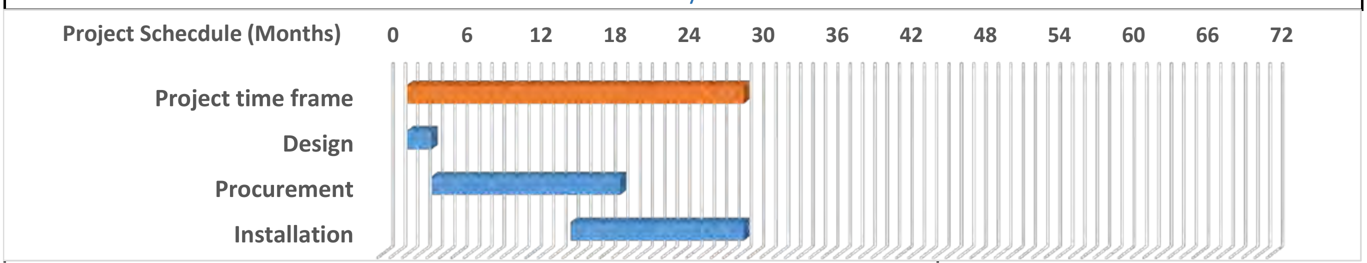
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
LAN and WLAN	Systems	2	$ 60,000	$ 200,000	$ 260,000
Contingency on labor	*Percentage*	10	$ 6,000	$ -	$ 6,000
Contingency on material	*Percentage*	5	$ -	$ 10,000	$ 10,000
PMC, Design & Supervision	*Percentage*	15	$ 9,000	$ 30,000	$ 39,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 75,000	$ 240,000	$ 315,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	1.0%	164,000	$ 32,000
Collection efficiency	1.0%	656,000	$ 129,000
Outages	0.5%		$ 1,000

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration between new and existing systems	Technical	Ensure enough resources are allocated to the debugging and programing of the interfaces between the different systems
Building in good condition to install the system	Institutional	Install a less robust and less costly wireless system that can be easily moved and upgraded at a later stage.
Selecting a qualified consultant who is capable of delivering the scope of the project, on time, and within budget.	Institutional	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with there accommodations and other fringes

Identification

Sub-Activity Name	Data center at VRA or Sunyani
Activity	Institutional Support
Area(s)	All
Foundational	Yes
Sub-Activity Dependency	None
Project Source	NEDCo

Problem Statement

The utility has an inadequate level of support (both systems and expert personnel) to execute the sub-activities under the loss and outage reduction activities funded by the MCC compact II. The problems facing the organization are lack of updated master plan, lack of a strong IT infrastructure to support the installation and integration of many of the business application and an inefficient organizational structure.

Sub-Activity Description

Intervention. NEDCo does not have its own data center to store customer service, energy sales, billing, collection, and other mission-critical information. NEDCo will install many systems that require enhanced data center services including a centralized CIS, an expanded SCADA, a managed network, and GIS. The current ad-hoc approach of buying individual servers and software packages is not scalable and is difficult to maintain.
This sub-activity provides for the design, procurement and installation of a data center in an existing space that will need to be refurbished.

Implementation. A contractor will be hired to update a detailed design based on the NEDCo ICT department technology roadmap and the 2012 eSolution report. Another contractor will be hired to refurbish existing space to house an improved and expanded data center in either the VRA data center or at the NEDCo Sunyani campus. The data center will have climate control, access control, backup power and fire suppression systems, and will be built to accommodate future growth and expansion of the ICT system and support sub activity (comm-04 and ICT-01.) Initially a limited number of servers will be installed under this investment. The space will prepared to accommodate additional servers envisioned by the NEDCO ICT team for various systems to be installed or migrated in the future.

Metrics

Investment	$	981,000	**Financial Rate of Return (IRR)**	31%
Net Present Value (NPV)	$	1,492,000	**Economic Rate of Return (ERR)**	17%
Yearly Operations and Maintenance	$	33,000		

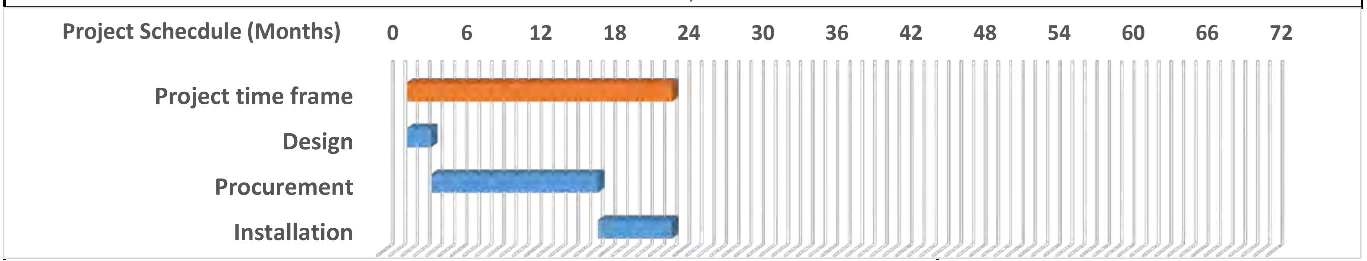
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Data Center	Data Center	1	$ 105,000	$ 700,000	$ 805,000
Contingency on labor	*Percentage*	10	$ 11,000	$ -	$ 11,000
Contingency on material	*Percentage*	5	$ -	$ 35,000	$ 35,000
PMC, Design & Supervision	*Percentage*	15	$ 16,000	$ 105,000	$ 121,000
Env/Social Mitigation	*Percentage*	1	$ 2,000	$ 7,000	$ 9,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 134,000	$ 847,000	$ 981,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	1.0%	164,000	$ 32,000
Collection efficiency	1.0%	656,000	$ 129,000
Outages	0.5%		$ 1,000

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration between new and existing systems	Technical	Ensure enough resources are allocated to the debugging and programing of the interfaces between the different systems
Wide area network communication	Technical	Ensure that nodes with high traffic are equipped with redundant links through different provider and physical infrastructure.
Selecting a qualified consultant who is capable of delivering the scope of the project, on time, and within budget.	Institutional	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with there accommodations and other fringes

Identification

Sub-Activity Name	Procure operations and maintenance materials
Activity	Outages Reduction
Area(s)	All
Foundational	No
Sub-Activity Dependency	NEDCo-Engr-22: Update distribution construction standards based on current low loss practices
Project Source	NEDCo

Problem Statement

In areas where outages are frequent or have long durations large industrial and commercial customers, who require reliable power, may decide to reduce their reliance on the utility by utilizing self-generation (part time or full time.) In extreme cases these customers my decide to relocate their facility to another area/country that offers a service standard that meets their needs. By reducing outages these consequences can be avoided and severely reduce the amount of unrealized or lost revenue.

Sub-Activity Description

Intervention. The purpose of this sub-activity is to improve NEDCo's ability to perform O&M on the distribution system. NEDCo has a limited inventory of spare parts and materials with which to perform emergency and routine repairs and maintenance on distribution feeders, laterals, distribution transformers, and services. This leads to inadequate repairs (for example, bypassing protection equipment) and prolonged outages.

Implementation. This sub-activity will involve procuring and distributing high-priority materials such as fuses, conductors, connectors, splices, and distribution transformers for all NEDCo service areas. The materials will be stored in regional warehouses typically located at the substations and will be able to serve the area rapidly for safe and fast outage restoration.

Metrics

Investment	$ 1,800,000	**Financial Rate of Return (IRR)**	1%
Net Present Value (NPV)	$ (933,000)	**Economic Rate of Return (ERR)**	n/a
Yearly Operations and Maintenace	$ -		

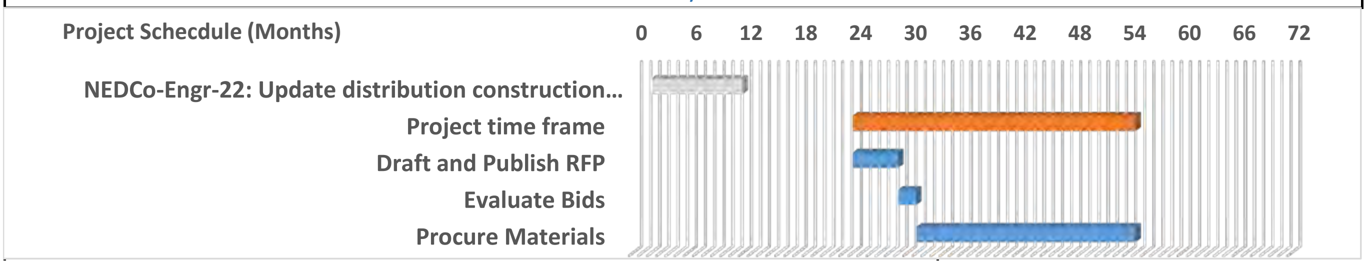
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Outage Maintenace Material	*Lot*	1	$ -	$ 1,500,000	$ 1,500,000
Contingency on labor	*Percentage*	10	$ -	$ -	$ -
Contingency on material	*Percentage*	5	$ -	$ 75,000	$ 75,000
PMC, Design & Supervision	*Percentage*	15	$ -	$ 225,000	$ 225,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ -	$ 1,800,000	$ 1,800,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	35.0%		$ 48,000

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Safe storage and accounting of procured materials	Institutional	Put in place tracking accounting procedure to estimate material used for construction and conduct random checks and counts at storage facilities

Identification

Sub-Activity Name	Installation of outage reporting and call center system
Activity	Outages Reduction
Area(s)	All
Foundational	Yes
Sub-Activity Dependency	NEDCo-Comm-04: Enterprise customer information system and integration with existing enterprise applications
Project Source	NEDCo

Problem Statement

In areas where outages are frequent or have long durations large industrial and commercial customers, who require reliable power, may decide to reduce their reliance on the utility by utilizing self-generation (part time or full time.) In extreme cases these customers my decide to relocate their facility to another area/country that offers a service standard that meets their needs. By reducing outages these consequences can be avoided and severely reduce the amount of unrealized or lost revenue.

Sub-Activity Description

Intervention. NEDCo needs an outage management system (OMS), which is a base requirement for a modern utility. Currently, the customer call center receives trouble calls, which are recorded into a flat database
For proper outage management, an OMS system should be based on system configuration from the GIS data and the CIS. Under a proper system, call center dispatches record information from the customer and assist the dispatched repair crews on proper course of action in the field. Once the repair crew restores service, the OMS records the duration of outage, cause, and remedy.

Implementation. Under this sub-activity, a contractor is hired to procure and install an outage reporting and call center system as an intermediate step to a full modern OMS. This system will provide call center functionality and will be integrated with the CIS. The system will be able to identify outage locations and causes, thereby reducing outage repaire time. The call center software module will be procured and the call center staff will be trained in its use.

Metrics

Investment	$	194,000	**Financial Rate of Return (IRR)**	44%
Net Present Value (NPV)	$	543,000	**Economic Rate of Return (ERR)**	57%
Yearly Operations and Maintenace	$	12,000		

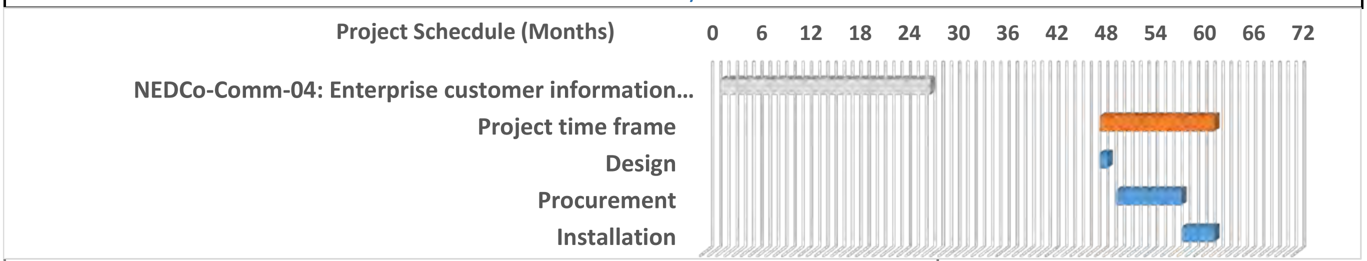
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
OMS Software and Hardware	*Users*	4	$ 11,000	$ 90,000	$ 101,000
Training	*Workd Days*	22	$ 28,000	$ -	$ 28,000
CMS integration	*Work Days*	22	$ 28,000	$ -	$ 28,000
Contingency on labor	*Percentage*	10	$ 7,000	$ -	$ 7,000
Contingency on material	*Percentage*	5	$ -	$ 5,000	$ 5,000
PMC, Design & Supervision	*Percentage*	15	$ 11,000	$ 14,000	$ 25,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 85,000	$ 109,000	$ 194,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	15.0%		$ 21,000

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Employee capacity to use software efficiently	Institutional	Ensure appropriate number of training sessions are budgeted with each software deployment and require that participants pass basic computer skill test before attending training
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the
Integration between new and existing systems	Technical	Ensure enough resources are allocated to the debugging and programing of the interfaces between the different systems
Wide area network communication	Technical	Ensure that nodes with high traffic are equipped with redundant links through different provider and physical infrastructure.
Selecting a qualified consultant who is capable of delivering the scope of the project, on time, and within budget.	Institutional	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with there accommodations and other fringes

Identification

Sub-Activity Name	Construction of customer service centers
Activity	Institutional Support
Area(s)	Northern; Sunyani
Foundational	No
Sub-Activity Dependency	None
Project Source	NEDCo

Problem Statement

The utility has an inadequate level of support (both systems and expert personnel) to execute the sub-activities under the loss and outage reduction activities funded by the MCC compact II. The problems facing the organization are lack of updated master plan, lack of a strong IT infrastructure to support the installation and integration of many of the business application and an inefficient organizational structure.

Sub-Activity Description

Intervention. NEDCo operating functions such as meter reading, bill delivery, collections, receiving and addressing customer complaints, service calls, and maintenance activities are all managed through local customer service centers. The customer service centers in many locations are inadequate and aging facilities that require upgrading and in some cases, total refurbishment. This activity will finance construction of half of the 43 new service centers in the Sunyani and Northern areas.

Implementation. A contractor will be hired to complete a detailed design of a mixture of new and existing offices. A contractor will be hired to construct new buildings and upgrade existing facilities. This sub-activity includes civil work, furnishings, and Internet and telephony infrastructure in the newly constructed facilities. One or more general contractors will be hired to complete the work.

Metrics

Investment	$ 3,670,000	**Financial Rate of Return (IRR)**		53%
Net Present Value (NPV)	$ 15,771,000	**Economic Rate of Return (ERR)**		8%
Yearly Operations and Maintenace	$ 120,000	**Yearly revenue from new cust.**	$	-

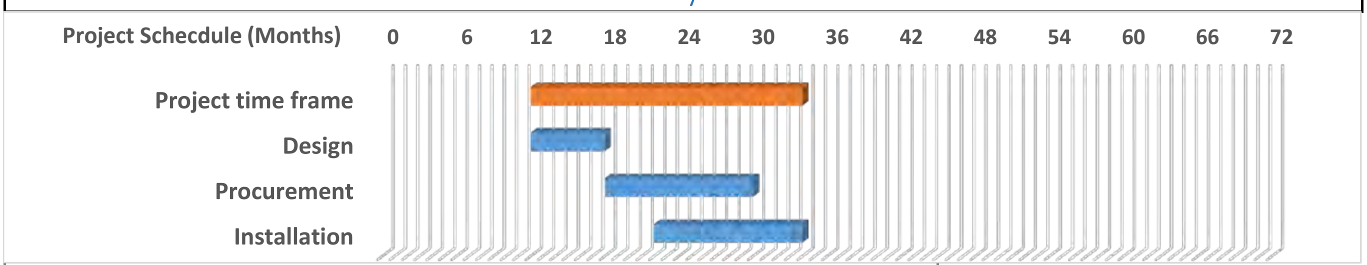
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Service Centre Structures, Techiman Area (Techiman, Wenchi, Kintampo, Atebubu, Ejura, Nkoranza, Kwame Danso, Yeji, Akomadan)	*Service Centers*	9	$ 312,000	$ 1,039,000	$ 1,351,000
Service Centre Structures, Northern Area Area (Tolon, Savelugu, Yendi, Bimbilla, Kete-Krachie, Damongo, Zabzugu, Gushegu, Kpassa, Saboba, Salaga)	*Service Centers*	11	$ 381,000	$ 1,270,000	$ 1,651,000
Contingency on labor	*Percentage*	10	$ 70,000	$ -	$ 70,000
Contingency on material	*Percentage*	5	$ -	$ 116,000	$ 116,000
PMC, Design & Supervision	*Percentage*	15	$ 104,000	$ 347,000	$ 451,000
Env/Social Mitigation	*Percentage*	1	$ 7,000	$ 24,000	$ 31,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 874,000	$ 2,796,000	$ 3,670,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	0.0%	-	$ -
Collection efficiency	25.0%	16,393,000	$ 3,223,000
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Clearance from electrical equipment	Technical	Reroute lines away from structure and there original path when possible and include a contingency to use pricier designs that do not require clearance or remove structures causing clearance issues
Real estate and right of way availability for substations	Technical	Include multiple sites location alternative for the substation location and plan for a higher contingency
Selecting a skilled local contractor who is capable of delivering the scope of the	Technical	Open bids to include international bidders and plan for line-man training classes on new standards before start of work

Identification

Sub-Activity Name	Procurement of vehicles, tools and equipment
Activity	Commercial Losses Reduction and Collection Efficiency Improvement
Area(s)	Northern; Sunyani
Foundational	Yes
Sub-Activity Dependency	None
Project Source	NEDCo

Problem Statement

Commercial losses represent the energy that is not billed to the customer due to illegalities. The causes of commercial losses are many and some of the most common are: (a) Illegal connection to the LV system; (b) Bypass of the Meter; (c) Tampering of the meter and/or meter instruments (Potential and Current transformers); (d) Inaccurate or dysfunctional meter and (e) any other situation causing inaccurate count of the energy used by a consumer.
Collection inefficiency is another type of losses that occur when the energy registered as used by a consumer is not paid for. The causes of these losses are many and some of the most common are: (a) undelivered, lost or non-printed bills, (b) inability of consumer to pay bill in full (c) inability of utility to disconnect delinquent accounts. Commercial and Collection losses are the most costly to the utility. Each kWh recovered from this category of losses brings net revenue closer to equaling the generation + transmission + distribution charge.

Sub-Activity Description

Intervention. The purpose of this sub-activity is to both enable and enhance the ability of NEDCo personnel to perform basic functions for an electricity distribution utility.
NEDCo has inadequate vehicles, tools, and equipment for the operating staff to use to adequately manage operating functions throughout the NEDCo electricity distribution system. This leads to unsafe situations during work and extended outage restoration times.

Implementation. Under this sub-activity, equipment required for NEDCo linemen, including personal protective equipment, pole climbing equipment, and hand tools, will be procured. Service vehicles will be procured for service centers and line bucket trucks purchased for area offices

Metrics

Investment	$ 4,506,000	**Financial Rate of Return (IRR)**	59%
Net Present Value (NPV)	$ 12,949,000	**Economic Rate of Return (ERR)**	n/a
Yearly Operations and Maintenace	$ 148,000		

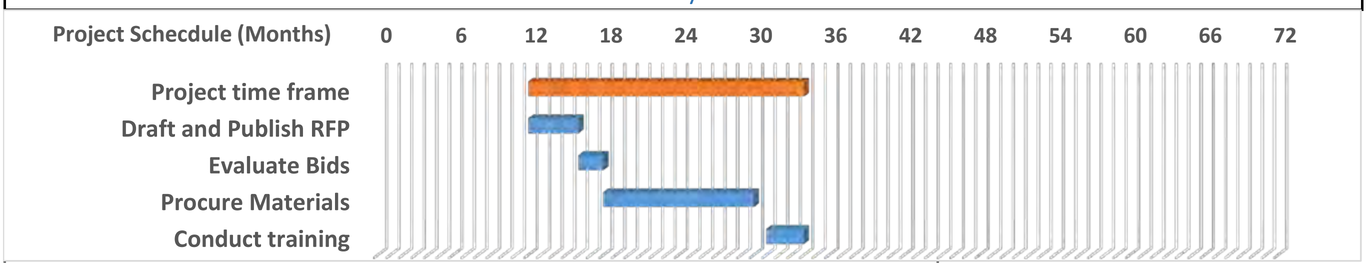
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Vehicules 4x4	*Vehicule*	35	$ -	$ 1,050,000	$ 1,050,000
Vehicules Bucket trucks with equipments	*Vehicule*	12	$ -	$ 1,560,000	$ 1,560,000
Training	*Work Days*	110	$ 138,000	$ -	$ 138,000
Tools and equipments	*Set*	100	$ -	$ 1,000,000	$ 1,000,000
Contingency on labor	*Percentage*	10	$ 14,000	$ -	$ 14,000
Contingency on material	*Percentage*	5	$ -	$ 181,000	$ 181,000
PMC, Design & Supervision	*Percentage*	15	$ 21,000	$ 542,000	$ 563,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 173,000	$ 4,333,000	$ 4,506,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	5.0%	822,000	$ 162,000
Collection efficiency	25.0%	16,393,000	$ 3,223,000
Outages	5.0%		$ 7,000

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Selecting a qualified consultant who is capable of delivering the scope of the project, on time, and within budget.	Institutional	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with there accommodations and other fringes
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the updated work procedures
Cooperation and willingness of utility staff to participate in sub-activity	Institutional	Establish a reward program based on performance and difficulty of the sub-activity to entice utility personal to participate

Identification

Sub-Activity Name	Technical Assistance Program
Activity	Institutional Support
Area(s)	All
Foundational	Yes
Sub-Activity Dependency	None
Project Source	NEDCo

Problem Statement

The utility has an inadequate level of support (both systems and expert personnel) to execute the sub-activities under the loss and outage reduction activities funded by the MCC compact II. The problems facing the organization are lack of updated master plan, lack of a strong IT infrastructure to support the installation and integration of many of the business application and an inefficient organizational structure.

Sub-Activity Description

Intervention. NEDCo requires external technical assistance to capture the benefits and value of the MCC investment. The current organizational structure is flat, and decision making is funneled to a small group of people. A team of technical advisors will help foster better-informed and faster decisions.

The technical assistance effort will link NEDCO departments to coordinate projects and to establish policies required to reduce technical and commercial losses, reduce outages, and improve collections and quality of service to the customer.

Implementation. We recommend that this program take place through 4 years of compact implementation and provide the foundation for all other programs. A contractor will be hired to execute the technical assistance effort, whose scope of work generally encompasses the following functions:

<u>1. Senior advisor with commercial experience for program direction and monitoring</u>. Provide support to NEDCO senior management with coordination between engineering and operations directorates. The senior advisor will manage and control an integrated loss management support team. The senior advisor will develop the program monitoring framework through which progress and issues will be collected and presented to senior NEDCO management and donor agencies, and will supervise the data verification process for loss reduction, revenue enhancement and overall performance improvement. The senior advisor will work with the commercial directorate on the implementation of certain sub-activities to allow for success, including; (1) primary metering on transformers, (2) implementation of a consumer census including a task to tie consumers into individual distribution transformers, (3) supervision inspection and normalization of services and meters, and (4) design for a program to inspect customer services on a frequent basis. These efforts will require the senior advisor to have commercial experience in non-technical loss reduction programs, and with experience of metering systems, CIS systems, and energy/loss reporting and monitoring programs.

<u>2. Engineer & Operations advisor</u>. This advisor functions will be to train and develop the engineering department in planning and cost effective methods to utility standards. His role will be to maintain the existing geographically information system GIS database of all utility plant assets and embed the internal policy and procedures to maintain this system. The advisor will train the engineering staff to evaluate technical losses, sectionalizing characteristics and strategies, and performance improvement analyses. The advisor will begin by evaluating NEDCO call center practices, coordination between the call center and the dispatch center, and practices and procedures designed to restore service after an outage has occurred. The advisor will review and evaluate maintenance materials and transport and communications capabilities, and will identify and design improved practices and procedures that will result in reduction in outages. The advisor will also introduce sectionalizing devices and improved linemen work practices. The advisor will mentor the NEDCo staff in these departments through the various processes rather than providing incremental support through each of the different implementation requirements.

Metrics

Investment	$ 4,950,000	**Financial Rate of Return (IRR)**	18%
Net Present Value (NPV)	$ 2,280,000	**Economic Rate of Return (ERR)**	-1%
Yearly Operations and Maintenace	$ -	**Yearly revenue from new cust.**	$ -

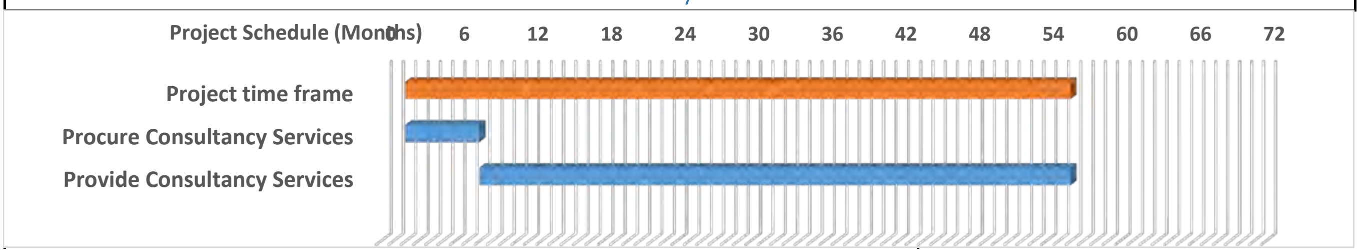
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Senior advisor with commercial experience for program direction and monitoring	*Worked Days*	1,056	$ 1,980,000	$ -	$ 1,980,000
Engineering and Operations technical advisor	*Worked Days*	1,056	$ 1,980,000	$ -	$ 1,980,000
Contingency on labor	*Percentage*	25	$ 990,000	$ -	$ 990,000
Contingency on material	*Percentage*	5	$ -	$ -	$ -
PMC, Design & Supervision	*Percentage*	-	$ -	$ -	$ -
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 4,950,000	$ -	$ 4,950,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.5%	82,000	$ 8,000
Commercial loss	5.0%	822,000	$ 162,000
Collection efficiency	5.0%	3,279,000	$ 645,000
Outages	0.5%		$ 1,000

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Selecting a qualified consultant who is capable of delivering the scope of the project, on time, and within budget.	Institutional	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with there accommodations and other fringes

Identification

Sub-Activity Name	Distribution System Master Plan
Activity	Institutional Support
Area(s)	All
Foundational	No
Sub-Activity Dependency	None
Project Source	None

Problem Statement

The utility has an inadequate level of support (both systems and expert personnel) to execute the sub-activities under the loss and outage reduction activities funded by the MCC compact II. The problems facing the organization are lack of updated master plan, lack of a strong IT infrastructure to support the installation and integration of many of the business application and an inefficient organizational structure.

Sub-Activity Description

Intervention. NEDCO has never had distribution master plan. Under VRA, a distribution master plan was developed in 2008. Certain sub-activities need to be completed before a master plan can be created, including population of the GIS database (currently underway) and updating the load forecast (correlated to actual loads). An updated master plan will increase operational efficiency at NEDCO.

Implementation. A contractor will be hired to prepare the master plan. The plan will include a roadmap for the 5-year horizon to meet the load forecast and provide system robustness. It also will address system elements such as creating loops or rings in the distribution system for contingency planning; location of switches, lines, and substations to ensure minimum disturbance to customers during system failures; and commercial aspects such as metering, SCADA, and other technology improvements.

Metrics

Investment	$ 437,000	**Financial Rate of Return (IRR)**	41%
Net Present Value (NPV)	$ 923,000	**Economic Rate of Return (ERR)**	49%
Yearly Operations and Maintenace	$ -	**Yearly revenue from new cust.**	$ 169,000

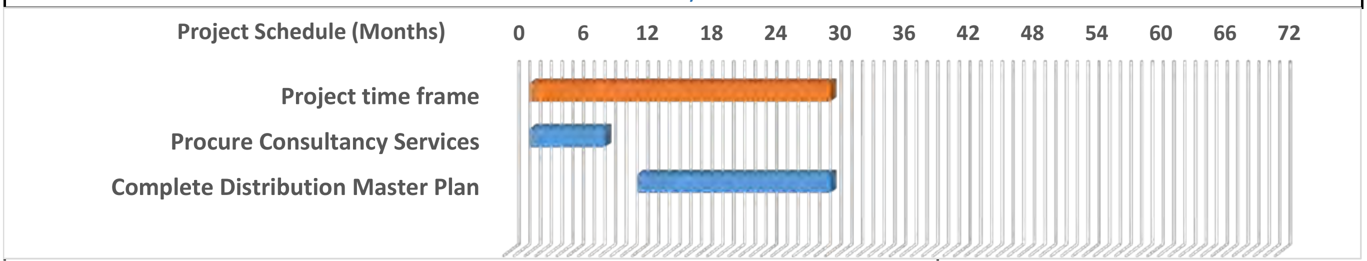
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Distribution Master Plan	*Work Days*	924	$ 349,000	$ -	$ 349,000
Contingency on labor	*Percentage*	10	$ 35,000	$ -	$ 35,000
Contingency on material	*Percentage*	5	$ -	$ -	$ -
PMC, Design & Supervision	*Percentage*	15	$ 53,000	$ -	$ 53,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 437,000	$ -	$ 437,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.5%	82,000	$ 8,000
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

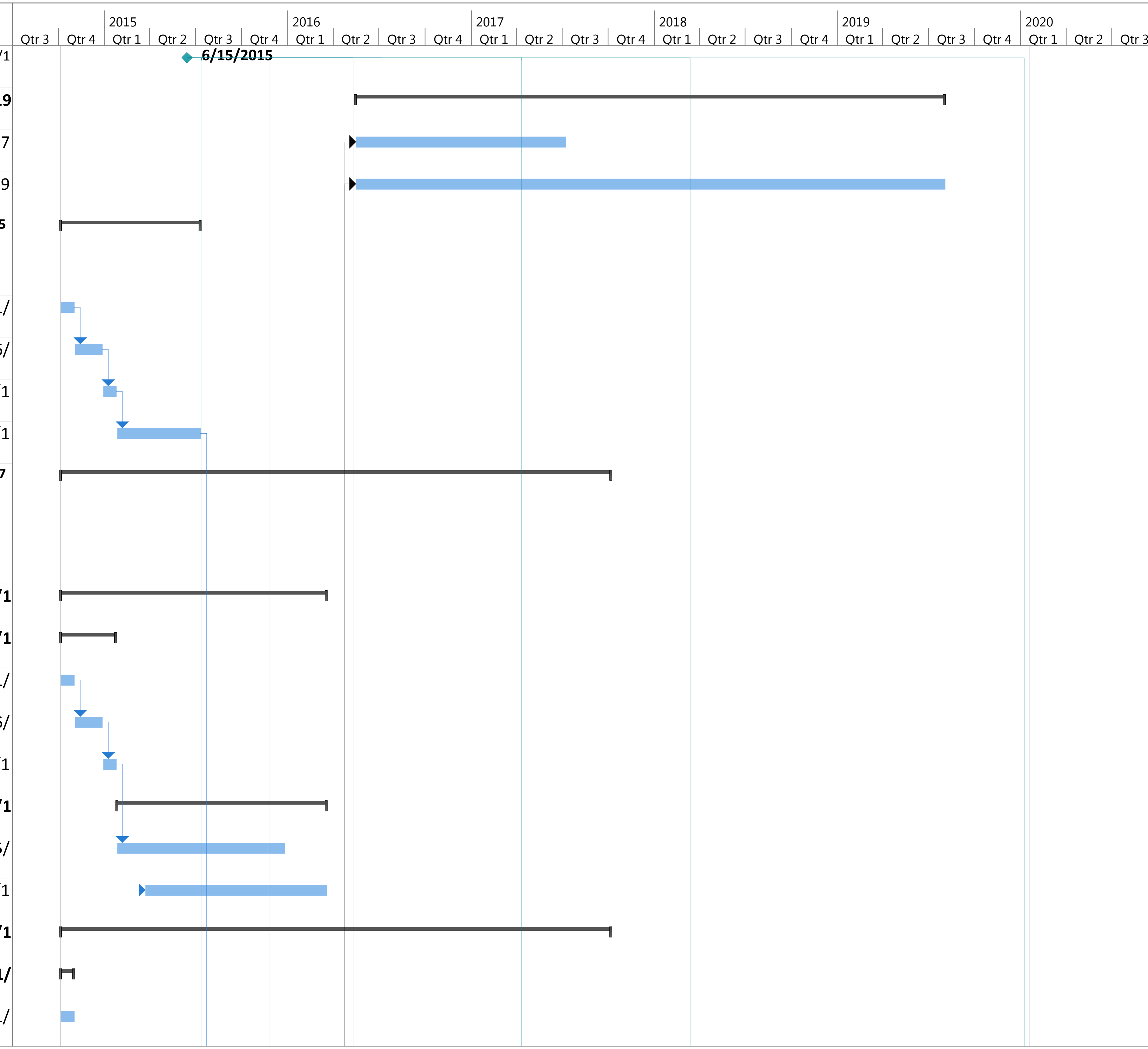
Description	Type	Mitigation
Selecting a qualified consultant who is capable of delivering the scope of the project, on time, and within budget.	Institutional	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with there accommodations and other fringes
NEDCo completing GIS system	Financial	Coordinate with Swiss donors to ensure that funds available for GIS are released in time. Follow Closely current progress of GIS implementation and adjust course accordingly.
Integration of new systems and work methods in existing work procedures	Institutional	Ensure that the technical advisors are engaged in the implementation of the new system and there integration into the work procedures. Also ensure that the technical advisor report any deviation from the

Appendix D
Sub-Activity Unit Cost Analysis and Assumptions

Description	Unit	Labor/Unit	Materials/Unit	Total Unit Cost	Source and Verification
Service Normalization	Service	$ 24	$ 77	$ 101	Material costs develop through buildup of theft-resistant service connection and catalogue material costs. Labor costs are 30 percent of material costs.
Meter electronic post-paid	Meter	$ 9	$ 30	$ 39	Cost based on GE basic electronic meter
Theft Resistant Service Standard development	Study	$ 60,500	$ -	$ 60,500	Labor estimate is based upon 1 month of expatriate engineer effort plus 3 local professionals (Drafting, Engineer, Commercial Advisor).
Service Standard Books Printing	Books	$ -	$ 3	$ 3	Cost of printing a small book for distribution to contractors
Prepaid meter installation	Meter	$ 40	$ 133	$ 173	Cost of a meter is based on the average cost of the pre-paid meters ECG has in circulation. Single phase pre-paid meters vary in cost from $30 currently used at NEDCO to $185 for a smart meter with PLC communication
Prepayment vending software deployment and integration	Software	$ 27,500	$ 10,000	$ 37,500	Software and hosting cost based on smart meter installation NRECA completed in Central and South America and one month labor by an expatriate expert
Instrument meter box with MV Pts and CTs	3ph meter instruments	$ 3,060	$ 10,200	$ 13,260	Cost of PT and CT from ECG material cost list and labor is 30 percent labor cost
Instrument meter box with LV Pts and CTs	3ph meter instruments	$ 330	$ 1,100	$ 1,430	Cost of PT and CT from ECG material cost list and labor is 30 percent labor cost
AMR Trivectors Meter	meter	$ -	$ 600	$ 600	Meter cost based on ECG substation cost and material list
AMR Interval Meter	meter	$ -	$ 300	$ 300	Meter cost based on ECG material list and cross checked with meter cost for AMI installation in Central and South America
4x4 pickup truck	Vehicle	$ -	$ 30,000	$ 30,000	Cost based on market research in Accra
Tools and testing equipment	Tool set	$ -	$ 10,000	$ 10,000	Hot sticks, MV load loggers, LV load loggers, PPE, Camera, Field PC, GPS, Binoculars, circuit tracers, meter tester, ladder and climbing gear.
Refurbish Office	Office	$ 9,000	$ 30,000	$ 39,000	Existing office space refurbished with furniture and computers to accommodate LCU supervisors and data analysts.
GIS enterprise license (1st user)	License	$ -	$ 12,000	$ 12,000	Price from ESRI
GIS enterprise license (2nd and after)	License	$ -	$ 4,000	$ 4,000	Price from ESRI
GIS Server	License	$ -	$ 12,000	$ 12,000	Price from ESRI
Database license per user	License	$ -	$ 20,000	$ 20,000	Based on oracle 11 g standard edition with a sever with 4 processors
Server Hardware	Server	$ 500	$ 5,000	$ 5,500	Based on a quad core intel based blade server (HP, Dell etc.)
Client Hardware	Workstation	$ 100	$ 2,000	$ 2,100	Based on a dual screen configuration with a laptop or a desktop pc
Tablets and sub meter GPS receivers	Tablet	$ -	$ 700	$ 700	Based on NRECA prior procurement
CYME ESRI integration module	License	$ -	$ 1,000	$ 1,000	From Cooper Cyme
Line_Survey_Cost	km	$ 70.00	0	70	Cost based on NRECA surveying team cost historical data
Census_Cost	Customer	$ 1.50	0	1.5	Cost based on NRECA surveying team cost historical data
Fix and switched capacitor bank at substation (Retrofit)	Capacitor Bank (600 kVAR)	$ 1,600	$ 18,400	$ 20,000	ECG provided bid documents. Individual comments verified with NRECA regional cost data
BSP outdoor	Substation	$ 646,154	$ 2,153,846	$ 2,800,000	Cost from GEDAP III engineering document
Supply and Installation of 2 X 20/26 MVA 34.55/11.kV Indoor Substation	Substation	$ 646,153.85	$ 2,153,846	$ 2,800,000	ECG provided component and labor data based on their standard substation design. Costs verified by NRECA regional and international cost data.
Supply and Installation of 1 X 20/26 MVA 34.5/11.5kV outdoor Substation	Substation	$ 461,538.46	$ 1,538,462	$ 2,000,000	ECG and NEDCo provided component and labor data based on their standard substation design. Costs verified by NRECA regional and international cost data.
OH Sub-Transmission	km	$ 31,846	$ 106,154	$ 138,000	Cost based on ECG and verified by NRECA based on regional cost data
UG Sub-Transmission	km	$ 93,000	$ 310,000	$ 403,000	Cost based on ECG and verified by NRECA based on regional cost data
MV OH lines (Express feeders)	km	$ 4,385	$ 14,615	$ 19,000	Cost based on ECG and verified by NRECA based on regional cost data
MV UG Lines (Express feeders)	km	$ 21,692	$ 72,308	$ 94,000	Cost based on ECG and verified by NRECA based on regional cost data
LV OH Line	km	$ 3,462	$ 11,538	$ 15,000	Cost based on ECG and NEDCo and verified by NRECA
Distribution Transformer	Transformer	$ 2,308	$ 7,692	$ 10,000	Cost based on ECG and NEDCo and verified by NRECA (50 and 100 kVA 3 phases)
Feeder Bifurcation LV to MV	km	$ 6,200	$ 32,400	$ 38,600	NRECA component cost data from Liberia and Tanzania built up for 1 KM of Bifurcation
Feeder sectionalizing and automation	Feeder	$ 13,950	$ 46,500	$ 60,450	Price based on the ECG cost of the following equipment to be installed on a typical feeder (1 recloser, 6 Sectionalizer, 30 fuse cutouts). Only OH sections require sectionalizing.
OMS Software	users	$ 2,750	$ 22,500	$ 25,250	Assume 8 users for dividing fixed fees. OMS for 1 millions customers, IVR, Vehicle Tracking (software only), Call management, Database server, Large displays, Client PCs.
Trouble men bucket truck and tools	Trucks	$ -	$ 130,000	$ 130,000	Based on 4 ton bucket truck prices in the US
Data Center	Data Center	$ 105,000	$ 700,000	$ 805,000	Servers, Racks, Refurbishment of space, Fire suppression system, Back up power, communication equipment and Air conditioning
LAN and WLAN	Systems	$ 30,000	$ 100,000	$ 130,000	Wiring District office for a reliable LAN system and include contingency to provide 2 WAN connections
NEDCo Service Center	Service Center	$ 34,615	$ 115,385	$ 150,000	Cost from NEDCo. Cost include purchase of land and construction of building including all furniture and equipment

Appendix E
NEDCo Work Plan

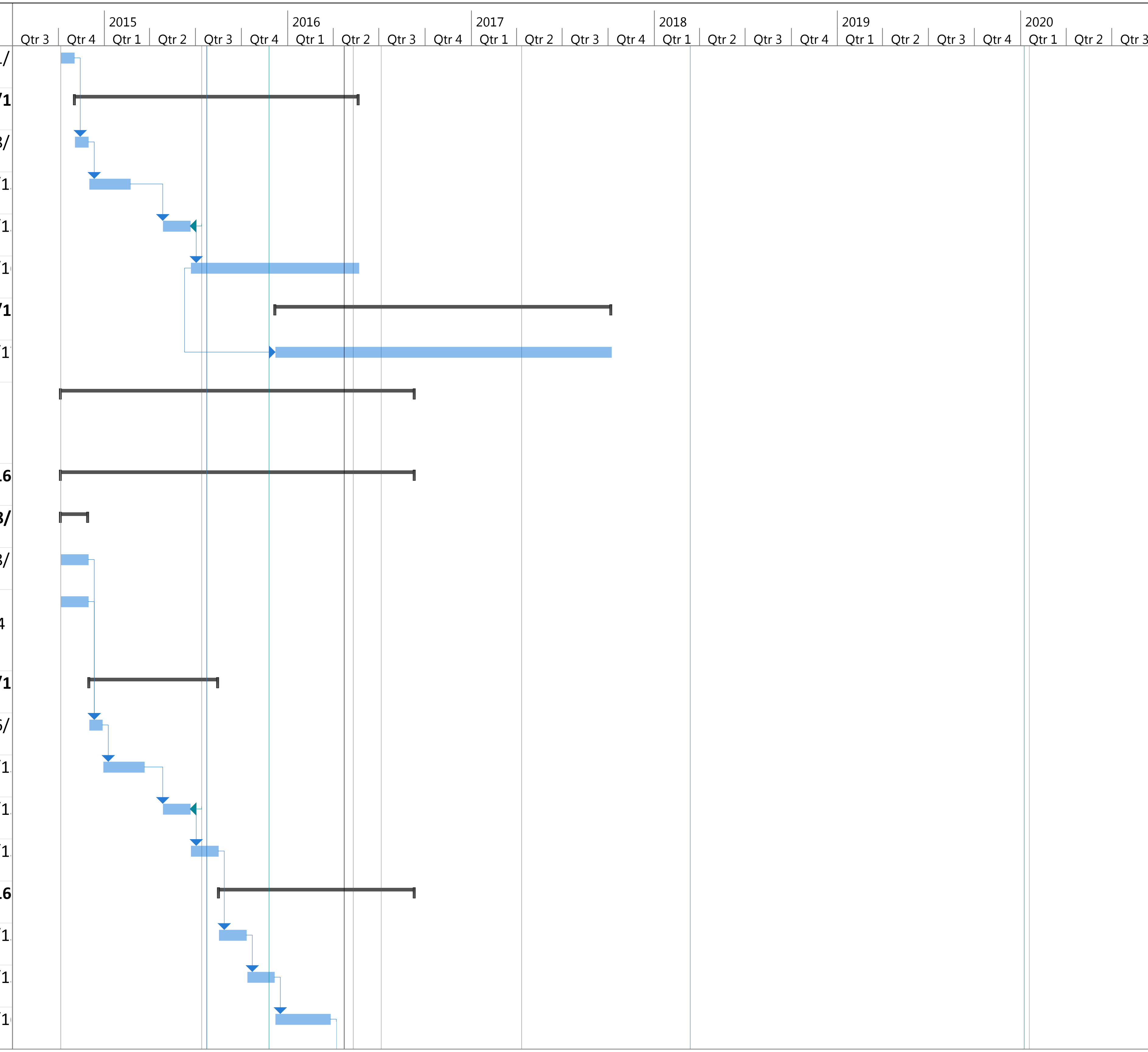
ID		Task Mode	Task Name	Duration	Start	Finish
1			Compact 5 year time clock start	0 mons	Mon 6/15/15	Mon 6/15/1
2			**Resettlement Action Plans (Impacting Substations, Biferc**	**42 mons**	**Mon 5/16/16**	**Fri 8/2/19**
3			Field Evaluation of Proposed Activities and Public Engag	15 mons	Mon 5/16/16	Fri 7/7/17
4			Work with Land evaluation commission and conduct res	42 mons	Mon 5/16/16	Fri 8/2/19
5			**Update distribution design, construction and service standards to reflect best practice**	**10 mons**	**Mon 10/6/14**	**Fri 7/10/15**
6			Draft RFP	1 mon	Mon 10/6/14	Fri 10/31/
7			Publish RFP, receive bids	2 mons	Mon 11/3/14	Fri 12/26/
8			Evaluate and award contracts	1 mon	Mon 12/29/1	Fri 1/23/1
9			Update distribution design and construction standards	6 mons	Mon 1/26/15	Fri 7/10/1
10			**Customer Census integrated with GIS based distribution management system and service normalization**	**39.25 mons**	**Mon 10/6/14**	**Fri 10/6/17**
11			**Customer Census (500,000 points)**	**19 mons**	**Mon 10/6/14**	**Fri 3/18/1**
12			**Procurement**	**4 mons**	**Mon 10/6/14**	**Fri 1/23/1**
13			Draft RFP	1 mon	Mon 10/6/14	Fri 10/31/
14			Publish RFP, receive bids	2 mons	Mon 11/3/14	Fri 12/26/
15			Evaluate and award	1 mon	Mon 12/29/1	Fri 1/23/1
16			**Conduct survey**	**15 mons**	**Mon 1/26/15**	**Fri 3/18/1**
17			Conduct LT lines and Consumer survey	12 mons	Mon 1/26/15	Fri 12/25/
18			Populate Geodatabase	13 mons	Mon 3/23/15	Fri 3/18/1
19			**Normalization of customer connections (40,000)**	**39.25 mons**	**Mon 10/6/14**	**Fri 10/6/1**
20			**Design Finalization**	**1 mon**	**Mon 10/6/14**	**Fri 10/31/**
21			Environmental and Social Impact Review	1 mon	Mon 10/6/14	Fri 10/31/



Project: Activity_Gant_Chart
Date: Wed 5/28/14

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID		Task Mode	Task Name	Duration	Start	Finish
22			Detailed Design and BOM Preparation	1 mon	Mon 10/6/14	Fri 10/31/
23			**Procurement**	**20.25 mons**	**Mon 11/3/14**	**Fri 5/20/1**
24			Draft RFPs	1 mon	Mon 11/3/14	Fri 11/28/
25			Publish RFPs, receive bids	3 mons	Mon 12/1/14	Fri 2/20/1
26			Evaluate and award contracts	2 mons	Mon 4/27/15	Fri 6/19/1
27			Delivery of materials	12 mons	Mon 6/22/15	Fri 5/20/1
28			**Installation**	**24 mons**	**Mon 12/7/15**	**Fri 10/6/1**
29			Service Connection Normalization	24 mons	Mon 12/7/15	Fri 10/6/1
30			**Installation of CIS system and integration with existing AMR & prepay metering systems**	**25.25 mons**	**Mon 10/6/14**	**Fri 9/9/16**
31			**Install and Integrate Computer System**	**25.25 mons**	**Mon 10/6/14**	**Fri 9/9/16**
32			**Design Finalization**	**2 mons**	**Mon 10/6/14**	**Fri 11/28/**
33			Detailed design and requirement specification	2 mons	Mon 10/6/14	Fri 11/28/
34			Collection of data output and imput of all system to be integrated	2 mons	Mon 10/6/14	Fri 11/28/14
35			**Procurement**	**9.25 mons**	**Mon 12/1/14**	**Fri 8/14/1**
36			Draft RFP	1 mon	Mon 12/1/14	Fri 12/26/
37			publish RFP, receive bids	3 mons	Mon 12/29/1	Fri 3/20/1
38			Evaluate and award contracts	2 mons	Mon 4/27/15	Fri 6/19/1
39			Delivery of materials	2 mons	Mon 6/22/15	Fri 8/14/1
40			**Installation**	**14 mons**	**Mon 8/17/15**	**Fri 9/9/16**
41			Installation of the system	2 mons	Mon 8/17/15	Fri 10/9/1
42			Integration with existing systems	2 mons	Mon 10/12/1	Fri 12/4/1
43			Beta testing	4 mons	Mon 12/7/15	Fri 3/25/1



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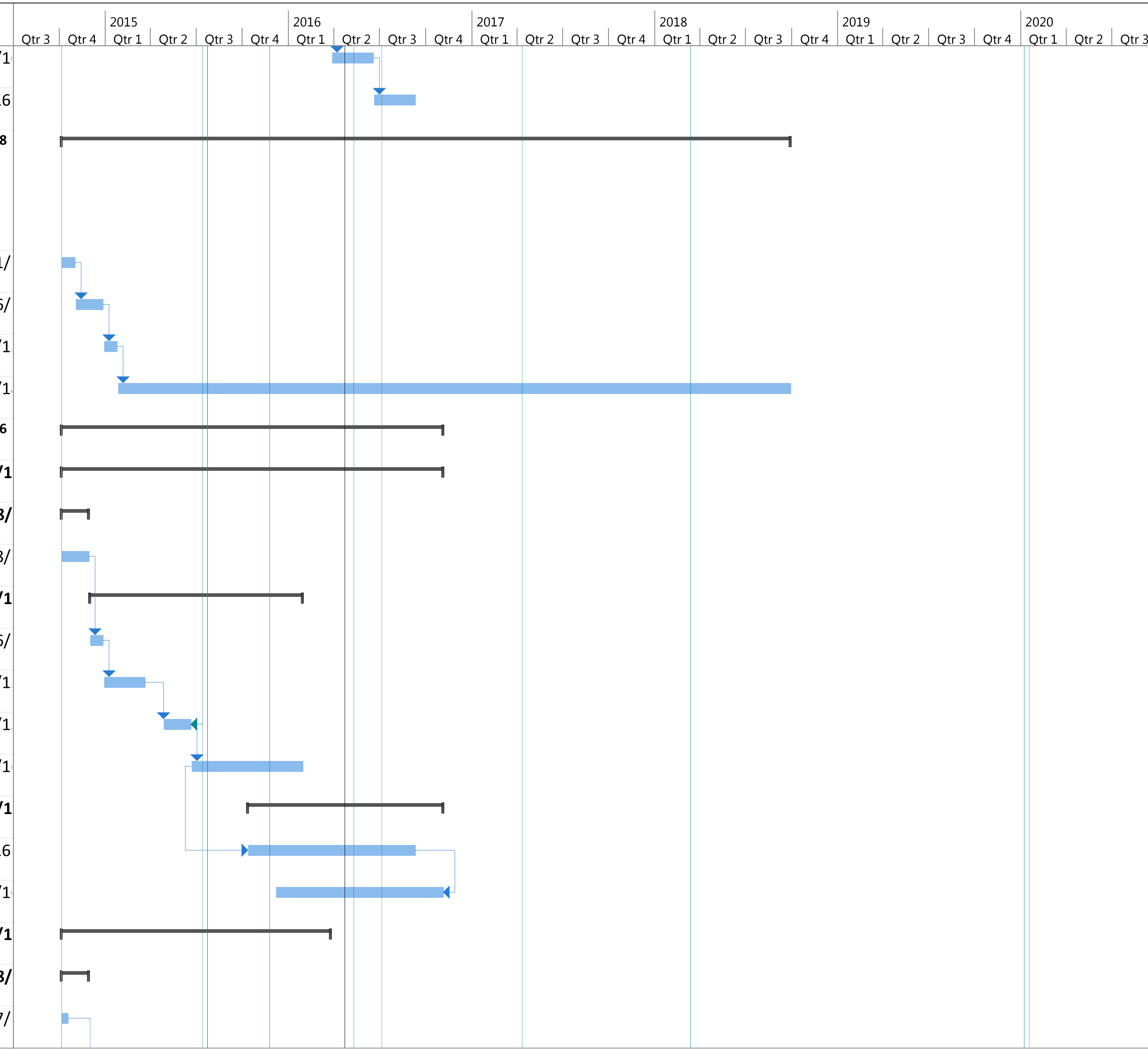
Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID		Task Mode	Task Name	Duration	Start	Finish
44			Modifications based on beta testing	3 mons	Mon 3/28/16	Fri 6/17/1
45			Phased rollout	3 mons	Mon 6/20/16	Fri 9/9/16
46			**Technical assistance (management advisory services to implement new processes and practices for commercial loss reduction orientation)**	**52 mons**	**Mon 10/6/14**	**Fri 9/28/18**
47			Draft RFP	1 mon	Mon 10/6/14	Fri 10/31/
48			Publish RFP, receive bids	2 mons	Mon 11/3/14	Fri 12/26/
49			Evaluate and award contracts	1 mon	Mon 12/29/1	Fri 1/23/1
50			Provide consultancy services	48 mons	Mon 1/26/15	Fri 9/28/1
51			**Data Center and Communication Network**	**27.25 mons**	**Mon 10/6/14**	**Fri 11/4/16**
52			**Install Local Area Network**	**27.25 mons**	**Mon 10/6/14**	**Fri 11/4/1**
53			**Design Finalization**	**2 mons**	**Mon 10/6/14**	**Fri 11/28/**
54			Detailed design and BOM Preparation	2 mons	Mon 10/6/14	Fri 11/28/
55			**Procurement**	**15.25 mons**	**Mon 12/1/14**	**Fri 1/29/1**
56			Draft RFP	1 mon	Mon 12/1/14	Fri 12/26/
57			Publish RFP, receive bids	3 mons	Mon 12/29/1	Fri 3/20/1
58			Evaluate and award contract	2 mons	Mon 4/27/15	Fri 6/19/1
59			Delivery of Material	8 mons	Mon 6/22/15	Fri 1/29/1
60			**Installation**	**14 mons**	**Mon 10/12/1**	**Fri 11/4/1**
61			Installation of LAN	12 mons	Mon 10/12/1	Fri 9/9/16
62			Testing and commisioning	12 mons	Mon 12/7/15	Fri 11/4/1
63			**Install Data center**	**19.25 mons**	**Mon 10/6/14**	**Fri 3/25/1**
64			**Design Finalization**	**2 mons**	**Mon 10/6/14**	**Fri 11/28/**
65			ESI review	0.5 mons	Mon 10/6/14	Fri 10/17/



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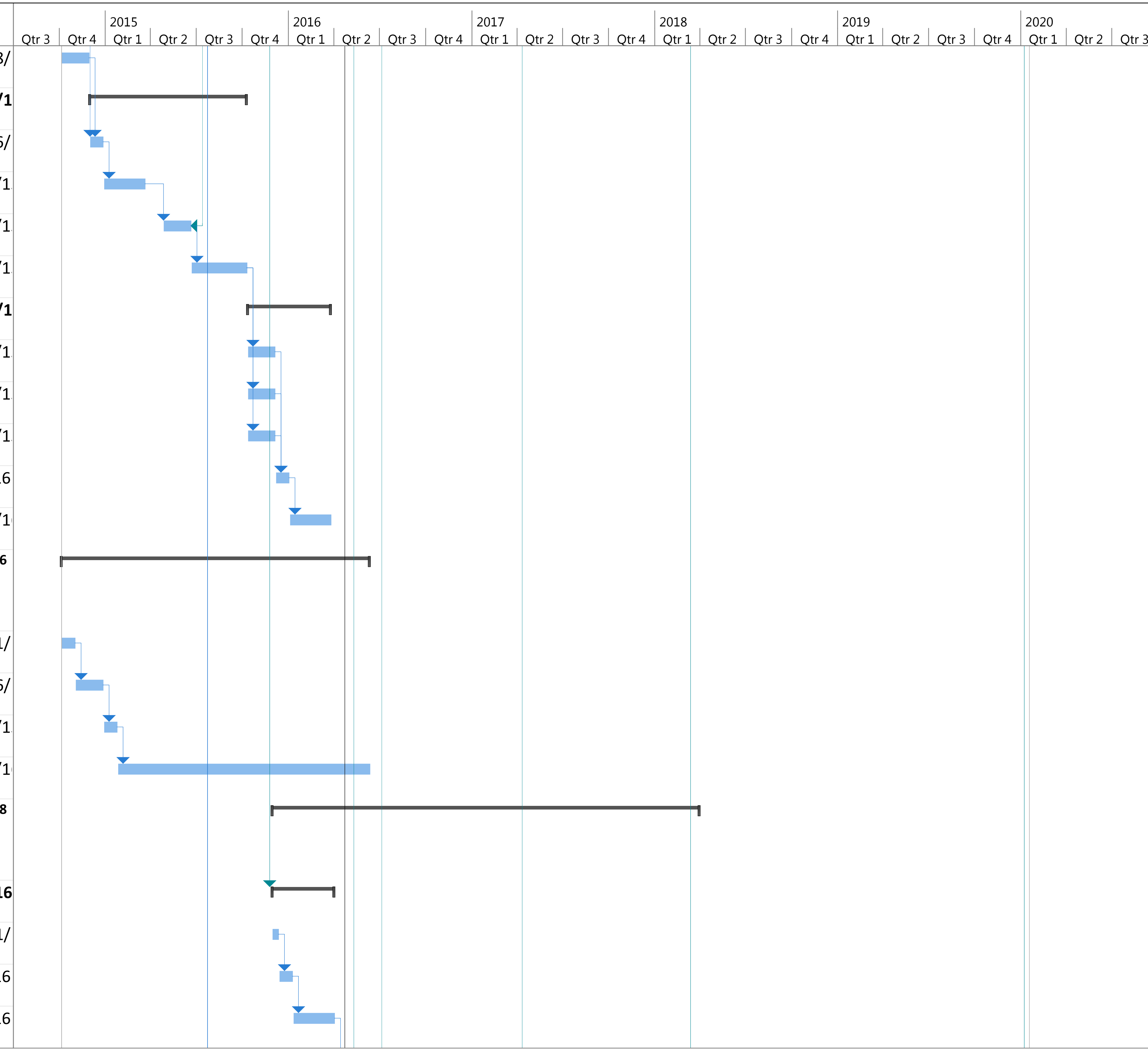
Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Mode	Task Name	Duration	Start	Finish
66		Detailed design and BOM Preparation	2 mons	Mon 10/6/14	Fri 11/28/
67		**Procurement**	**11.25 mons**	**Mon 12/1/14**	**Fri 10/9/1**
68		Draft RFP	1 mon	Mon 12/1/14	Fri 12/26/
69		Publish RFP, receive bids	3 mons	Mon 12/29/1	Fri 3/20/1
70		Evaluate and award contract	2 mons	Mon 4/27/15	Fri 6/19/1
71		Delivery of Material	4 mons	Mon 6/22/15	Fri 10/9/1
72		**Installation**	**6 mons**	**Mon 10/12/1**	**Fri 3/25/1**
73		Room preparation	2 mons	Mon 10/12/1	Fri 12/4/1
74		Back up power installtion	2 mons	Mon 10/12/1	Fri 12/4/1
75		Comunication installtion	2 mons	Mon 10/12/1	Fri 12/4/1
76		Server racking system installtion	1 mon	Mon 12/7/15	Fri 1/1/16
77		Migrtion of exisitn server to the data center	3 mons	Mon 1/4/16	Fri 3/25/1
78		**Distribution master plan (short & Long Term capital improvements)**	**22 mons**	**Mon 10/6/14**	**Fri 6/10/16**
79		Draft RFP	1 mon	Mon 10/6/14	Fri 10/31/
80		Publish RFP, receive bids	2 mons	Mon 11/3/14	Fri 12/26/
81		Evaluate and award contracts	1 mon	Mon 12/29/1	Fri 1/23/1
82		Distribution Master Plan	18 mons	Mon 1/26/15	Fri 6/10/1
83		**Installation of meters at critical distribution network nodes**	**30.5 mons**	**Mon 11/30/15**	**Fri 3/30/18**
84		**Design Finalization**	**4.5 mons**	**Mon 11/30/1**	**Fri 4/1/16**
85		Metering points selection	0.5 mons	Mon 11/30/1	Fri 12/11/
86		ESI review	1 mon	Mon 12/14/1	Fri 1/8/16
87		Detailed Design and BOM Preparation	3 mons	Mon 1/11/16	Fri 4/1/16



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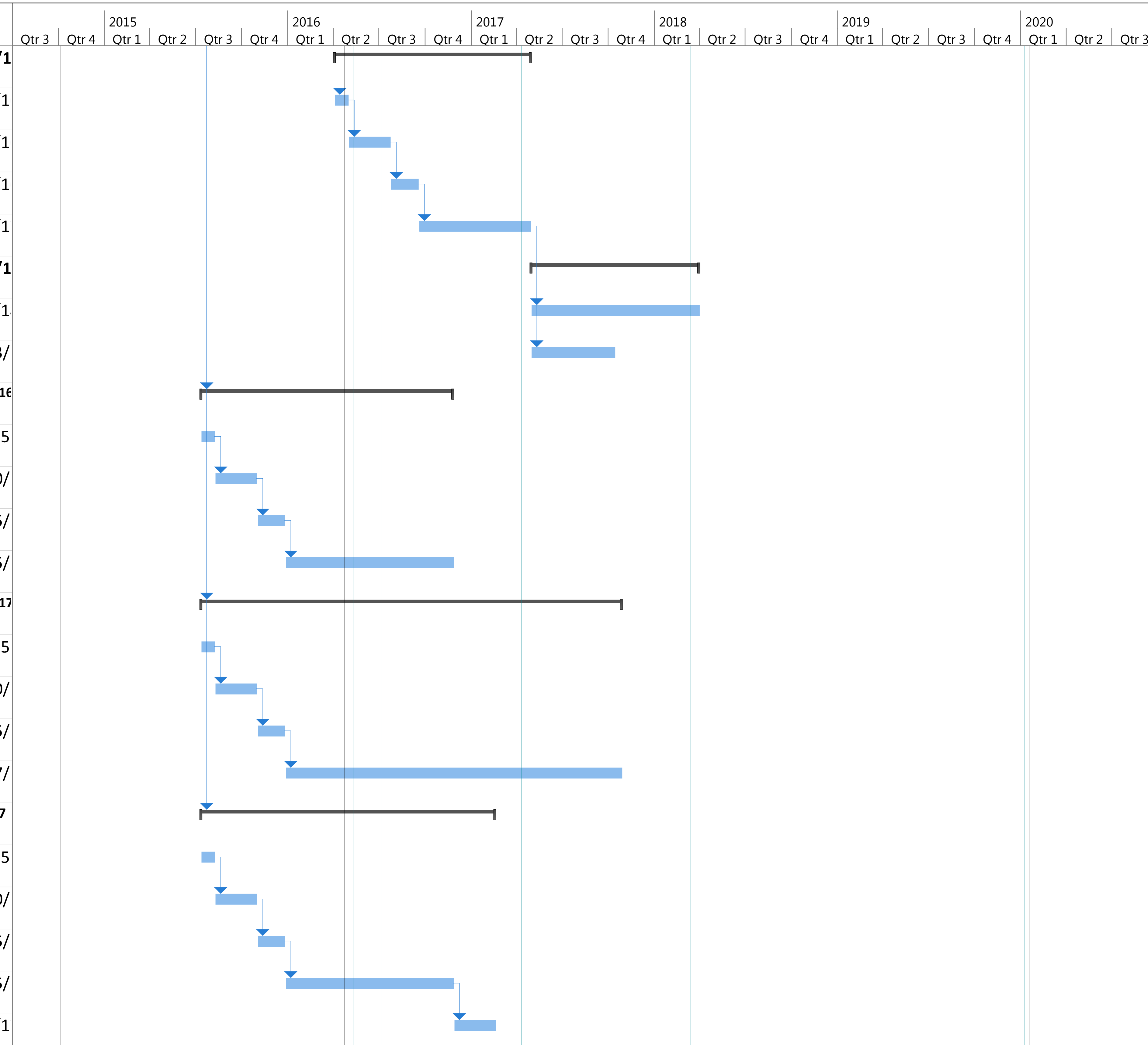
Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID		Task Mode	Task Name	Duration	Start	Finish
88			**Procurement**	**14 mons**	**Mon 4/4/16**	**Fri 4/28/1**
89			Draft RFP	1 mon	Mon 4/4/16	Fri 4/29/1
90			Publish RFP, receive bids	3 mons	Mon 5/2/16	Fri 7/22/1
91			Evaluate and award contract	2 mons	Mon 7/25/16	Fri 9/16/1
92			Delivery of Material	8 mons	Mon 9/19/16	Fri 4/28/1
93			**Installation**	**12 mons**	**Mon 5/1/17**	**Fri 3/30/1**
94			Install meters on distribution transformers	12 mons	Mon 5/1/17	Fri 3/30/1
95			Install meters at MV nodes	6 mons	Mon 5/1/17	Fri 10/13/
96			**Service materials for new service connections**	**18 mons**	**Mon 7/13/15**	**Fri 11/25/16**
97			Draft RFP	1 mon	Mon 7/13/15	Fri 8/7/15
98			Publish RFP, receive bids	3 mons	Mon 8/10/15	Fri 10/30/
99			Evaluate and award contracts	2 mons	Mon 11/2/15	Fri 12/25/
100			Delivery of materials	12 mons	Mon 12/28/1	Fri 11/25/
101			**Operations maintenance materials**	**30 mons**	**Mon 7/13/15**	**Fri 10/27/17**
102			Draft RFP	1 mon	Mon 7/13/15	Fri 8/7/15
103			Publish RFP, receive bids	3 mons	Mon 8/10/15	Fri 10/30/
104			Evaluate and award contracts	2 mons	Mon 11/2/15	Fri 12/25/
105			Delivery of materials	24 mons	Mon 12/28/1	Fri 10/27/
106			**Vehicles, tools, and equipment**	**21 mons**	**Mon 7/13/15**	**Fri 2/17/17**
107			Draft RFP	1 mon	Mon 7/13/15	Fri 8/7/15
108			Publish RFP, receive bids	3 mons	Mon 8/10/15	Fri 10/30/
109			Evaluate and award contracts	2 mons	Mon 11/2/15	Fri 12/25/
110			Delivery of materials	12 mons	Mon 12/28/1	Fri 11/25/
111			Training	3 mons	Mon 11/28/1	Fri 2/17/1



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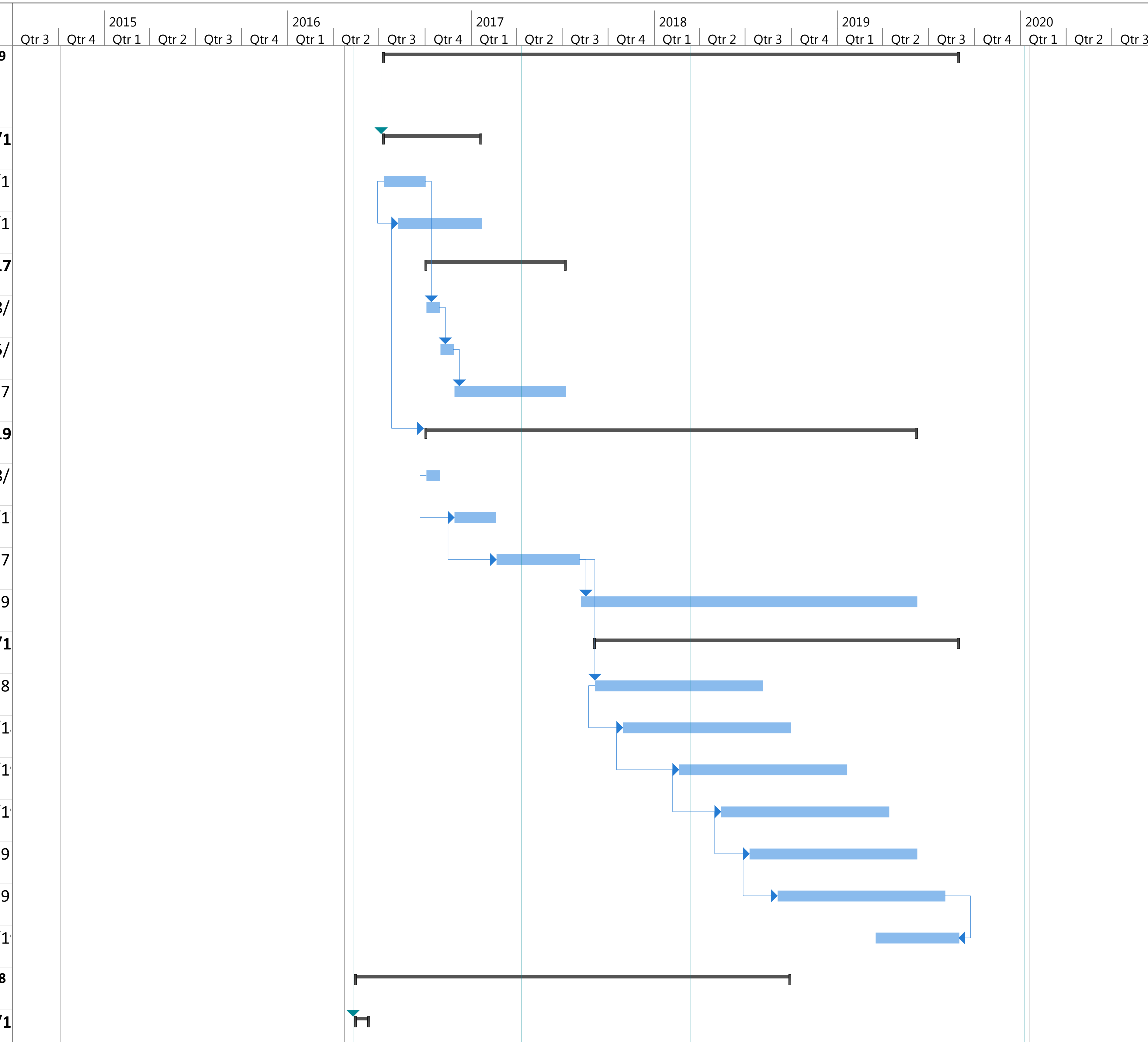
Date: Wed 5/28/14

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID		Task Mode	Task Name	Duration	Start	Finish
112			**Install primary substations with interconnecting 33kV links and 11kV offloading circuits**	**41 mons**	**Mon 7/11/16**	**Fri 8/30/19**
113			**Design Finalization**	**7 mons**	**Mon 7/11/16**	**Fri 1/20/1**
114			Site Selection and ESI Review	3 mons	Mon 7/11/16	Fri 9/30/1
115			Detailed Design and BOM Preparation	6 mons	Mon 8/8/16	Fri 1/20/1
116			**Resettlement**	**10 mons**	**Mon 10/3/16**	**Fri 7/7/17**
117			Conduct Resettlement Field Assessment on proposed	1 mon	Mon 10/3/16	Fri 10/28/
118			Finalize Resettlement Action Plan	1 mon	Mon 10/31/1	Fri 11/25/
119			Conduct Resettlement	8 mons	Mon 11/28/1	Fri 7/7/17
120			**Procurement**	**35 mons**	**Mon 10/3/16**	**Fri 6/7/19**
121			Draft RFP	1 mon	Mon 10/3/16	Fri 10/28/
122			Publish RFP, receive bids	3 mons	Mon 11/28/1	Fri 2/17/1
123			Evaluate and award contracts	6 mons	Mon 2/20/17	Fri 8/4/17
124			Delivery of materials	24 mons	Mon 8/7/17	Fri 6/7/19
125			**Installation**	**26 mons**	**Mon 9/4/17**	**Fri 8/30/1**
126			Pre-Construction Site Work	12 mons	Mon 9/4/17	Fri 8/3/18
127			Site Preparation	12 mons	Mon 10/30/1	Fri 9/28/1
128			Concrete Work	12 mons	Mon 2/19/18	Fri 1/18/1
129			Steel Erection and Civil Construction	12 mons	Mon 5/14/18	Fri 4/12/1
130			Equipment installation	12 mons	Mon 7/9/18	Fri 6/7/19
131			Equipment Testing	12 mons	Mon 9/3/18	Fri 8/2/19
132			Site Restoration and Commissioning	6 mons	Mon 3/18/19	Fri 8/30/1
133			**Capacitor banks for reactive power compensation**	**31 mons**	**Mon 5/16/16**	**Fri 9/28/18**
134			**Design Finalization**	**1 mon**	**Mon 5/16/16**	**Fri 6/10/1**



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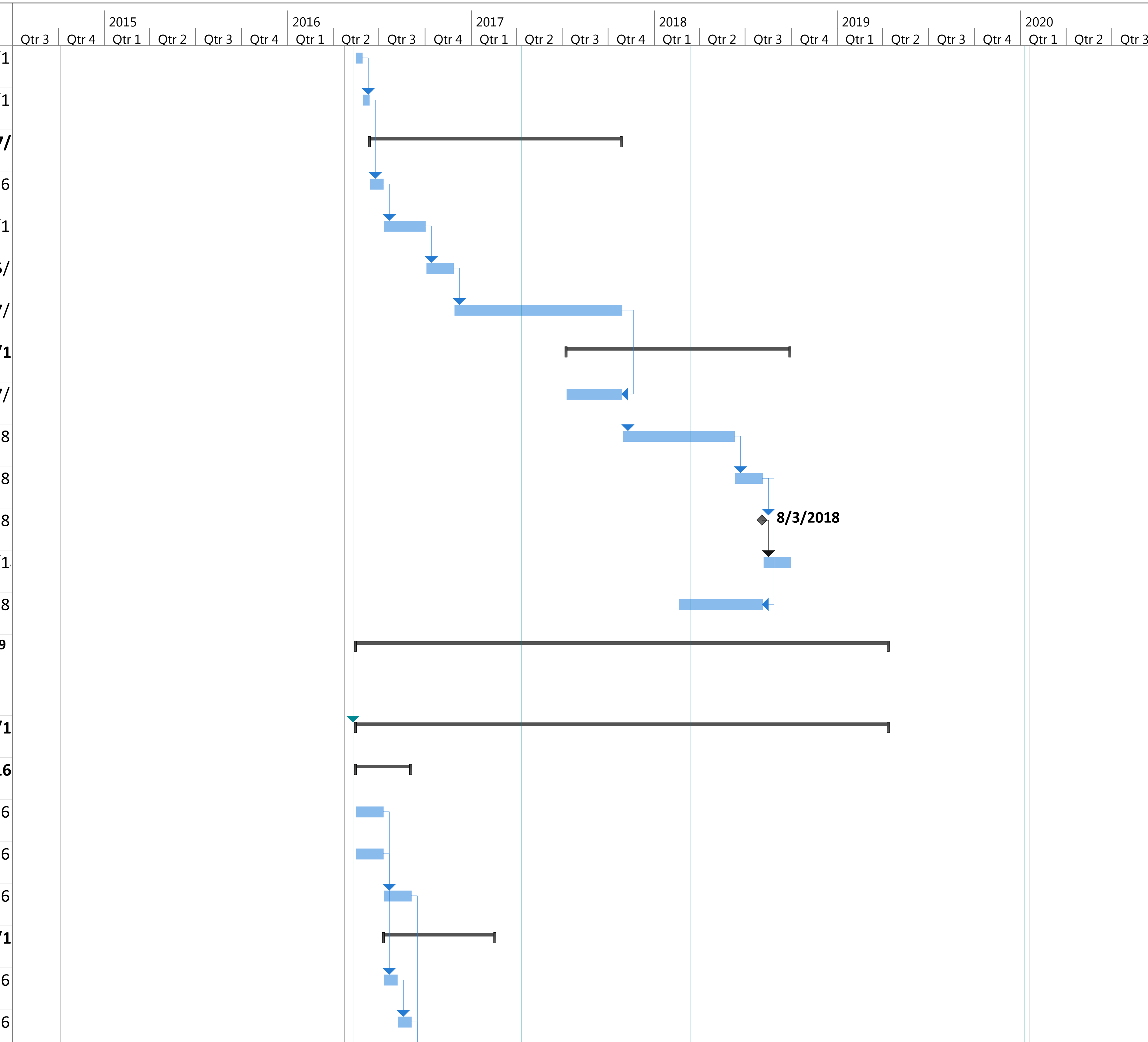
Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Mode	Task Name	Duration	Start	Finish
135		Substation and Feeder Selection and ESI Review	0.5 mons	Mon 5/16/16	Fri 5/27/1
136		Detailed Design and BOM Preparation	0.5 mons	Mon 5/30/16	Fri 6/10/1
137		**Procurement**	**18 mons**	**Mon 6/13/16**	**Fri 10/27/**
138		Draft RFP	1 mon	Mon 6/13/16	Fri 7/8/16
139		Publish RFP, receive bids	3 mons	Mon 7/11/16	Fri 9/30/1
140		Evaluate and award contracts	2 mons	Mon 10/3/16	Fri 11/25/
141		Delivery of materials	12 mons	Mon 11/28/1	Fri 10/27/
142		**Installation**	**16 mons**	**Mon 7/10/17**	**Fri 9/28/1**
143		Site preparation for additional CB retrofit	4 mons	Mon 7/10/17	Fri 10/27/
144		Capacitor bank mounting structure installation	8 mons	Mon 10/30/1	Fri 6/8/18
145		Equipment wiring and testing	2 mons	Mon 6/11/18	Fri 8/3/18
146		Energization of capacitor banks in substations	0 mons	Fri 8/3/18	Fri 8/3/18
147		Site Restoration and Commissioning	2 mons	Mon 8/6/18	Fri 9/28/1
148		Install capacitors on poles	6 mons	Mon 2/19/18	Fri 8/3/18
149		**Rehabilitation/upgrgrade of lines and underground cables, conversion of shield wire schemes**	**38 mons**	**Mon 5/16/16**	**Fri 4/12/19**
150		**OH Distribution Line Construction**	**38 mons**	**Mon 5/16/16**	**Fri 4/12/1**
151		**Design Finalization**	**4 mons**	**Mon 5/16/16**	**Fri 9/2/16**
152		Verify Alignment	2 mons	Mon 5/16/16	Fri 7/8/16
153		Environmental and Social Impact Review	2 mons	Mon 5/16/16	Fri 7/8/16
154		Detailed Design and BOM Preparation	2 mons	Mon 7/11/16	Fri 9/2/16
155		**Resettlement**	**8 mons**	**Mon 7/11/16**	**Fri 2/17/1**
156		Conduct Resettlement Field Assessment on propos	1 mon	Mon 7/11/16	Fri 8/5/16
157		Finalize Resettlement Action Plan	1 mon	Mon 8/8/16	Fri 9/2/16



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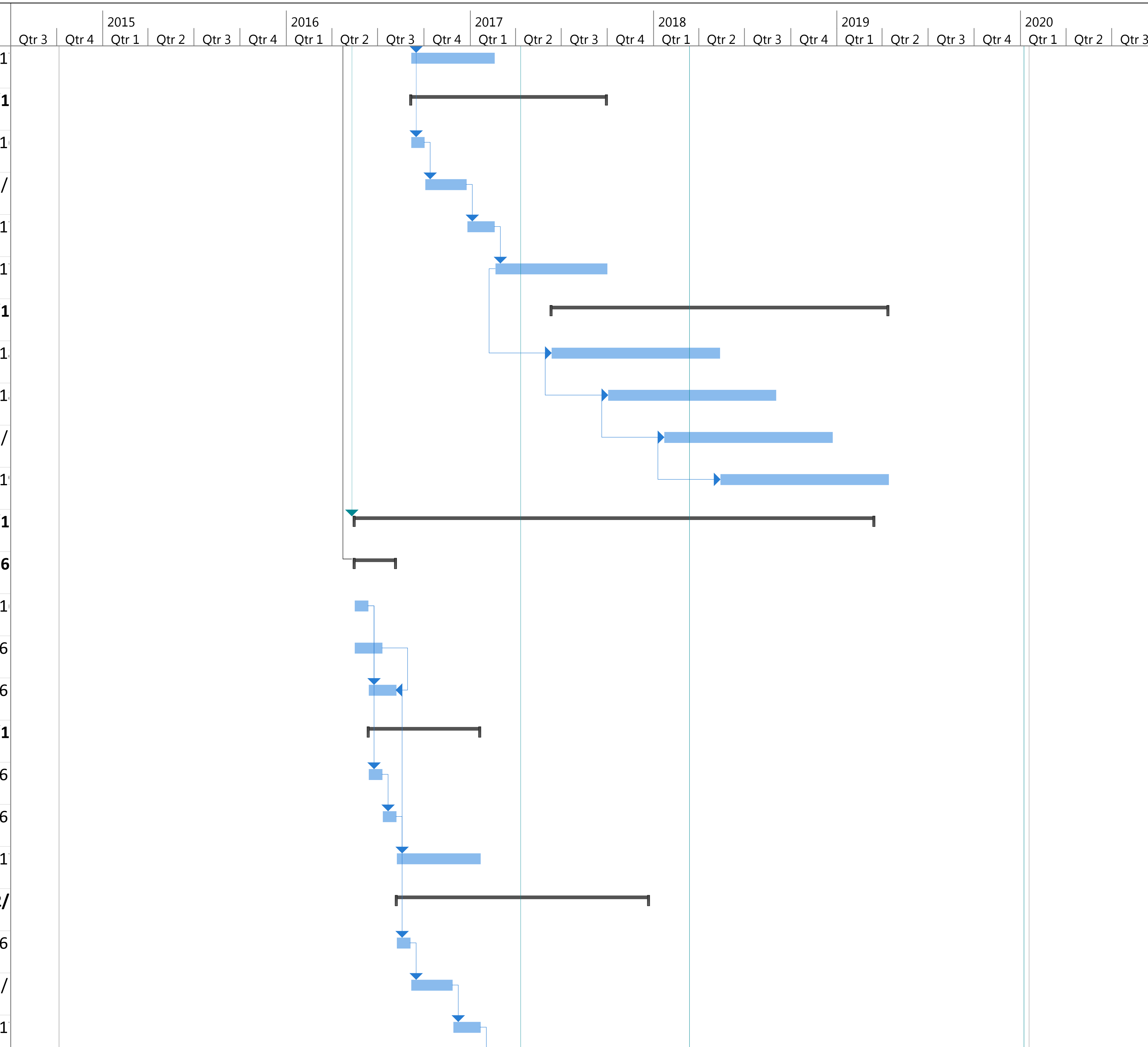
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID		Task Mode	Task Name	Duration	Start	Finish
158			Conduct Resettlement	6 mons	Mon 9/5/16	Fri 2/17/1
159			**Procurement**	**14 mons**	**Mon 9/5/16**	**Fri 9/29/1**
160			Draft RFP	1 mon	Mon 9/5/16	Fri 9/30/1
161			Publish RFP, receive bids	3 mons	Mon 10/3/16	Fri 12/23/
162			Evaluate and award contracts	2 mons	Mon 12/26/1	Fri 2/17/1
163			Delivery of materials	8 mons	Mon 2/20/17	Fri 9/29/1
164			**Installation**	**24 mons**	**Mon 6/12/17**	**Fri 4/12/1**
165			Pole Installation and Framing	12 mons	Mon 6/12/17	Fri 5/11/1
166			Wire stringing	12 mons	Mon 10/2/17	Fri 8/31/1
167			Equipment Installation and Transfers	12 mons	Mon 1/22/18	Fri 12/21/
168			Removal of Existing Poles and Equipment	12 mons	Mon 5/14/18	Fri 4/12/1
169			**Underground Distribution Line Construction**	**37 mons**	**Mon 5/16/16**	**Fri 3/15/1**
170			**Design Finalization**	**3 mons**	**Mon 5/16/16**	**Fri 8/5/16**
171			Feeder Selection	1 mon	Mon 5/16/16	Fri 6/10/1
172			Environmental and Social Impact Review	2 mons	Mon 5/16/16	Fri 7/8/16
173			Detailed Design and BOM Preparation	2 mons	Mon 6/13/16	Fri 8/5/16
174			**Resettlement**	**8 mons**	**Mon 6/13/16**	**Fri 1/20/1**
175			Conduct Resettlement Field Assessment on propos	1 mon	Mon 6/13/16	Fri 7/8/16
176			Finalize Bifercation Resettlement Action Plan	1 mon	Mon 7/11/16	Fri 8/5/16
177			Conduct Resettlement	6 mons	Mon 8/8/16	Fri 1/20/1
178			**Procurement**	**18 mons**	**Mon 8/8/16**	**Fri 12/22/**
179			Draft RFP	1 mon	Mon 8/8/16	Fri 9/2/16
180			Publish RFP, receive bids	3 mons	Mon 9/5/16	Fri 11/25/
181			Evaluate and award contracts	2 mons	Mon 11/28/1	Fri 1/20/1



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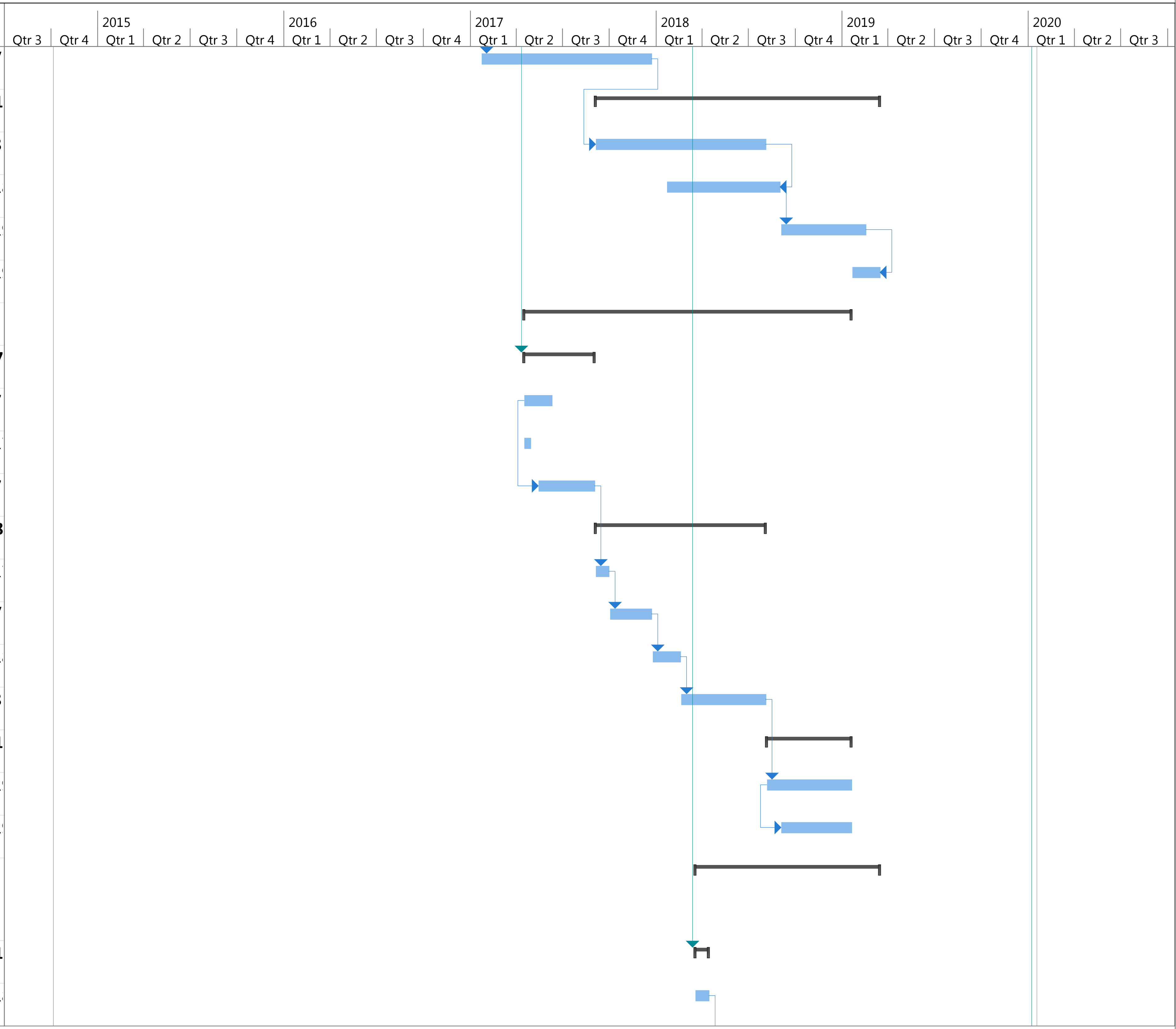
Split	Inactive Task	Duration-only	Finish-only	Progress	
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress	
Summary	Inactive Summary	Manual Summary	External Milestone		

ID		Task Mode	Task Name	Duration	Start	Finish
182			Delivery of materials	12 mons	Mon 1/23/17	Fri 12/22/
183			**Installation**	**20 mons**	**Mon 9/4/17**	**Fri 3/15/1**
184			Trench digging and conduit layout	12 mons	Mon 9/4/17	Fri 8/3/18
185			Cable pulling/laying	8 mons	Mon 1/22/18	Fri 8/31/1
186			Equipment Installation and Enrgization	6 mons	Mon 9/3/18	Fri 2/15/1
187			Site restoration	2 mons	Mon 1/21/19	Fri 3/15/1
188			**Sectionalizing study, new SCADA system in Tamale**	**23 mons**	**Mon 4/17/17**	**Fri 1/18/19**
189			**Design Finalization**	**5 mons**	**Mon 4/17/17**	**Fri 9/1/17**
190			Conduct Sectionalizing Study	2 mons	Mon 4/17/17	Fri 6/9/17
191			ESI Review	0.5 mons	Mon 4/17/17	Fri 4/28/1
192			Detailed Design and BOM Preparation	4 mons	Mon 5/15/17	Fri 9/1/17
193			**Procurement**	**12 mons**	**Mon 9/4/17**	**Fri 8/3/18**
194			Draft RFP	1 mon	Mon 9/4/17	Fri 9/29/1
195			Publish RFP, receive bids	3 mons	Mon 10/2/17	Fri 12/22/
196			Evaluate and award contracts	2 mons	Mon 12/25/1	Fri 2/16/1
197			Delivery of materials	6 mons	Mon 2/19/18	Fri 8/3/18
198			**Installation**	**6 mons**	**Mon 8/6/18**	**Fri 1/18/1**
199			Equipment Installtion	6 mons	Mon 8/6/18	Fri 1/18/1
200			SCADA installation	5 mons	Mon 9/3/18	Fri 1/18/1
201			**Installation of outage reporting and call center system**	**13 mons**	**Mon 3/19/18**	**Fri 3/15/19**
202			**Design Finalization**	**1 mon**	**Mon 3/19/18**	**Fri 4/13/1**
203			Detailed design and requirement specification	1 mon	Mon 3/19/18	Fri 4/13/1



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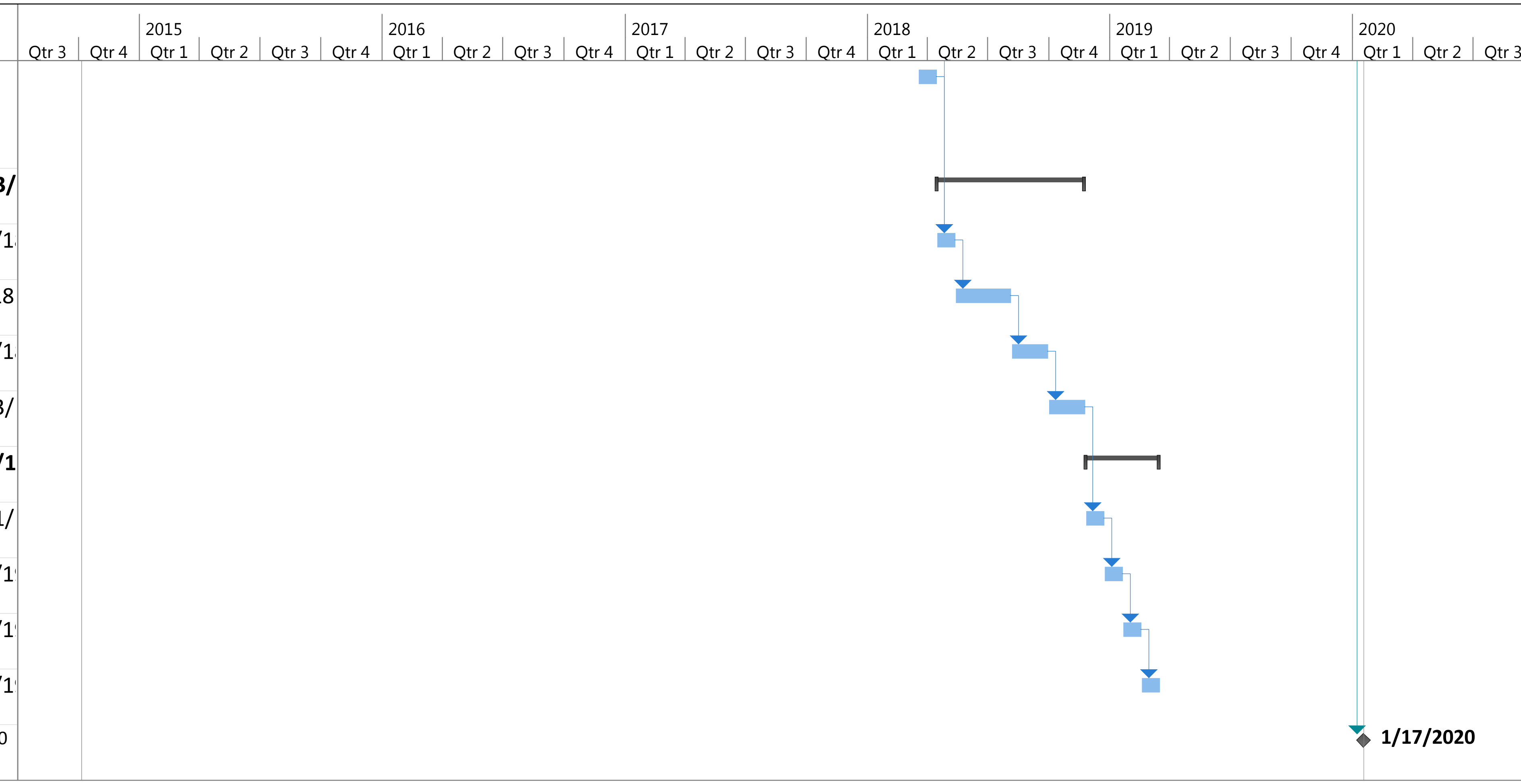
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID		Task Mode	Task Name	Duration	Start	Finish
204			Collection of data output and imput of all system to be integrated	1 mon	Mon 3/19/18	Fri 4/13/18
205			**Procurement**	**8 mons**	**Mon 4/16/18**	**Fri 11/23/**
206			Draft RFP	1 mon	Mon 4/16/18	Fri 5/11/1
207			publish RFP, receive bids	3 mons	Mon 5/14/18	Fri 8/3/18
208			Evaluate and award contracts	2 mons	Mon 8/6/18	Fri 9/28/1
209			Delivery of materials	2 mons	Mon 10/1/18	Fri 11/23/
210			**Installation**	**4 mons**	**Mon 11/26/1**	**Fri 3/15/1**
211			Installation of the system	1 mon	Mon 11/26/1	Fri 12/21/
212			Integration with existing systems	1 mon	Mon 12/24/1	Fri 1/18/1
213			Beta testing	1 mon	Mon 1/21/19	Fri 2/15/1
214			Modifications based on beta testing and rollout	1 mon	Mon 2/18/19	Fri 3/15/1
215			Compact 5 year mark	0 mons	Fri 1/17/20	Fri 1/17/20



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Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

Appendix F
Environmental, Social, and Gender Impact Assessment

Appendix F
Framework Environmental and Social Impact Assessment for NEDCo Proposed Distribution Sub-Activities Under MCC Ghana Compact II

Contents

Tables

Figures

Acronyms and Abbreviations

BMP	best management practice
BSP	bulk supply point
CIS	customer information system
EA	Environmental Assessment
ECG	Electric Company of Ghana
EHS	Environmental Health and Safety
EI	Executive Instrument
EIA	Environmental Impact Assessment
EP	environmental permit
EPA	Environmental Protection Agency
ERP	enterprise resources planning
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
FESIA	Framework Environmental and Social Impact Assessment
GEC	Global Energy Consulting Engineers India
GIS	geographic information system
GoG	Government of Ghana
GRIDCo	Grid Company of Ghana
GRM	grievance redress mechanism
ha	hectare(s)
HV	high voltage
ICT	Information Communication Technology
IFC	International Finance Corporation
km	kilometer(s)
kV	kilovolt(s)
LCU	Loss Control Unit
LV	low voltage
m	meter(s)
MCC	Millennium Challenge Corporation
MiDA	Millennium Development Authority
mm	millimeter(s)
MV	medium voltage
MVA	megavolt ampere
NEAP	National Environmental Action Plan
NEDCo	Northern Electricity Distribution Company
OMS	outage management system
OP	Operational Policy (World Bank)
PAP	potentially affected person
PEA	Preliminary Environmental Assessment
PPE	personal protective equipment
PS	Performance Standard

RAP	Resettlement Action Plan
RMT	Resettlement Management Team
ROW	right-of-way
SAC	Site Advisory Committee
SAD	Sub-Activity Description
SCADA	supervisory control and data acquisition
SEA	Strategic Environmental Assessment
SOP	standard operating procedure
V	volt(s)
VRA	Volta River Authority

SECTION 1

Introduction

As part of a grant to be provided to the Government of Ghana (GoG) under the authority of Section 609(g) of the Millennium Challenge Act of 2003, the Millennium Challenge Corporation (MCC) engaged U.S. Army Corps of Engineers/CH2M HILL, on behalf of the GoG, to undertake the project screening and feasibility studies for a portfolio of potential distribution technical and commercial Activities for the Northern Electric Distribution Company (NEDCo). This Framework Environmental and Social Impact Assessment (ESIA) addresses the distribution projects identified for NEDCo through the Phase I and Phase II screening process conducted under MCC Ghana Compact II.

The objective of the FESIA is to clearly define each of the proposed NEDCo Sub-Activities and to assess their potential for environmental and social impacts. While operations of NEDCo cover more than 60 percent of the total land area of Ghana, the Sub-Activities addressed in this assessment are all located in the NEDCo service territory, within the Northern and Brong Ahafo regions of Ghana, and are under consideration for inclusion in the MCC Ghana Compact II.

A total of 21 NEDCo Sub-Activities (projects) within four Activities have been identified as the top priority for NEDCo funding under the MCC Ghana Compact II. The Sub-Activities and activities are presented in Section 7 of this report. The Sub-Activities are presented in Section 7 of this FESIA, along with their potential social and environmental impacts. Section 8 describes other potential environmental and social impacts that apply to the Compact as a whole. These relate to compliance regarding issues of the use of child and forced labor, security arrangements, and bio-diversity. Section 9 contains the gender assessment of Compact II Sub-Activities that was undertaken in parallel with the FESIA. Section 10 describes the draft Environmental and Social Management Plan (ESMP).

This FESIA is based on existing Sub-Activity information that includes the conceptual design and representative Sub-Activity locations, both of which will be refined as part of the MCC Ghana Compact II. Once actual project sites are identified and project/footprint design information is available, additional site specific impact analyses can be conducted. The analyses presented herein are intended to provide an overview of the potential impacts associated with each of the Sub-Activities based on their characteristics, known existing conditions in the identified general area, and the implementation of internationally recognized best management practices (BMPs). The Sub-Activities were evaluated against the requirements of the GoG and the environmental and social standards and guidelines established by the 2012 MCC Environmental Guidelines, which incorporate the International Finance Corporation (IFC) performance standards (PSs).

SECTION 2

Summary of Key Findings

The Phase I project screening and prioritization and Phase II feasibility study have resulted in the identification of 4 Activities and 21 Sub-Activities. The four Activities are listed below:

- Commercial Losses Reduction and Collection Efficiency Improvement
- Institutional Support
- Technical Losses Reduction
- Outages Reduction

A summary of the 21 Sub-Activities is presented in Table 2-1 at the end of this section. A summary of the key findings is presented in the following sub-sections.

2.1 Status of Sub-Activities

The Sub-Activities discussed in this assessment were developed by NEDCo and evaluated as part of Phases I and II of the MCC Ghana Compact II. The Sub-Activities encompass improvements to NEDCo's ongoing business practices, changes to customer metering, improvements to existing substation and distribution infrastructure, and the construction of the substations and distribution lines. These projects are all conceptual in that specific locations and design specification have not yet been fully developed. Once MCC has selected the specific Sub-Activities to be funded, final siting and design work can be initiated. As part of the final siting and engineering design work, appropriate Sub-Activity detailed analyses and ESMPs and systems can be developed. Information on potential environmental and social impacts and appropriate mitigation, presented herein, describes these features based on the currently existing information.

2.2 Project Classification

All projects in Ghana with the potential to result in environmental and social impacts are required to obtain an Environmental Permit from the Ghana Environmental Protection Agency (EPA). The Ghana EPA is the Ghanaian regulatory agency responsible for implementing environmental regulations and environmental permitting in the country. The level of environmental and social analysis required to obtain an Environmental Permit depends on a project's potential for impact. An evaluation of the likely level of environmental and social analyses to be required for each of the proposed NEDCo Sub-Activities was conducted. The evaluation was based on the Ghana EPA's *Guidelines for Environmental Impact Assessment for the Energy Sector* and the 2012 MCC Environmental Guidelines project classification system.

A summary of each of the 21 Sub-Activities is provided in Table 2-1. As the table indicates, 17 of the 21 Sub-Activities are classified as Ghana Environmental Protection Agency (EPA) Category A projects and therefore will only require the preparation of Form EA1; no Environmental Impact Assessment (EIA) will be required. The remaining four Sub-Activities, all, are Category B projects and will require the preparation of a Preliminary Environmental Assessment (PEA) after completing Form EA1; three of these involve substation construction, and the fourth (NEDCo-7) requires the construction of a medium voltage (MV) line adjacent to the Techiman-Abofour. The need for a full EIA will be assessed depending on the information provided in the PEA. Similarly, 14 of the Sub-Activities are classified as Category C projects according to the MCC categorization system and are likely to have minimal or no adverse environmental impacts, with no further ESIA required. Seven of the Sub-Activities that require construction of substations or distribution lines are classified as MCC Category B projects. These projects will have the potential to result in some level of environmental and social impacts; however, these impacts are likely to be site-specific and few if any will be irreversible. A fit for purpose ESIA focusing on the anticipated impacts will be required for the MCC Category B Sub-Activities.

2.3 Resettlement

Six of the Sub-Activities, all involving the construction of substations and/or distribution lines have the potential to require some level of resettlement. The remaining Sub-Activities will not require resettlement. A short summary of resettlement issues is provided in Section 4. The Resettlement Policy Framework (RPF) submitted concurrently with this report contains a detailed assessment of potential resettlement impacts, measures to reduce these impacts, and mitigation measures for those that are unavoidable. Because the locations and detailed design of the Sub-Activities potentially requiring resettlement have not been finalized, a precise estimate of resettlement needs cannot be prepared. However, various impact avoidance or mitigation measures can be taken to minimize the need for resettlement, including:

- Line routing to avoid highly developed areas
- Undergrounding of distribution cables where necessary
- Designing the distribution lines to minimize relocation requirements and damage to property.

By implementing these mitigation measures, the overall need for resettlement will be minimized. The distribution lines will primarily be located within the existing utility corridors along both sides of most public roads in Ghana. Therefore, it is anticipated that most resettlement will focus on either the temporary or permanent relocation of small businesses currently operating within the existing utility corridors.

2.4 Potential Impacts and Mitigation

Because of the nature of the proposed Sub-Activities, potential impacts will be relatively minor and should be mitigated effectively using standards international BMPs. Those Sub-Activities involving construction of Substations and transmission line may result in the following impacts and risks:

- Ground disturbance resulting in sedimentation and possible impacts to surface water drainages
- Soil and groundwater impacts from the improper disposal of construction related chemicals, sanitary waste, and oil and grease associated with equipment maintenance
- Temporary localized impacts to air quality and noise from transportation of workers and materials and operation of construction equipment
- Generation and disposal of wastes from site clearing, equipment packaging, and other small quantity sources
- As with any work-related activity, some level of potential worker health and safety risk associated with substation and distribution line projects through traffic accidents as well as injuries during installation of the new substation and distribution lines
- Short-term positive impacts on local economic activity and employment due to the need for construction and maintenance workers
- Temporary impacts to traffic and commercial, residential, or recreational land uses during construction activities.
- Risks to community health and safety related to construction hazards, possible interactions with construction workers, and safety issues associated with construction activities at the substation and along the distribution line ROWs.

All of these potential impacts can be effectively mitigated and should be addressed in the Sub-Activity-specific ESMP documents. NEDCo will develop an overall Environmental and Social Management System (ESMS) that envelops all of the individual Sub-Activities.

Because most distribution line construction will take place in existing utility corridors adjacent to public roads, only minimal impacts to soils, water quality, vegetation, wildlife habitats, critical habitat, protected species, and legally protected and internationally recognized areas are expected. Screening for these resources should be included as part of the further environmental screening of the substation sites and distribution line ROWs as part of finalization of the Sub-Activities.

The most important impacts associated with the various Sub-Activities are the potential need for resettlement and the disconnection and loss of electrical service by customers. As discussed in Section 4, resettlement may be required for those Sub-Activities that involve the construction and/or modification of distribution lines (see Table 2-1). Although the exact amount of relocation cannot be predicted based on current location and design information, a number of location and design options can be considered to minimize the overall need for resettlement. These mitigation measures should be used in the finalization of the design of the final selected Sub-Activities.

2.5 Overview of Energy Losses Due to Electricity Theft

Recent studies indicate that a considerable number of NEDCo customers are not legally connected to the electric system and are involved in the theft of electricity. A summary of the major findings regarding the theft of electricity is provided below.

The 2012 study on NEDCo Loss Control Units (LCUs), prepared by (Global Energy Consulting Engineers Private Limited, India, 2012) was conducted to assess losses from the NEDCo system due to the theft of electricity. The results of the study showed that the LCUs in each of the five regions served by NEDCo are first, not doing an adequate job detecting theft of electricity, and second, that reliable estimates of energy theft are not available. A similar study conducted for ECG showed a theft rate of 12.8%, it is likely that energy theft from NEDCo is similar to that experienced by ECG. A wide range of customer types were found to be involved with pilfering of electricity. The LCU study showed that the recovery of the estimated theft amount in 2011 ranged from a low of 2.14 percent in the Upper East Region to a high of 100% in Techiman Region. These results indicate that in three of the five regions which were able to recover 66.7% or more of the lost revenue due to theft, many of those who were stealing energy were in fact capable of paying their electric bill but chose not to. The major sources of energy theft were through meter by passing (81%) and meter tampering (19%). In a 2011 study of the urban poor by the World Bank, Energy Access and Productive Uses for the Urban Poor (World Bank, 2011), it was found that despite high access to electricity in the slums studied, only 46.2% of the households acquired their electricity connection directly and legally from NEDCo and thus had functioning electric meters. Many of the remaining 53.8% of the households were connected to their neighbors' electric meters, a phenomenon that is referred to in the slums as 'by-pass' and considered as illegal. A major reason for the illegal electricity connections was households' inability to provide building permits or police certification to make valid their applications for electricity connection from NEDCo. Other issues that are contributing factors to the elevated number of illegal connections include easy access to wires in the home that make it easy to connect lines up gradient of the electric meters (this is being addressed by the installation of new meters and normalization of service interconnections), lengthy wait times for legal connections, inability to pay for legal connections and the belief that the theft will not be caught or prosecuted.

The following Sub-Activity has the potential to result in customers with currently illegal connections to lose their service:

- NEDCo-Comm-03: Customer census and normalization of existing service connections

This Sub-Activity will involve NEDCo employees visiting customers and inspecting the existing electrical connections, modifying the connections, and installing prepaid meters. Through this process, some customers with illegal connections will be identified, and NEDCo's practice is to disconnect all illegal connections. Illegal connections may reflect theft of electricity or on-selling by one customer to another—in both cases, the existing connections will be terminated. This may present a financial burden for customers who may not be able to afford the reconnection fees.

Standard procedures used by NEDCo regarding illegal connections include disconnecting the line, imposing a requirement that the estimated value of the stolen electricity be paid back, along with a 50GHS penalty. It is anticipated that MCC and the Millennium Development Authority (MiDA) will work closely with NEDCo to develop an equitable procedure to address the needs of customers who suffer a termination of electrical service.

While it is clear that some individuals who engage in theft of electricity can afford to pay for the legal connection and the subsequent electric bill, there are other segments of the population who cannot. To minimize adverse impacts to the poor who could lose their current illegal access to electricity, MCC/MiDA will have to work closely with NEDCo to develop programs to increase access to legal connections at an affordable price. One of the proposed Sub-Activities, the installation of prepaid meters, will give customers better control over their electric use and payment schedule and should minimize the number of disconnections for lack of payment and subsequent additional fees for reconnection. The current use of lifeline tariffs, which provide subsidized electric rates for low volume users, will continue to help the poor with paying for their electric service. Other mitigating actions that can moderate the negative impact on poor customers who lose their electrical service due to illegal connections include:

- Development of an amnesty program where customers in an area can be informed of planned activities that could result in their loss of service due to illegal connections and provide the customers with the opportunity to come forward in advance of the activities and request a legal connection.
- The cost of new connections cud be subsidized for members of the community without the financial resources to pay for the full cost of the legal connection.
- Development of a public information program to explain the importance of having a legal and safe electrical connection and how this can be accomplished.
- NEDCo can improve their electrical connection installation service and schedule.
- Provide access to high efficiency electric bulbs and other common household appliances to help reduce overall electric consumption and overall household electric costs.
- Revise the documentation requirements for obtaining a legal connection to be more in line with documentation that is typically available to those customers with limited financial resources.

The above potential mitigation measures and others should be evaluated NEDCo, MiDA and MCC to finalize a set of actions that will assist those with limited financial resources to obtain legal electrical connections and pay for continuing electrical services without imposing significant financial burdens on NEDCo.

TABLE 2-1
Summary of Sub-Activity Characteristics and Potentially Important Impacts

Sub-Activities	Ghana EPA Categorya	MCC PS Categoryb	Potential Resettlement	Potentially Important Impacts
Activity: Institutional Support				
NEDCo-ICT-01: Communication Network	A	C	No	None
NEDCo-ICT-04: Data center at VRA or Sunyani	A	C	No	None
NEDCo-Comm-04: Enterprise customer information system and integration with existing enterprise applications	A	C	No	None
NEDCo-Service-01A: Construction of customer service centers	A	C	No	None
NEDCo-Service-05: Technical Assistance Program	A	C	No	None
NEDCo-Service-06: Technical Assistance Master Plan Development	A	C	No	
Activity: Commercial Losses Reduction and Collection Efficiency Improvement				
NEDCo-Comm-01: Service connection materials	A	C	No	None
NEDCo-Comm-03: Customer census and normalization of existing service connections	A	C	No	Potential customer disconnections
NEDCo-Engr-24: Metering at critical nodes of the distribution system	A	C	No	None
NEDCo-Service 02A: Procurement of vehicles, tools and equipment	A	C	No	None
Activity: Outages Reduction				
NEDCo-Engr-03A: Replace faulty and aging underground conductors Expansion	A	B	Yes	Possible resettlement for distribution lines
NEDCo-ENGR-29: Sectionalizing study of MV networks within NEDCo's territory	A	C	No	None
NEDCo-OPS-02: Procure operations and maintenance materials	A	C	No	None
NEDCo-OPS-03: Installation of outage reporting and call center system	A	C	No	None
Technical Loss Reduction				
NEDCo-Engr-07: Shield wire conversion to 34.5 kilovolt (kV) system Techiman-Abofour	B	B	Yes	Possible resettlement
NEDCo-Engr-08: Install Banvim primary substation with interconnecting sub-T lines, MV offloading circuits and low voltage (LV) network	B	B	Yes	Possible resettlement
NEDCo-Engr-09: Install Islamic primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	B	B	Yes	Possible resettlement
NEDCo-Engr-11: Install Fiapre primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	B	B	Yes	Possible resettlement

TABLE 2-1
Summary of Sub-Activity Characteristics and Potentially Important Impacts

Sub-Activities	Ghana EPA Categorya	MCC PS Categoryb	Potential Resettlement	Potentially Important Impacts
NEDCo-Engr-18: Reactive power compensation for primary substations and MV lines	A	B	No	None
NEDCo-Engr-19A: LV feeder bifurcation with MV upgrade	A	B	Yes	Possible resettlement
NEDCo-Engr-22: Update distribution construction standards	A	C	No	None

Note: *Both the Ghana EPA and the MCC have developed categorization schemes to classify projects according to their potential for causing environmental and social impacts. These categorization schemes also establish the level of impact analysis that is required for each category. The Ghana EPA and MCC categorization schemes are presented below.*

[a] Ghana EPA Categorization

Category A - This undertaking or development requires that the proponent fills out Form EA1. This category is used when the undertaking/development is unlikely to have significant negative environmental impacts. No EIA is required.

Category B - This category of undertaking or development requires that the proponent carry out a PEA after completing Form EA1 because the undertaking/development may have specific negative environmental impacts.

Category C - This category of undertaking or development requires that the proponent fill out Form EA2. This category is used when the undertaking/development is likely to have diverse and significant negative environmental impacts and the preparation of an EIA is mandatory.

Category D - Strategic Environmental Assessment (SEA). This is an environmental assessment process applied to national policies, plans, and programs by providing a framework within which important matters such as cumulative effects, greenhouse gas policies, conservation of resources, and issues of sustainability are taken into account. SEA is a two-stage EIA; the first stage is the overall environmental impact on the country and the second stage is a site-specific enquiry.

[b] 2012 MCC Environmental Guidelines Categorization

Category A - A project is classified as Category A if it has the potential to have significant adverse environmental and social impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. Category A, in principle, includes projects in sensitive sectors or located in or near sensitive areas. For Category A projects, MCC will require an ESIA in accordance with the 2012 MCC Environmental Guidelines as well as an ESMP, which describes the process of mitigating and managing adverse environmental and social impacts during the implementation of a project.

Category B - A project is classified as Category B if its potential environmental and social impacts are less adverse than those of Category A projects. Typically, these impacts are site-specific; few if any of them are irreversible; and mitigation measures are more readily available. For a Category B project, MCC requires specific environmental and social impact analyses, including ESMPs, as appropriate.

Category C - A project is classified as Category C if it is unlikely to have adverse environmental and social impacts. Although MCC generally will not require environmental and social impact analyses for a Category C project, MCC reserves the right to require specific environmental and social impact studies, reporting, or training where relevant or where positive environmental and social impacts may be enhanced.

Category D - A proposed project is classified as Category D if it will involve an intermediate facility (such as a municipal public grant fund) that will use MCC funding to finance subprojects that may potentially result in adverse environmental and social impacts.

SECTION 3

Regulatory Basis of Analysis

The following policies and legal and administrative framework were considered in preparing this ESIA:

- Ghana's Environmental Policy
- National Land Policy
- Resettlement and Compensation Policy
- The EPA Act of 1994 (Act 490)
- The EA Regulations (LI 1652) and EIA procedures
- Ghana EPA Environmental Impact Assessment Guidelines for the Energy Sector (Volumes 1 and 2)
- Local Government Act, 1993 (Act 462)
- IFC PSs on Environmental and Social Sustainability

An overview of the relevant policies and legal and administrative framework are presented below.

Ghana's Environmental Policy—The environmental policy of Ghana established in the National Environmental Action Plan (NEAP) of 1993 relies heavily on prevention as the most effective tool for environmental protection. The NEAP is directed at the sound management of resources and environment, and the mediation between economic planning and environmental resources utilization for sustainable national development. It also seeks to institute environmental quality control and sustainable development programs by requiring prior environmental assessments for all proposed developments, and to provide appropriate measures to protect critical ecosystems, including flora and fauna, against harmful impacts, nuisances, and other destructive practices. The adoption of the NEAP led to the enactment of the EPA Act 1994 (Act 490), and subsequently the passing of the Ghana EIA procedures into the EA Regulations, 1999 (LI 1652).

The EPA Act—The EPA Act of 1994 (Act 490) grants the agency enforcement and standards-setting powers, and the power to enforce compliance with the Ghana EA requirements/procedures. Additionally, the agency is required to create environmental awareness and build environmental capacity as it relates to all sectors. The EPA (including its regional and district offices) is also vested with the power to determine what constitutes an adverse effect on the environment or an activity posing a serious threat to the environment or public health. The agency also has the authority to require the preparation of EAs, environmental management plans, and other documentation for an undertaking, and to regulate and serve enforcement notice for any offending or non-complying undertaking. The agency is required to conduct monitoring to verify compliance with approval/permit conditions, required environmental standard compliance, and mitigation commitments.

EA Regulations and Procedures—The EA regulations address both EA procedures and environmental management systems. The regulations prohibit beginning an undertaking/activity without prior registration and environmental permit (EP). Undertakings are grouped into schedules for ease of screening, registration, and permitting. The schedules include undertakings requiring registration and EPs (Schedule 1), EIA mandatory undertakings (Schedule 2), as well as Schedule 5 relevant undertakings (in environmentally sensitive areas).

The EA regulations also define the relevant stages and actions, including registration, screening, preliminary environmental assessment, scoping and terms of reference, EIA, review of EA reports, public notices and hearings, environmental permitting and certification, fee payments, environmental management plans, suspension/ revocation of permit, complaints/appeals, etc.

EA (Amendment) Regulations, 2002—The EA (Amendment) regulations were passed to amend sections of the EA fees regime of LI 1652 (the principal enactment) on fee payment for EPs and certificates issued by the agency.

Land Acquisition and Compensation Laws—Acquisition of land for infrastructure projects is regulated by the Lands (Statutory Wayleaves) Act of 1963 Act 186 (Vide Section 1, 2(1) and 2, 6 (1-5). A wayleave instrument contains a description (with measurements) of the land affected by the statutory wayleave, together with a plan showing the location of the works. A copy of a wayleave instrument is served on the owner or occupier of the land affected by the statutory wayleave. Under Section 6(1) of the Act, any person who suffers any loss or damage as a result of the construction, maintenance etc., shall be entitled to compensation. A claim for compensation shall in the prescribed form not more than 3 months after the date of declaration made by the President under Section 1 of the Act. The relevant legal and regulatory provisions include:

- The Constitution of the Republic of Ghana, 1992
- The State Lands Act, 1962
- The Lands (Statutory Wayleaves) Act, 1963
- Land ownership may be categorized into the following two main groups:
  - Customary land comprising stool and family lands
  - Public land comprising state and vested lands

MCC Environmental and Social Policies—MCC's environmental and social performance team works with partner countries to integrate internationally accepted principles of environmental and social sustainability into the design and implementation of compacts. MCC recently amended its environmental guidelines to formally adopt the IFC PSs on Environmental and Social Sustainability as part of continuing efforts to enhance the sustainability and effectiveness of MCC compacts and improve standards for managing environmental and social risks.

The IFC (part of the World Bank Group) established its PSs to address potential environmental, social, health, and safety issues associated with project development. The PSs became effective on April 30, 2006, and were revised in 2012. The PSs serve as the basis of review of projects by the MCC and other financial institutions and also serve as the basis for the Equator Principles. The IFC also published *Guidance Notes: Performance Standards on Social and Environmental Sustainability* (January 1, 2012) as a companion document with detailed interpretive guidance on the requirements of each individual standard.

The PSs provide a framework for the design, construction, and operations of projects that are environmentally and socially acceptable, and provide measures to prevent, mitigate, or compensate adverse environmental and social impacts of projects. The PSs focus on outcomes rather than processes and require the implementation of robust ESMS by NEDCo. There are eight PS, describe in more detail below:

PS 1—Assessment and Management of Environmental and Social Risks and Impacts, covers social and environmental impact assessment and management (for example, the social and environmental management system for the project that is the main operational output of the ESIA).

Objectives are to:

- Identify and evaluate environmental and social risks and impacts of the project.
- Adopt mitigation to avoid, minimize, or compensate/offset for risks and impacts to workers, affected communities, and the environment.
- Promote improved environmental and social performance of clients through the effective use of management systems.
- Respond to and appropriately manage impact assessment scoping concerns and grievances from affected communities and external communications from other stakeholders.
- Promote and provide means for adequate engagement with affected communities throughout the project cycle and disclose and disseminate relevant environmental and social information.

PS 2—Labor and Working Conditions, covers compliance with local and international labor standards and worker health and safety.

Objectives are to:

- Promote fair treatment, non-discrimination, and equal opportunity of workers.
- Establish, maintain, and improve the worker-management relationship.

- Promote compliance with national employment and labor laws.
- Protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain.
- Promote safe and healthy working conditions, and the health of workers.
- Avoid the use of forced labor.

PS 3—Resource Efficiency and Pollution Prevention, covers pollution prevention and abatement, including greenhouse gases, other potential trans-boundary effects, and emergency response.

Objectives are to:

- Avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities.
- Promote sustainable use of resources, including energy and water.
- Reduce project-related greenhouse gas emissions

PS 4—Community Health, Safety, and Security, covers potential effects on nearby communities, including introduction of crime, disease (for example, imported workers/workers camps), pollution, project-triggered events (such as tailings dam failures), and interactions with project security guards.

Objectives are to:

- Anticipate and avoid adverse impacts on the health and safety of the affected communities during the project life from both routine and non-routine circumstances.
- Safeguard personnel and property in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the affected communities.

PS 5—Land Acquisition and Involuntary Resettlement, covers the acquisition of land for proposed projects.

Objectives are to:

- Avoid, and when avoidance is not possible, minimize displacement by exploring alternative project siting, routing and/or designs.
- Improve, or restore, the livelihoods and standards of living of displaced persons.
- Improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.

PS 6—Biodiversity Conservation and Sustainable Management of Living Natural Resources, covers species of concern, habitat, and ecosystem services. The application of PS 6 can require significant effort, including detailed critical habitat/population biology assessments and possibly biodiversity offsets.

Objectives are to:

- Protect and conserve biodiversity from threats such as habitat destruction and invasive alien species.
- Maintain the benefits from ecosystem services.
- Promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.
- Emphasize biodiversity and protection of critical habitat and endangered or threatened species.

Ecosystem Services:

- Provisioning services may include food, freshwater, timber, fibers, and medicinal plants.

- Regulating services may include surface water purification, carbon storage and sequestration, nutrient cycling, disease regulation, climate regulation, and protection from natural hazards.
- Cultural services may include natural areas that are sacred sites and areas of importance for recreation and aesthetic enjoyment.
- Supporting services may include soil formation, nutrient cycling, and primary production.

PS 7—Indigenous Peoples, recognizes indigenous people as social groups with identities that are distinct from mainstream groups in national societies and provides for special consideration of their status and needs in project review.

Objectives are to:

- Ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of indigenous peoples.
- Anticipate and avoid adverse impacts of projects on communities of indigenous peoples, or when avoidance is not possible, minimize, mitigate, and/or compensate for such impacts.
- Promote sustainable development benefits and opportunities for indigenous peoples in a culturally appropriate manner.
- Establish and maintain an ongoing relationship based on informed consultation and participation with the indigenous peoples affected by a project throughout the project's life cycle.
- Ensure the free, prior, and informed consent of the directed affected communities of indigenous peoples when the circumstances described in this PS are present.

PS 8—Cultural Heritage, covers built and other types of cultural heritage, its protection and conservation, and equitable sharing of benefits from potential business activities.

Objectives are to:

- Protect cultural heritage from the adverse impacts of project activities and support its preservation.
- Promote the equitable sharing of benefits from the use of cultural heritage.
- In addition to the PS listed above, the MCC screening process also incorporated the World Bank's general and industry specific environmental health and safety (EHS) guidelines.

SECTION 4

Resettlement Overview

4.1 Overview

For these reasons, project-specific Resettlement Action Plans (RAPs) for physical displacement and procedures to compensate for economic displacement cannot be prepared at this stage. Therefore, an RPF[1] has been prepared to specify how resettlement and compensation planning and implementation would proceed where avoidance of displacement is impossible, once individual projects are selected and designed. A summary of key points from the RPF is presented below.

In accordance with the requirements of PS 5, Land Acquisition and Involuntary Resettlement, the RPF addresses all involuntary resettlement activities, including those that result from damage to property caused by construction activities integral to project implementation. These types of damages will lead to a temporary disruption of business operations that are capable of reinstatement and will require neither relocation nor permanent changes in land use.

Compact activities may also give rise to shorter-term disturbances to business operations and household activities.[2] These types of disturbances will be identified and managed by applying the requirements of PS 1, Assessment and Management of Environmental and Social Risks and Impacts, and PS 4, Community Health, Safety, and Security. As such, measures to mitigate these types of disruption are included in the ESMP presented in Section 10 of this Appendix.

All Compact II Sub-Activities were screened for their potential involuntary resettlement impacts. Once the institutional and capacity building Sub-Activities had been screened out, seven Sub-Activities were identified as potentially requiring involuntary resettlement. These Sub-Activities involve the construction or modification of substations and distribution lines. Distribution lines are typically located within existing 6-m-wide utility corridors situated on both sides of most public roads in Ghana. The utility corridors provide opportunities to maintain multiple linear utility facilities within a single ROW as well as reducing potential impact on private land.

In theory, ROWs should be unencumbered—i.e., free from structures. In practice, it is common along many of Ghana's busy streets for vendors and shops to be located in structures that encroach into the utility corridors. These structures are of two general types: converted steel shipping containers and temporary structures made out of wood or other impermanent materials. However, few permanent structures are located within ROWs. Some of these businesses are legal in that they have received licenses from the local municipality, and some have not. One of the conditions of the licenses for operating within the utility corridors is that the license owner acknowledges that the license is temporary and the businesses may need to be relocated if the corridors are needed for the placement of utilities such as distribution lines. These relocations can be either temporary or permanent. In most cases, people do not live within the utility corridors and therefore, most of the involuntary resettlement requirements associated with the distribution Sub-Activities will involve economic displacement and not loss of shelter. More detail on these potential impacts is contained in Section 7, with full details provided in the RPF.

The level of involuntary resettlement required for the NEDCo Sub-Activities will ultimately depend upon the final location of the various proposed Sub-Activities, the existing level of development within the utility corridors and surrounding areas, and the technical design of the Sub-Activities. Sites for two of the sub-stations (Banvim and Islamic Center) but the site for the third (Fiapre) have yet to be identified. The specific routes for the interconnecting 11-kilovolt (kV) and 34.5-kV distribution lines have yet to be identified; therefore, the level of involuntary resettlement is uncertain at this time. The routes for other distribution line construction and

1 Submitted concurrently with this report. The RPF contains considerably more detail on all aspects related to resettlement, and the interested reader should refer to this document if he or she requires additional information.

2 Examples are the need for temporary health and safety buffers around some construction activities that could cause minor, short-lived (e.g., in the order of a few minutes to a couple of hours) disruptions,

modification Sub-Activities have likewise yet to be established. Therefore, even though the individual Sub-Activities that have the potential for involuntary resettlement can be identified, the level of resettlement cannot. It is important to note, however, that it is a policy of NEDCo to locate and design its distribution lines in a manner that minimizes potential resettlement impacts to the local communities.

4.2 Guiding Principles and Objectives

In 2012, MCC amended its environmental guidelines to formally adopt the IFC PSs on Environmental and Social Sustainability as part of continuing efforts to enhance the sustainability and effectiveness of MCC compacts and improve standards for managing environmental and social risks. The resettlement principles and objectives contained in the RPF are thus governed by the requirements of IFC PS 5, Land Acquisition and Involuntary Resettlement. The over-arching objectives of PS 5 are summarized as follows:

- Minimize and mitigate impacts of involuntary resettlement on affected persons resulting from the implementation of the MCC Ghana Compact II.
- Ensure that people who are adversely affected are fully compensated and successfully resettled; the livelihoods of displaced people are re-established; and that their standard of living is, wherever possible, improved.
- Prevent the impoverishment of affected persons as a consequence of compulsory land acquisition or loss of livelihood for purposes of implementing these Sub-Activities.
- Make certain that all affected persons are informed of the process and aware of procedures for expressing grievances that are accessible and responsive.
- Provide needed additional assistance for vulnerable groups, such as women-headed households.
- Provide full and accurate information about the project, and afford potentially affected person (PAPs) meaningful opportunities for participation in design, implementation and monitoring.

These objectives will be achieved for Compact II through the application of the following guiding principles:

- Minimize involuntary resettlement through a combination of: (i) ensuring that design engineers incorporate the need to minimize involuntary resettlement into the design process; (ii) introducing flexibility into design standards for ROWs and the land required for sub-stations; (iii) placing new distribution lines within existing utility corridors to the extent practicable; and (iv) holding frequent meetings between the design and resettlement teams, and discussions with affected persons.
- Implement an inclusive approach to entitlements that includes compensation and other assistance for those with no legal land occupancy right as well as those with legal or recognized customary title to their land and those with land use rights.
- Compensation for land that will be lost will be at full market value, and assets at full replacement value.
- Provide cash compensation and/ or in-kind assistance, including relocation sites where economically feasible, that best suits the needs of affected persons commensurate with the extent of the impacts that they will experience.
- Provide disturbance payments to mitigate the impact on the livelihoods of affected persons having to relocate their residence and/or business.
- Implement measures to restore the livelihoods of affected persons who will be unable to maintain their current standard of living immediately following relocation.
- Implement additional measures to address the relocation needs of vulnerable groups.
- Maintain a continual process of consultations, disclosure, and negotiations with affected persons throughout the entire resettlement process, including establishing an accessible and transparent grievance redress procedure.

- Have a clear and transparent process for the disbursement of any monetary compensation and ensure that all persons having to relocate receive their compensation before they have to vacate their land or property.

These principles, along with other policies contained in the RPF, will be adopted during the preparation and implementation of the RAPs that will be required for each Compact Sub-Activity involving involuntary resettlement (see Section 10). This is not to say that those preparing RAPs will not have the flexibility to make amendments to RPF policies and guidelines (e.g., institutional arrangements and implementation processes and monitoring requirements) in the light of each Sub-Activity's resettlement characteristics.

4.3 Minimizing the Need for Resettlement

Of the objectives listed above, the most important is the minimization of involuntary resettlement. Based on the initial assessment undertaken for Compact II, the principal resettlement impacts will arise from:

- The removal of structures, residential and business, from existing ROWs in urban areas for new distribution lines.
- The relocation of non-owners, such as residential and business tenants and employees, from urban ROWs.
- The creation of new wayleaves over agricultural land for new transmission lines and land for the siting of poles.
- Permanent acquisition of land parcels for new sub-stations – typically up to 0.5 hectare (ha), but ranging from 0.2 ha to 1 ha.
- Temporary disturbance during construction that will entail some damage to property and restrictions on business operations in the ROW. Apart from the rare cases when relocation is necessary, the physical damage will be capable of being repaired. The periods of disturbance will vary widely depending on the nature of the operations – from under an hour for line-stringing to a few hours for pole operations, and up to 2 to 3 months for installing underground cables. During most periods of disturbance, establishments will be able to remain in operation. These impacts will be the most widespread in that they will affect the greatest number of people.

These potential impacts can be minimized in a number of ways, including:

- Selecting routes within the existing designated 6-m-wide utility corridors.
- Adopting flexible design standards: current practice in Ghana is that formal requirements for fully clearing the ROWs for 11 kV and 440 volt (V) transmission lines are waived where these would give rise to involuntary resettlement. Likewise, not imposing the 2-m setback for conductors where these pass over temporary structures.
- The flexible routing of trenches: (i) using less-encumbered roads; (ii) using the less-encumbered side of a road; (iii) switching the trench alignment between the front and rear of roadside structures; (iv) putting the trench in a conduit that runs under structures; and (v) shifting existing structures within the existing land parcel, thereby enabling current occupants to remain in their current location and avoiding their permanent relocation.
- Replacing existing lines and poles, which exist on most roads, instead of creating new alignments.
- Varying pole spacing to avoid concentrations of establishments and switching the alignment from one side of the road to the other.
- Designing the distribution structures, cross arms, and conductors to minimize the area needed to increase clearance from existing structures.
- In cases where distribution lines must cross a congested area, installing the line underground, thereby minimizing impacts to existing structures.

- Selecting sites for sub-stations that are vacant or under-used and reducing the area required as much as possible.
- With respect to easements over agricultural land, the same general principles apply, such as siting transmission lines along existing ROWs and avoiding more-productive land areas. Construction can also, on occasion, be timed to coincide with the cultivation cycle so that land is taken after the harvest season. These impacts are, in any case, transitory because once the transmission lines have been erected and the land reinstated, cultivation can resume.

Adopting the above practices, when taken together, can substantially reduce the need for involuntary resettlement associated with the construction or modification of distribution lines. However, the most important point is that, with the possible exception of the design of distribution structures, all the above are already current practice for NEDCo engineers because they are well aware of the potential difficulties and costs that would result from removing existing structures from utility corridors.

These standard practices, which all serve to reduce involuntary resettlement, will be further strengthened by ensuring that project resettlement experts work with the design teams during the preparation of the final designs for each Sub-Activity.

With respect to temporary disturbance, the following specific measures shall be adopted:

- Phasing trench-digging and cable-laying in such a way that the period of disturbance is decreased—e.g., minimizing the period when there will be an open trench and providing temporary access across the trench for this period (or temporary backfilling); reducing, as far as possible, the gap between trench digging and cable-laying; and ensuring a high level of reinstatement where trenches have damaged hard standings and other ancillary structures.
- Whenever feasible, employing mechanical methods to dig holes and erect poles for overhead lines.
- Providing timely information to ROW occupants on: (i) the day on which construction activities will take place; (ii) the time of day when these operations will occur; (iii) the type of activities that will take place; and (iv) any precautionary measures that ROW occupants will need to take.
- When appropriate, providing assistance to vendors in identifying and occupying temporary selling locales during periods of disturbance.
- Adopting appropriate measures to reduce the spread of dust.
- Ensuring that a safety officer is on hand to warn occupants when their movements need to be restricted.
- The implementation of these measures will be managed under the requirements of the ESMP presented in Section 10 of this Appendix.

Collectively, these measures have the potential to substantially reduce the need for involuntary resettlement from Compact II Sub-Activities. This is a different situation from many projects where design constraints limit the potential for reducing resettlement in this way.

4.4 Gap Analysis

The requirements of IFC PS 5 summarized in the previous subsection are compared below to the current provisions for land acquisition and compensation provided under the Ghanaian law summarized in earlier subsections.

The principal findings from this analysis are as follows:

- Ghanaian legislation covers several of the requirements of IFC PS 5: an acceptance that those losing land or property should be properly compensated; compensation is valued at replacement value; additional allowances for ‘disturbance’ and other impacts resulting from involuntary resettlement may be provided; notification of compulsory purchase is required; redress is provided through the legal system; and limited consultation procedures are required. There is no explicit requirement to minimize involuntary resettlement, although there is little incentive for design teams not to do so given that unresolved resettlement issues can seriously delay projects and add to their cost.

- There are significant gaps between the law and the requirements of IFC PS 5. The most important of these is that under current GoG legislation, those who do not have a legal (or customary) right to land are not entitled to any compensation for lost property or assets. These groups, who would therefore not qualify for compensation, include squatters (including occupiers of ROWs) whether residential or business, renters, and employees of affected enterprises.
- There are no provisions for additional measures to aid livelihood recovery or for increased assistance to vulnerable groups.
- ~~R~~equirements for consultations with affected persons and other stakeholders, disclosure of relevant documents, and grievance redress procedures fall well short of IFC PS 5 requirements. Act 125 has no provision for public consultation and involvement in the acquisition process - although some provision does exist within the environmental legislation and there is no provision for grievance redress outside recourse to the legal system.
- There is no legal requirement to prepare RAPs or to undertake monitoring of the resettlement process.

Given that adherence to IFC PS 5 is a requirement of the MCC, this RPF therefore requires that the executing authorities (NEDCo) do not rely solely on current legislation but must satisfy the requirements of PS 5, especially in relation to the provision of compensation to those without a legal entitlement to the land they are occupying and in the preparation and implementation of RAPs. In this context, it should be noted that recent projects financed by the World Bank and the MCC have incorporated provisions related to these legislative gaps to ensure compliance with World Bank Operational Policy 4.12 or IFC PS 5. These include additional assistance to squatters, enhanced consultation, disclosure and grievance procedures: "as a result of the compliance with WB OP 4.12, PAPs are involved in resettlement through public hearings and forums; they are given compensation at open market value and those previously considered as squatters receive supplementary assistance to help them relocate".[3]

There are therefore precedents for the full adoption of IFC PS 5, which means that compliance with PS 5 is unlikely to be a controversial issue when addressing resettlement impacts arising from MCC Compact II Sub-Activities.

It should be noted that adherence to IFC PS 5 does not preclude compliance with statutory legislative requirements relating to the compulsory purchase of land by GoG.

4.5 Resettlement Planning and Implementation

Resettlement impacts resulting arising from Compact II Sub-Activity Descriptions (SADs) will be planned and implemented according to the requirements of PS 5, which are set out in the RPF. The RPF establishes the general policies and procedures that will be adopted for all resettlement activities and provides the specification for the RAPs that will be prepared for individual SADs or groups of similar schemes, such as sub-stations, underground cables, or overhead lines. The RAPs will provide the basis for implementing resettlement activities.

The RPF contains, in summary, the following:

- <u>Entitlements</u>: The rights to compensation for PAPs experiencing different types of loss, such as land, structures, or business location, as well as temporary disruption to business operations. Entitlements are based on three over-arching principles of PS 5: (i) physical losses should be compensated at full replacement value; (ii) PAPs will receive compensation irrespective of their legal right of occupation of the affected land;

3 MCC, 2009, *Resettlement Action Plan for Upgrading of the N1 Highway between Tetteh-Quarshie Interchange and Mallam Road Junction,* and Volta River Authority, 2007*, Land Acquisition & Resettlement Policy Framework - Ghana Energy Development and Access Project.*

and (iii) compensation for loss of income during periods of relocation or temporary disruption to their activities.

- Consultations and participation: Required consultation procedures to ensure that PAPs are adequately and effectively involved throughout the resettlement process.
- Establishment of a Grievance Redress Mechanism (GRM) to ensure that PAPs have a means of redress should they consider the compensation offered to be insufficient to cover their losses.
- Implementation arrangements: Agencies involved (e.g. MiDA, NEDCo, Land Valuation Division); institutional arrangements (resettlement teams and oversight committees; staffing and training requirements.
- Specification of a monitoring and evaluation system designed to: (i) report on the progress of RAP implementation; and (ii) to ensure that PAPs are able to regain pre-project incomes and living standards.
- Procedures for the valuation of assets, negotiating and agreeing on compensation and in-kind assistance packages with PAPs, disbursing compensation, and site vacation.

Unless there are site-specific considerations that dictate otherwise, the policies contained in the RPF relating to the above will be adopted for all Compact II resettlement activities. In relation to RAP preparation, the RPF sets out the requirements for RAP preparation and content. In summary these are:

- Measures undertaken to minimize resettlement.
- Undertaking the census and inventory of assets that identifies: (i) the numbers and characteristics of PAPs; (ii) the extent of their losses; and (iii), where appropriate, options for cash and in kind assistance.
- Collection of information needed to establish unit costs for all relevant types of compensation.
- Preparation of PAP compensation packages.
- Resettlement cost estimate and implementation program.
- Schedule of consultations held.

SECTION 5

Environmental Health and Safety Institutional Capacity

NEDCo is a subsidiary of Volta River Authority (VRA), having been formed on May 8, 2012 out of the Northern Electricity Department of VRA. The Northern Electricity Department itself was established as a subsidiary of VRA in April 1987 when the northern electricity distribution operations of the then Electricity Corporation of Ghana were ceded to the VRA. Currently, there are no NEDCo personnel with responsibility for environmental, social, or health and safety issues and management. These services, when needed, have historically been provided through VRA's staff, policies and procedures. Although VRA has the necessary EHS instructional capacity to support the proposed NEDCo Sub-Activities, formal arrangements will need to be made with the oversight of MCC to properly address all necessary environmental, social health and safety issues. A summary of VRA's environmental, safety and health policies is provided below.

The VRA Corporate Environmental Policy Statement commits the organization to continuous improvement of environmental performance and to minimizing the impacts of all its operations on the environment, in line with the principles of sustainable development, in addition to complying with national and international environmental protection regulations.

The VRA Safety Policy commits the organization to making safety a primary concern throughout the organization in its activities and operations. It also seeks to achieve an acceptable standard of safety for its employees by effectively managing all risks resulting from or associated with its activities and operations. The VRA Safety Policy provides for measures to be taken to secure and maintain compliance with all relevant legislation on environmental protection and safety and the health and welfare of all its employees.

Safety rules, protection code, and safe working practice documents have subsequently been prepared to inform, educate, and ensure adherence. The VRA's safety rules provide information on major safety areas as follows:

- General safety rules for workers engaged in construction, operation, or maintenance work
- Safety guidelines relating to the use of tools and equipment
- Safety procedures associated with the transportation and of personnel and materials
- Safety procedures relating to forestry work
- Safety procedures relating to transmission line work
- Safety procedures for materials handling, storage, and disposal

The VRA Corporate Health Policy statement commits the organization to establishing and maintaining health standards, facilities, and services to promote and safeguard the health, well-being and safety of the organization's employees, their families and dependents, as well as others who may be affected by its operations.

SECTION 6

Description of Sub-Activity Components

This section presents an overview of the seven types of Sub-Activity components with the potential to result in environmental and social impacts and potentially require resettlement. A map of the Sub-Activities with the potential to result in environmental and social impacts, including resettlement, is presented in Figure 6-1. A description of each of the Sub-Activity components and an overview of the site/route selection practices is provided in the following subsections.

6.1 Sub-Activity Descriptions

The Sub-Activities that have the potential to result in some level of environmental and social impacts and that may require resettlement will have one or more of the following components:

- Primary substations
- Underground cables
- Sub-transmission lines
- MV distribution lines
- LV distribution lines
- LV feeder bifurcation
- Shield wire conversion

A brief description of each of the above seven components is provided below.

6.1.1 Primary Substations

The primary substations currently serving the NEDCo service territory will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the BSP substations, primary substations will be installed at key points in the NEDCo distribution system. As part of the functioning of the NEDCo distribution system, the electricity injected at the BSP substations will be transformed at the primary substations from 34.5 kV to 11 kV levels for distribution to customer areas. A final step down to 440 V is accomplished by transformers located on distribution poles located at or near individual customer connection points.

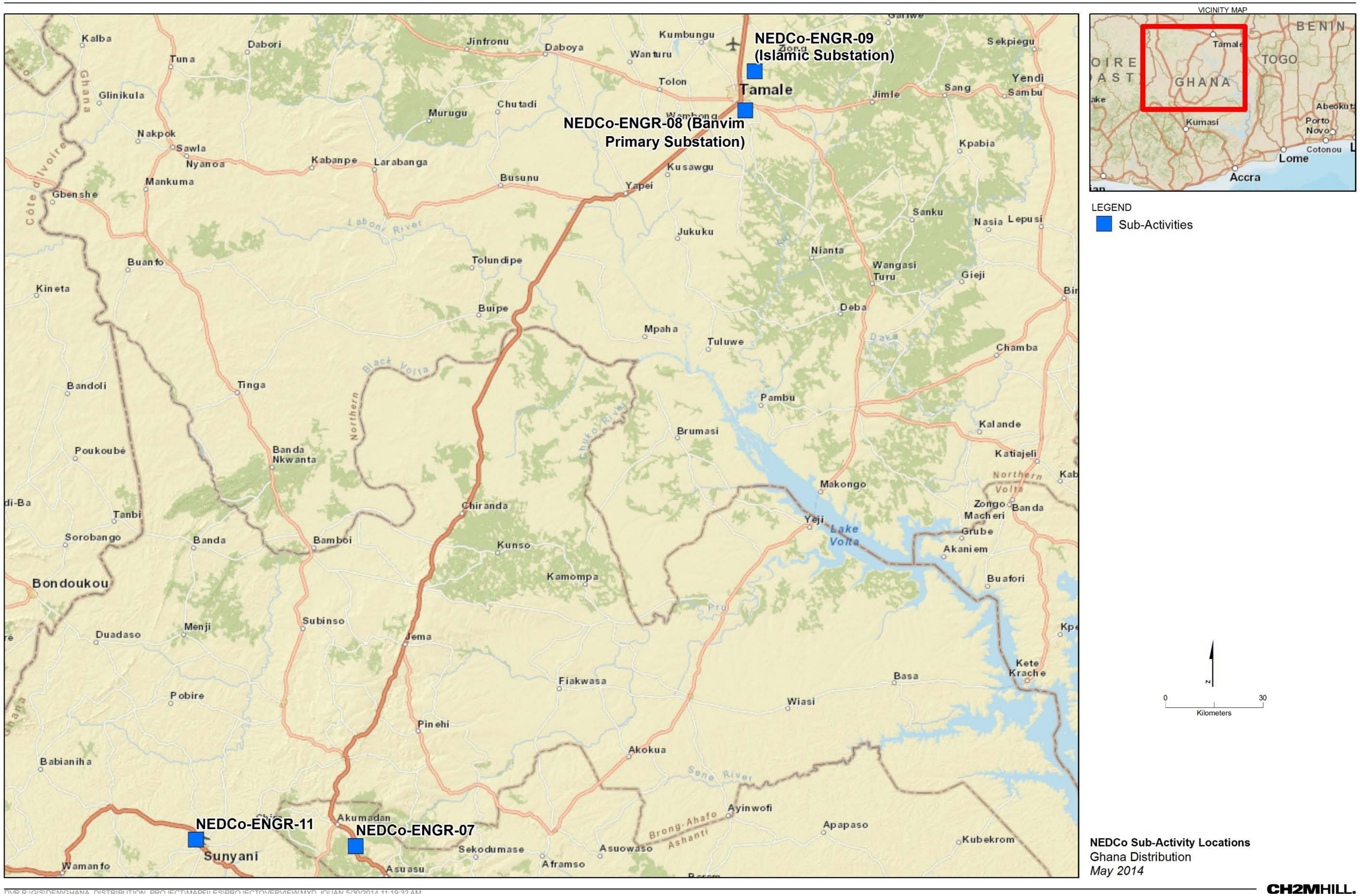
A contractor will be hired to build the primary substations that conform to NEDCo's and standard substation design. The primary substations will have a footprint of up to approximately 100 by 100 feet and will include matched transformers, a switch yard, capacitor banks, and a control house within the fenced perimeter of the substation. The primary substations will also include the incoming sub-transmission lines and outgoing MV distribution lines that extend for distances ranging from 500 m to multiple kilometers (km) to a point where they will interconnect with existing NEDCo substitutions or lines.

6.1.2 Underground Cable

NEDCo SAD3A involves the replacement of faulty and aging underground conductors covering around 30 km of cables in the towns of Sunyani, Techiman, Bolgatanga, and Tamale.

For economic reasons, overhead lines are used extensively for the transmission and distribution of electricity in rural areas where environmental or practical considerations do not dictate otherwise. However, in urban areas, it is common to install insulated cables, which primarily are buried underground. Underground cables can be used for both MV and LV lines in locations where overhead distribution lines are not feasible or would result in unacceptable impacts to existing land uses. Underground lines have the advantages of presenting no visual impacts once installation is complete, increasing flexibility in routing in densely populated area, and requiring a narrower surrounding ROW than overhead lines. Underground cables do, however, have a higher cost than overhead lines.

FIGURE 6-1
NEDCo Sub-Activities with the Potential for Environmental and Social Impacts



Underground cables typically have a plastic insulation layer and can be installed as a direct buried line or one that is installed in a buried conduit. With the direct bury method, the insulated cable is placed directly in a trench and then covered with soil. When using a conduit, first a conduit, typically made of polyvinyl chloride measuring 100 millimeters (mm) or 125 mm diameter, is laid in the trench and then the insulated conductor is pulled through the conduit and connected to surface structures. Both methods are used by NEDCo. Typical standard and minimum installation depths used for underground cable are presented below (Table 6-1).

TABLE 6-1
Standard and Minimum Installation Depths Used for Underground Cable

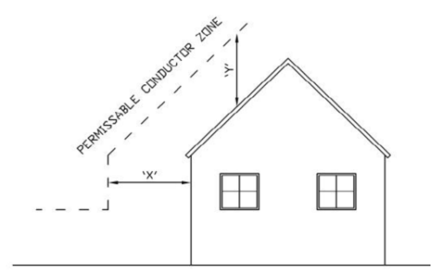
Voltage	Relevant SADs	Installation Depth Standard	Installation Depth Minimum
34.5 kV	NEDCo SAD 3A	1,100 mm	900 mm
11 kV		900 mm	800 mm

Note: No undergrounding of LV cables is currently envisaged for any of the Compact II SADs.
Source: *Ghana Energy Development Access Project Distribution Design Manual*, 2013.

6.1.3 Sub-Transmission Lines

Sub-transmission lines are used to move power between two substations at a voltage of 34.5 kV. Sub-transmission lines consist of steel lattice towers, cross bars, insulators and conductors. The standard ROW width for sub-transmission lines is 15 m, 7.5 m on each side of the centerline; the required setback from nearest structures is 2 m horizontal. There is no approved vertical setback, therefore these lines cannot be constructed over existing structures (see Figure 6-2).

FIGURE 6-2
Horizontal Vertical Setback Standards



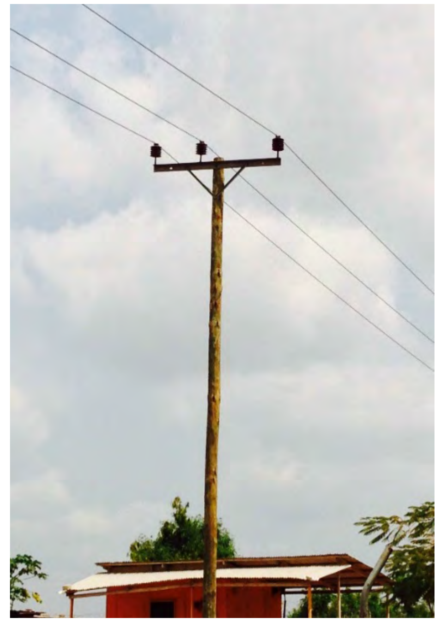
The standard and maximum span distances between sub-transmission structures are 170 m and 200 m respectively. The height of sub-transmission structures will be a minimum of 14 m, and the maximum height will depend on site-specific conditions and topography. Sub-transmission structures will erected on concrete foundations approximately 1 to 2 m in diameter. Most of the foundation will be buried, with areas for bolting on the tower exposed above grade (see Figure 6-3). Following erection of the tower, the cross bar and insulators are installed and the conductors pulled from one structure to the next.

FIGURE 6-3
Foundation Construction and Base of Steel Lattice Tower

6.1.4 MV Distribution

MV distribution lines are used to move power at 34.5/11 kV from one area of the distribution system to another. MV lines consist of wood poles, cross bar, insulators and conductor. A representative wood pole MV line is presented in Figure 6-4. The standard ROW width for MV lines is 10 m, 5 m on each side of the centerline; the required setback from nearest structures is 2 m horizontal. There is no approved vertical setback; therefore, these lines cannot be constructed over existing structures.

FIGURE 6-4
Typical Wood Pole MV Distribution Line

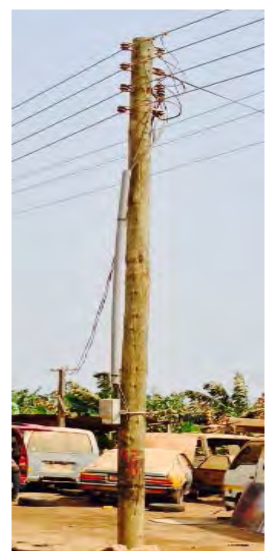


The standard and maximum span distances between structures are 100 and 120 m, respectively. The height of MV structures range from 11 to 14 m above ground, but actual heights will depend on site-specific conditions and topography. MV poles typically are buried directly in the ground without a concrete foundation. An excavation of appropriate depth is either dug by auger or by hand; then the pole is placed in the excavation and the native soil is backfilled and packed. Following erection of the pole, the cross bar and insulators are installed and the conductors pulled from one structure to the next.

6.1.5 LV Distribution

LV distribution lines are used to move power at 440 volts to provide service to customers. LV lines consist of wood poles, cross bar, insulators and conductors (see Figure 6-5). The standard ROW width for LV lines is 5 m, 2.5 m on each side of the centerline; the required setback from nearest structures in 2-meters horizontal. There is no approved vertical setback for LV lines.

FIGURE 6-5
Typical LV Distribution Line

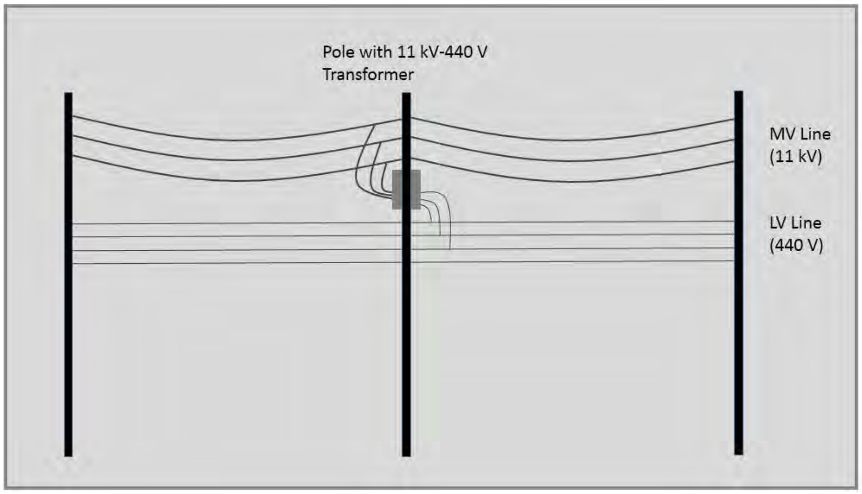


The standard and maximum span distances between LV structures are 46 and 50 m, respectively. The height of LV structures is from 8 to 10 m above ground, actual heights will depend on site-specific conditions and topography. LV poles typically are buried directly in the ground without a concrete foundation. An excavation of appropriate depth would be dug either by auger or by hand; then the pole is placed in the excavation and the native soil is backfilled and packed. Following erection of the pole, the insulators are installed and the conductors pulled from one structure to the next.

6.1.6 LV Feeder Bifurcation

When LV lines are long and heavily loaded, their losses can result in drops in voltage and other service problems. The objective of this Sub-Activity is to reduce the length of the LV circuits (segmenting a large circuits into multiple smaller ones) so that the LV trunk lines do not exceed a length that affects the quality of service to the customer and a technical loss threshold on the distribution system. To accomplish this objective, segments of 11 kV line will be constructed on the same poles as the existing LV lines (see Figure 6-6). Because both circuits will be located on the same wood pole, the existing poles will need to be replaced with taller poles, generally in the same location. The old poles will be either recycled or disposed of. Step-down transformers will be located on the same poles as the MV and LV lines and will serve to lower the 11 kV MV to 440 V LV for service to customers.

FIGURE 6-6
Low Voltage Bifurcation



NB. Figure not drawn to scale, for illustrative purposes only.

6.1.7 Shield Wire Conversion

A shield wire is typically a coaxial a wire connected directly from the top of one transmission structure to another to protect conductors from a direct lightning strike, thereby minimizing the possibility of power outages. In the past, NEDCo has served some rural villages with single-phase power supplied via the shield wire on a GRIDCo transmission line to communities adjacent to transmission corridors. The existing transmission line shield wire has exceeded its designed capacity, which has been causing outages at peak hours due to the protection relay on the line tripping the breaker.

This Sub-Activity will discontinue the use of the transmission line shield wire for distributing power and will involve the construction of a new MV distribution line along the Kumasi-Techiman highway from the existing Techiman BSP substation to the town of Abofour. The new MV line will be built using three-phase distribution on wooden poles. This conversion will improve electricity supplies to communities in and around Techiman to Abofour via the existing BSP substation in Techiman.

6.2 Siting and Routing of Sub-Activity Components

An overview of the approach used by NEDCo to site substation locations and distribution line routes is presented below.

6.2.1 Substations

The locations of primary substations are based on the needs of the electrical transmission and distribution systems and specific land uses within the general area within which a substation is required. Once the need for a new substation within a general area has been established based on system planning, a screening process to identify a parcel of land of suitable size (up to approximately 100 by 100m)[4] to support the new substation is conducted. NEDCo's practice is to identify a suitable parcel of land and then negotiate with a willing seller based on fair market value. It is currently understood that NEDCo has already acquired land for two of the proposed sub-stations (Banvim and Islamic Centre). However the site for the Fiapre sub-station has yet to be identified.

Although NEDCo typically negotiates with a willing seller based on fair market value, the utility can expropriate land using statutory procedures. In all cases, the acquisition process will need to be consistent with the requirements of IFC PS 5.

4 In practice most are much smaller than this, typically 02 to 0.5 ha.

6.2.2 Distribution Lines

The routing of distribution lines is based on the need to interconnect various distribution system facilities such as BSP and primary substations and other MV and LV lines, with customers. Most public roads in Ghana have a 6-m utility corridor designated on each side of the road for electric, phone and water utilities. NEDCo's general practice is to locate distribution lines within the designated utility corridors to the extent possible. This practice minimizes adverse impacts to most permanent structures. However, it is common in Ghana for permitted and non-permitted small businesses to locate within these utility corridors, especially along busy streets. These businesses can be located in various types of structures and kiosks. Although compensation for impacts to these businesses is not required under Ghana law, compensation consistent with IFC PS 5 will need to be provided for projects conducted under the MCC Ghana Compact II.

Sub-transmission and MV lines typically have a level of flexibility that allows NEDCo to select routes that minimize impacts to existing infrastructure. In areas of very dense development, underground cables should be used to minimize overall impacts. NEDCo's policy is to minimize resettlement as a result of new distribution line construction and to also consider various design options that minimize the need to relocate structures and local businesses.

The routing of LV lines is directly related to customer locations and as such has less flexibility in route selection. The routing of LV lines is directly related to customer locations and as such has less flexibility in route selection; on the other hand, pole locations can usually be selected that avoid most impacts to residents and commercial structures. Although LV lines should maintain the required 2-m setback from existing structures, in practice this is rarely done because to enforce the setback would require relocating large numbers of structures, which would be socially disruptive and could threaten project implementation.

SECTION 7

Sub-Activity Impact Assessment

Each of the 21 NEDCo Sub-Activities under evaluation for MCC Ghana Compact II is discussed in this section. The Sub-Activities are grouped by Activity, as shown Table 7-1. The four categories of Activities are:

- Commercial Losses Reduction and Collection Efficiency Improvement
- Institutional Support
- Technical Losses Reduction
- Outages Reduction

Each of the 21 Sub-Activities is designed to facilitate the intended outcomes of its associated Activity with regard to overall improvements to the existing NEDCo distribution system. Each of the Sub-Activity assessments presented below provides a concise description of the Sub-Activity, an overview of the existing conditions of the areas where the Sub-Activity will be implemented, and descriptions of both potential environmental and social impacts and their mitigation. The specific sites and detailed designs have not been selected for the individual Sub-Activities. Therefore, the impact analysis has been based on the best available conceptual information on both the Sub-Activity generic site locations and design.

7.1 NEDCO-ICT-01 Communication Network

7.1.1 Sub-Activity Description

Intervention: NEDCO requires many new business applications, including an enterprise information system (Sub-Activity Comm-04). These systems will require a network backbone on which the software will run. Furthermore, the enterprise resource planning (ERP) must be networked throughout the regional, area, and customer service offices to provide the information required to manage billing and collections and to resolve customer issues as they arise. NEDCo will have access to fiber optic lines from a private communication provider who is installing its system on NEDCo poles. NEDCo will use this system to connect field offices on the wide area network. In the areas where this system is unavailable, NEDCo will use 4G wireless providers.

Implementation: A contractor will be hired to create a detailed design based on the NEDCo Information Communication Technology (ICT) department technology roadmap. This Sub-Activity will connect the data center to the network and upgrade the local area network in all the offices. The currently used wide area network connections will also be evaluated during detailed design. For high-priority nodes such as regional offices, a redundant connection will need to be installed if one does not exist.

7.1.2 Existing Conditions

The Sub-Activity involves the design, procurement, implementation of software and hardware solutions and will take place within existing NEDCo facilities. No structures or direct interactions with customers will be required.

7.1.3 Environmental Impacts

The Sub-Activity will take place in existing NEDCo facilities, so no environmental impacts will result for the Sub-Activity.

7.1.4 Socioeconomic Impacts

The project will not result in any direct or indirect social impacts.

7.1.5 Mitigation

No mitigation is required other than implementing the project in a manner that provides equal opportunities for NEDCo staff and contractors.

TABLE 7-1
Summary of Sub-Activity Impact Levels

Potential Impacts	Relevant IFC PS[1]	Activities																				
		Institutional Support						Commercial Losses Reduction and Collection Efficiency Improvement				Outages Reduction				Technical Losses Reduction						
		Sub-Activities																				
		ICT-01 Communication network	ICT-04 Data center at VRA or Sunyani	Comm-04 Enterprise customer information system and integration with existing enterprise applications	Service-01A - Construction of customer service centers	Service-05 Technical Assistance Program	Service-06 Technical Assistance Master Plan Development	Comm-01 Service connection materials	Comm-03 Customer census and normalization of existing connections	Engr-24 Metering at critical nodes of the distribution system	Service 02A Procurement of vehicles, tools and equipment	Engr-03A Replace faulty and aging underground conductors Expansion	ENGR-29 Sectionalizing study of MV networks within NEDCo's territory	OPS-02 Procure operations and maintenance materials	OPS-03 Installation of outage reporting and call center system	Engr-07 Shield wire conversion to 34.5 kV system Techniman-Abofour	Engr-08 Install Banvim primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	Engr-09 Install Islamic primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	Engr-11 Install Fiapre primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	Engr-18 Reactive power compensation for primary substations and MV lines	Engr-19A Low voltage feeder bifurcation with medium voltage upgrade	Engr-22 Update distribution construction standards
Impacts to Soils *(erosion)*	6	4	4	4	3	4	4	4	4	3	4	3	4	4	4	3	3	3	3	3	3	4
Impacts to Critical Habitat	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4
Impacts on Vegetation	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	4	4	4
Impacts to Wildlife and Habitat	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4
Impacts to Drainage, Surface Water Resources	3	4	4	4	3	4	4	4	4	4	4	3	4	4	4	3	3	3	3	4	3	4
Impacts to Legally Protected and Internationally Recognized Areas	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4
Noise and Vibration	3	4	4	4	3	4	4	4	4	4	4	3	4	4	4	3	3	3	3	4	3	4
Air Emissions	3	4	4	4	3	4	4	4	4	4	4	3	4	4	4	3	3	3	3	4	3	4
Visibility	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	4	4	4
Wastes	3	4	3	4	3	4	4	4	4	4	4	3	4	4	4	3	3	3	3	4	3	4
Worker Health and Safety	2	4	3	4	3	4	4	4	3	3	4	3	3	4	3	3	3	3	3	3	3	4
Average Environmental Impact Score		4.0	3.82	4.0	3.45	4.00	4.0	4.0	3.91	3.82	4.0	3.45	3.91	4	3.91	3.0	3.27	3.27	3.27	3.82	3.45	4.0
Socio-Economic Impacts																						
Impacts to Archaeological and Cultural Heritage Resources	8	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	4	4	4
Resettlement: Physical/Economic Displacement	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	4	2	4
Potential for Loss of Electrical Interconnection	5	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4	4	4	4	4	4	4
Restriction of Land Use and Land Rights	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	4	3	4

TABLE 7-1
Summary of Sub-Activity Impact Levels

Potential Impacts	Relevant IFC PS[1]	Activities																				
Economic Activity and Employment	1	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	5	5	5	4	4	4
Gender Issues	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Community Health and Safety	4	4	4	4	3	4	4	4	3	3	4	3	4	4	4	3	3	3	3	4	3	4
Traffic and Infrastructure	4	4	4	4	3	4	4	4	4	4	4	3	4	4	4	3	3	3	3	4	3	4
Average Socioeconomic Impact Score		4.0	4.0	4.0	3.88	4.0	4.0	4.0	3.63	3.88	4.0	3.75	4.0	4.0	4.0	3.25	3.38	3.38	3.38	4.0	3.38	4.0

Relative Severity Ranking for Potential Impacts		[1]IFC PS
Positive: *Will have a beneficial/positive impact.*	5	MCC-funded activities must meet the IFC PS on environmental and social responsibility. These include the assessment of associated infrastructure.
None: *Will have no impact on resource.*	4	
Slight: *Impacts (a) not likely to be significant (even if not mitigated) or (b) be easily mitigated with standard measures.*	3	
Moderate: *interactions may be significant but can effectively be mitigated with standard, proven measures.*	2	
Serious: *interactions have potential to cause significant harm and may require specially design measures.*	1	

7.2 NEDCO-ICT-04 Data Center at VRA or Sunyani

7.2.1 Sub-Activity Description

Intervention: NEDCo does not yet have its own data center to store customer service, energy sales, billing, collection, and other mission-critical information. NEDCo is considering installing a number of systems that require enhanced data center services, including a centralized customer information system (CIS), an expanded supervisory control and data acquisition system, a managed network, and geographic information system (GIS). The current ad-hoc approach of buying individual servers and software packages is not scalable and is difficult to maintain.

Implementation A contractor will be hired to update a detailed design based on the NEDCo ICT department technology roadmap. Another contractor will be hired to refurbish existing space to house an improved and expanded data center in either the VRA data center or at the NEDCo Sunyani campus. The data center will have climate control, access control, backup power and fire suppression systems, and will be built to accommodate future growth and expansion of the ICT system and support Sub-Activity (Comm-04 and ICT-01.) Initially, a limited number of servers will be installed under this investment. The space will prepared to accommodate additional servers envisioned by the NEDCO ICT team for various systems to be installed or migrated in the future.

7.2.2 Existing Conditions

Space to house an improved and expanded data center will be located within either the VRA data center or at the NEDCo Sunyani campus. Necessary renovations to provide climate control, access control, backup power and fire suppression systems, and space for future growth and expansion of the ICT system will be constructed in either of the existing locations. No new building construction will be required. The existing facilities will be modified to accommodate the expanded data centers.

7.2.3 Environmental Impacts

Because this Sub-Activity will involve refurbishing an existing building, anticipated environmental impacts will be minimal. As with all construction activities, measures to protect worker health and safety should be implemented because there will be some level of worker health and safety risk associated with the Sub-Activity. These risks can be associated with general construction activities, including the installation of electrical service. Risks of human health and safety impacts associated with the Sub-Activity can be effectively mitigated by developing and implementing a worker health and safety plan that includes adequate training. Depending on the original date of construction of the facilities to be renovated, an analysis for the presence of asbestos should be undertaken. If asbestos is found to be present, a remediation plan for the safe removal and disposal of the asbestos should be developed as part of the ESMP. Any asbestos remediation plan must be in compliance with applicable GoG requirements and best international practices. Small quantities of construction and demolition waste will be generated and should be disposed of in a licensed landfill. There should be no adverse environmental impacts during operation of the Sub-Activity.

7.2.4 Socioeconomic Impacts

Social impacts associated with the project will be minimal. There will be no land acquisition, economic displacement, or restriction of land uses or land use rights. There may be beneficial (positive) impacts during system operation due to improved company communication. There should be no adverse social or gender impacts associated with the project.

7.2.5 Mitigation

Development and implementation of a worker health and safety plan as part of an overall ESMP that focuses on worker safety and hygiene is recommended to mitigate impacts of the Sub-Activity. Depending on the age of the facilities to be renovated, an analysis for the presence of asbestos should be undertaken. If asbestos is present, a remedial plan consistent with best international practices should be developed and implemented. A plan for the proper disposal of wastes should be incorporated into the ESMP for the Sub-Activity. The Sub-Activity should be implemented in a manner that provides equal opportunities for NEDCo staff and contractors.

7.3 NEDC0-Comm-04 Enterprise CIS

7.3.1 Sub-Activity Description

Intervention. ERP generally comprises an integrated suite of business software applications using a common database. Enterprise solutions integrate internal and external management information across an entire organization, embracing processes spanning finance/accounting, asset management, customer relationship management, and energy capital management. The purpose of an integrated enterprise application solution suite is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders.

NEDCo currently uses individual applications with disconnected regional databases in many of its business applications. The current practice leads to inefficiencies and poor data availability and quality, which can result in compromised intelligence for business decisions.

Implementation. A contactor will be hired to finalize the ERP specification based on the approach that was developed by E-solutions in 2012. NEDCo plans to implement an ERP application via a CIS that will integrate general ledger and accounting, customer billing, warehouse control, work order, asset management, human resource, payroll, and other business applications with which NEDCo will manage its core business functions. This project will finance the procurement of the hardware, software licenses, and implementation / customization costs for the enterprise CIS for the NEDCo ERP system according to specifications.

7.3.2 Existing Conditions

The Sub-Activity will be implemented by an outside contractor and installed within the existing NEDCo infrastructure. No additional construction will be required.

7.3.3 Environmental Impacts

The project will not result in any environmental impacts.

7.3.4 Socioeconomic Impacts

The project will not result in any direct social impacts. The project should improve communications and decision making, both within NEDCo and with other stakeholders.

7.3.5 Mitigation

No mitigation is required other than implementing the project in a manner that provides equal opportunities for NEDCo staff and contractors.

7.4 NEDCo-Service-01A Construction of Customer Service Centers

7.4.1 Sub-Activity Description

Intervention. NEDCo operating functions such as meter reading, bill delivery, collections, receiving and addressing customer complaints, service calls, and maintenance activities are all managed through local customer service centers. The customer service centers in many locations are inadequate and aging facilities that require upgrading and in some cases, total refurbishment. This activity will finance construction of half of the 43 new service centers in the Sunyani and Northern areas.

Implementation A contractor will be hired to complete a detailed design of a mixture of new and existing offices. It is assumed that approximately half of the new customer service centers will be renovations of existing building and half will involve new building construction. The building will be relatively small, and will be constructed adjacent to existing roads in areas convenient to local communities. The service centers may be constructed on land currently owned by NEDCo or land that is purchased from a willing seller. This Sub-Activity includes civil work, furnishings, and Internet and telephony infrastructure in the newly constructed facilities. One or more general contractors will be hired to complete the work.

7.4.2 Existing Conditions

The regional context is the Brong-Ahafo and Northern regions. Population density in these regions is rather low (58 persons per /km^2 for Brong-Ahafo and 35 per / km^2 for Northern, according to the Ghana Statistical Service, 2010). However, population is higher for the capitals—371,351 for the Tamale metropolis and 123,224 for the Sunyani municipal area (Ghana Statistical Service, 2010).Some customer service centers exist but are in need of renovation/refurbishment or are inadequate. At the current time, specific sites for the customer service centers are not known and it is assumed that only some of the centers will require new-build options and the others will be in refurbished facilities. The service centers will be located in and around various population centers throughout the Northern and Brong-Ahafo regions.

7.4.3 Environmental Impacts

Ground disturbance will be associated with construction of the new service centers. Construction of these facilities has the potential to result in short term sedimentation from disturbed soils and impacts to surface water drainages. However, these highly localized erosion risks can be mitigated by seeding and/or mulching the exposed soils. Soil and groundwater also has the potential to be affected by improper disposal of construction-related chemicals, sanitary waste, and oil and grease from equipment maintenance. Mitigation measures for these potential impacts should be provided in the ESMP to be developed for the Sub-Activity. Final siting of the newly constructed service centers should screen for critical habitat, vegetation, wildlife and their habitat, and legally protected and internationally recognized areas. However, because the service centers will be built in and around population centers, there is little potential for impacts to these resources.

Construction of the new service centers will result in temporary localized impacts to air quality and noise from transportation of workers and materials and operation of construction equipment. These impacts will be limited in intensity, area, and duration. Construction of new and renovated service centers will not have a large impact on visual resources. Construction and renovation of the service centers will result in the generation of wastes from site clearing, demolition, equipment packaging, and other small quantity sources. Waste disposal should be addressed as part of the ESMP developed for the Sub-Activity. Depending upon the original date of construction of the facilities to be renovated, an analysis for the presence of asbestos should be undertaken. If asbestos is found to be present in the area to be renovated, a remediation plan for the safe removal and disposal of the asbestos should be developed as part of the ESMP. Any asbestos remediation plan must be in compliance with applicable GoG requirements and best international practices.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with service center projects. These risks can be associated with traffic accidents as well as injuries during installation of the new substation and distribution lines. Health and safety risks associated with the projects can be effectively mitigated by developing and implementing an environmental, health, and safety plan and providing adequate training. There should be no additional adverse environmental impacts during operation of the customer service centers.

7.4.4 Socioeconomic Impacts

New land acquisition will be required for some of the service centers. NEDCo typically purchases land from willing sellers for the acquisition of property for service centers; therefore, involuntary resettlement of residents or economic displacement will occur as a result of this Sub–Activity. Any land purchase will need to comply with the requirements of IFC PS5. Construction of the service centers will result in short-term positive impacts on local economic activity and employment due to the need for construction and maintenance workers.

Temporary impacts to traffic may occur as a result of increased transportation needs for the transport of workers and materials. Potential risks to community health and safety will be related to construction hazards, possible interactions with construction workers, and safety issues associated with construction activities at the service centers. These potential health and safety risks should be addressed in the ESMP developed for the Sub-Activity.

7.4.5 Mitigation

Risks of human health and safety impacts associated with construction/refurbishment of the service centers can be effectively mitigated by developing and implementing an ESMP that includes worker health and safety and providing adequate training. These risks can be associated with traffic accidents as well as injuries during installation of the electrical interconnections. A health and safety plan that focuses on worker safety and health must be developed and implemented to minimize these risks. Compliance with safe driving procedures and obeying all applicable traffic laws must be emphasized. Measures to protect the health and safety of members of the public should also be planned and implemented during construction. Locations for the customer service centers should be selected to provide easy access for the customers and should have adequate area for parting. Compatibility with the surrounding land uses should be considered as part of the siting process for the service centers.

7.5 NEDCo-Service-05 Technical Assistance Program

7.5.1 Sub-Activity Description

Intervention. NEDCo requires external technical assistance to capture the benefits and value of the MCC investment. The current organizational structure is flat, and decision making is funneled to a small group of people. A team of technical advisors will help foster better-informed and faster decisions. The technical assistance effort will link NEDCO departments to coordinate projects and to establish policies to reduce technical and commercial losses, reduce outages, and improve collections and quality of service to the customer.

Implementation. It is recommend that this program be continued through 4 years of Compact implementation and provide the foundation for all other programs. A contractor will be hired to execute the technical assistance effort, whose scope of work generally encompasses the following functions:

1. <u>Senior advisor with commercial experience for program direction and monitoring.</u> Provide support to NEDCo senior management with coordination between engineering and operations directorates. The senior advisor will manage and control an integrated loss management support team. The senior advisor will develop the program monitoring framework through which progress and issues will be collected and presented to senior NEDCO management and donor agencies, and will supervise the data verification process for loss reduction, revenue enhancement, and overall performance improvement. The senior advisor will work with the commercial directorate on the implementation of certain Sub-Activities to allow for success, including: (1) primary metering on transformers, (2) implementation of a consumer census including a task to tie consumers into individual distribution transformers, (3) supervision inspection and normalization of services and meters, and (4) design for a program to inspect customer services on a frequent basis. These efforts will require the senior advisor to have commercial experience in non-technical loss reduction programs, and with experience of metering systems, CIS systems, and energy/loss reporting and monitoring programs.

2. <u>Engineering and operations advisor</u>. This advisor will train and develop the engineering department in planning and cost-effective methods to improve utility standards. This advisor will maintain the existing GIS database of all utility plant assets and embed the internal policy and procedures to maintain this system. The engineering and operations advisor will train the engineering staff to evaluate technical losses, sectionalizing characteristics and strategies, and performance improvement analyses. The advisor will begin by evaluating NEDCo call center practices, coordination between the call center and the dispatch center, and practices and procedures designed to restore service after an outage has occurred. The advisor will review and evaluate maintenance materials and transport and communications capabilities, and will identify and design improved practices and procedures that will devices and improved linemen work practices. The advisor will mentor the NEDCo staff in these departments through the various processes rather than providing incremental support through each of the various implementation requirements.

7.5.2 Existing Conditions

The Sub-Activity will be implemented by hiring an outside contractor and work will be conducted within existing NEDCo infrastructure. No additional construction will be required.

7.5.3 Environmental Impacts

The project will not result in any environmental impacts.

7.5.4 Socioeconomic Impacts

The project will not result in any direct social impacts. The project will improve various corporate functions within NEDCo.

7.5.5 Mitigation

No mitigation is required other than implementing the project in a manner that provides equal opportunities for NEDCo staff and contractors.

7.6 NEDCo-Service-06 Distribution System Master Plan

7.6.1 Sub-Activity Description

Intervention. NEDCo has never had distribution master plan. Under VRA, a distribution master plan was developed in 2008. Certain Sub-Activities need to be completed before a master plan can be created, including population of the GIS database (currently underway) and updating the load forecast (correlated to actual loads). An updated master plan will increase operational efficiency at NEDCo.

Implementation. A contractor will be hired to prepare the master plan. The plan will include a roadmap for the 5-year horizon to meet the load forecast and provide system robustness. It also will address system elements such as creating loops or rings in the distribution system for contingency planning; location of switches, lines, and substations to ensure minimum disturbance to customers during system failures; and commercial aspects such as metering, supervisory control and data acquisition, and other technology improvements.

7.6.2 Existing Conditions

A contractor will be hired to prepare the master plan. The contractor will work with NEDCo personnel within the current NEDCo facilities to integrate the plan into NEDCo's business practices. No construction of new facilities will be required.

7.6.3 Environmental Impacts

The project will not result in any environmental impacts.

7.6.4 Socioeconomic Impacts

The project will not result in any direct social impacts. The project will improve overall planning and customer service.

7.6.5 Mitigation

No mitigation is required other than implementing the project in a manner that provides equal opportunities for NEDCo staff and contractors.

7.7 NEDCo-Comm-01 Service Connection Materials

7.7.1 Sub-Activity Description

Intervention. In recent years, the annual connection rate of new consumers in the NEDCo service territory has been approximately 10 percent of its customer base, or about 40,000 new customers. The connection process includes payment of a connection fee by the consumer. In practice, NEDCo-supplied connection materials—wires, connectors, meter boxes and other accessories—are in limited supply and an inventory is not maintained. Therefore customers resort to open market purchase and installation of non-standard service connection materials. The open market material is not always consistent with NEDCo standards and leads to implementation challenges, including unsafe practices, non-reliable wiring, and connections that are susceptible to tampering. This Sub-Activity will provide a connection inventory to facilitate timely and standardized connections (Sub-

Activity Engr-22) to the electric service. It also enables NEDCo to meet new customer connection demands while maintaining control over the most important portion of the distribution network in limiting commercial losses.

Implementation. Service materials will be procured by NEDCo and stocked in the area's warehouse. The service materials will be procured according to the new service specifications and will be hardened against tampering and theft. The service materials include wires, connectors, meter boxes, main breaker, and other accessories. This project will help NEDCo to meet new customer connection demands while maintaining control over the most important portion of the distribution network in limiting commercial losses.

7.7.2 Existing Conditions

Service connection materials will be shipped to existing NEDCo warehouse facilities within the existing NEDCo service territory.

7.7.3 Environmental Impacts

No major adverse environmental impacts are anticipated for this Sub-Activity. It is expected that the project will improve access to electricity through facilitating connections to the national grid for individuals. Shipping of materials will result in small quantities of vehicle air emissions from and minor increases in vehicular traffic. These impacts should not result in a measurable increase over background conditions.

7.7.4 Socioeconomic Impacts

The availability of additional service connection materials and an improvement in interconnection service should have a positive impact on the socioeconomic livelihoods of persons affected and positive impacts on gender, particularly in relation to women marginalized to small-scale informal activities requiring electricity.

7.7.5 Mitigation

Service connection materials should be transported in well-maintained trucks to minimize air emissions. Drivers should be instructed in the appropriate traffic and public safety laws and requirements.

7.8 NEDCo-Comm-03 Customer Census and Normalization of Existing Service Connections

7.8.1 Sub-Activity Description

Intervention. NEDCo has served consumers in the legacy system for more than three decades. The customer information system has numerous errors regarding customer identification, particularly missing data, duplicates, and / or wrong locations. As new business systems (Sub-Activity Comm-04) are brought on line, it will be important to check that customer information has been updated. Furthermore, services and meter installation in the utility's service territory have been historically non-compliant with published standards. Contractors hired to install new services do not consistently follow construction standards and have not been subject to routine inspection of proper installation of services and meters. This leads to service installations that are easily tampered with, which is the leading cause of the commercial losses from illegalities (meter bypass, meter tampering, paralleling the meter with jumpers).

Implementation. A contractor will be hired to conduct a census of all connected consumers with an audit of their associated service connections. For those consumers whose meter installations are improperly installed or located, the contractor will normalize (replace) the connection to restore integrity of the services in accordance with Sub-Activity Engr-22.

7.8.2 Existing Conditions

The spatial coverage of this Sub-Activity includes all areas served by NEDCo, including existing connections in cities such as Tamale, as well as smaller villages and rural areas. Commercial, industrial, governmental, and residential customer areas will be included in both the customer census and normalization of existing service connections. No new construction will be needed for this Sub-Activity.

7.8.3 Environmental Impacts

Because this Sub-Activity will involve survey and office work as well as modifications to existing customer connections only, anticipated environmental impacts will be minimal. No ground disturbance/soil erosion impacts or impacts to critical habitats, vegetation, wildlife and their habitats, protected and internationally recognized areas, or surface water are anticipated. As with all construction activities, measures to protect worker health and safety should be implemented because there will be some level of worker health and safety risk associated with the project. These risks can be associated with general construction activities, including the installation of the electrical service. Risks of human health and safety impacts associated with the project can be effectively mitigated by developing and implementing a worker health and safety plan that includes adequate training. There should be no adverse environmental impacts during operation of the project. Small quantities of waste may be generated during connection modifications and should be disposed of in a licensed landfill.

7.8.4 Socioeconomic Impacts

Social impacts associated with the project will be minimal. There will be no land acquisition, economic displacement, or restriction of land uses or land use rights. There will be a small, short-term increase in traffic activity associated with the installation workers in residential and commercial areas. It will be important that all workers are well-trained in the proper protocols for interacting with members of the public and in obeying all applicable traffic laws. There is the potential for illegally connected customers to be disconnected. There should be no other adverse social or gender impacts associated with the project. The interaction of workers with residents, most of whom will be women (taking care of the homes and also doing petty trading), could slightly inconvenience their activities.

7.8.5 Mitigation

Development and implementation of a worker health and safety plan that focuses on worker safety and hygiene and proper procedures for interacting with members of the public is recommended. Compliance with safe driving procedures and obeying all applicable traffic laws should be emphasized. The Sub-Activity will be implemented in a manner that provides equal opportunities for NEDCo staff and contractors. Because there is the potential for customers to be disconnected from the grid because of illegal connections identified through execution of the project, a protocol should be developed with NEDCo to mitigate this impact on the most vulnerable members of the community. A public information program should be implemented that informs customers of the project's intent, processes, and schedule.

7.9 NEDCo-Engr-24 Metering at Critical Nodes of the Distribution System

7.9.1 Sub-Activity Description

Intervention. Metering at critical nodes in the distribution system will allow NEDCo to identify and monitor where technical and commercial losses are occurring. The critical nodes are:

- The bulk supply point (BSP) incoming feeders
- The primary substation outgoing feeders
- The distribution transformers that serve more than one customer

This Sub-Activity is predicated on the implementation of the GIS Sub-Activity (Engr-01), which will help provide the foundation for an electrical model of the system to calculate total losses. Critical node data will allow NEDCo to identify losses that occur between node points, and high loss variations between these points will help NEDCo to select the geographic areas on which to focus resources.

Implementation. Under this Sub-Activity, meters with communication capability will be purchased and installed at all the critical nodes in the distribution system so that information can be relayed to the newly installed CIS system.

The CIS system has a module capable of accounting for all the energy recorded by the critical meters and then computing the losses in each system segment. These losses can then be compared to the anticipated technical loss and the commercial losses calculated. This information is used by the LCU to target the area of the system with the highest commercial energy losses.

Meters will be placed within existing and newly constructed substations and with distribution transformers. Minimal ground disturbance will be required and the newly installed meters will represent a minor incremental addition to the existing distribution infrastructure.

7.9.2 Existing Conditions

This Sub-Activity will be implemented at various points along the existing NEDCo service territory, including substations and distribution transformers. Implementation will take place within existing NEDCo facilities.

7.9.3 Environmental Impacts

Because this Sub-Activity will occur at existing NEDCo facilities, installation of the meters will not result in major adverse impacts to the environment. The meters' placement in existing facilities will not result in major ground disturbance/soil erosion impacts, impacts to critical habitat, vegetation, wildlife and their habitats, protected and internationally recognized areas, or surface waters. Meters will be installed either within existing substations or on poles adjacent to existing distribution transformers. Meters on poles adjacent to existing distribution transformers may require the installation of new poles, which would result in localized and minor ground disturbances. The ground disturbances would be on the order of several meters in diameter, and the disturbance periods would typically be 1 to 2 weeks or less. As such, potential adverse impacts from sedimentation and impacts to surface waters would be minimal and could be effectively mitigated using standard erosion control methods.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with meter replacement. These impacts can be associated with traffic accidents as well as injuries during placement of the meters. Health and safety risks associated with meter replacement can be effectively mitigated by developing and implementing an environmental, health, and safety plan and providing adequate training. There should be no additional adverse environmental impacts during operation of the meters.

7.9.4 Socioeconomic Impacts

Social impacts associated with meter placement will be minimal. There will be no land acquisition or economic displacement. There will be a small increase in traffic activity associated with the installation workers traveling in residential and commercial areas. It will be important that all workers are well-trained in the proper protocols for interacting with members of the public and in obeying all applicable traffic laws. There should be no adverse social or gender impacts during operation of the meters.

7.9.5 Mitigation

Recommended mitigation for meter placement includes the development and implementation of a health and safety plan as part of the ESMP for the Sub-Activity that focuses on worker safety, hygiene, and proper procedures for interacting with members of the public. Compliance with safe driving procedures, company policies, and obeying all applicable traffic laws should be emphasized.

7.10 NEDCo-Service-02A NEDCo-wide Vehicles, Tools, and Equipment

7.10.1 Sub-Activity Description

Intervention NEDCo has inadequate vehicles, tools, and equipment for its operating staff to adequately perform operating functions throughout the NEDCo system. This leads to unsafe situations during work and extended outage restoration times.

Implementation. Under this Sub-Activity, equipment required for NEDCo linemen, including personal protective equipment, pole climbing equipment, and hand tools, will be procured. Service vehicles will be procured for service centers and line bucket trucks purchased for area offices. Training will also be provided on the proper and safe use of the equipment.

7.10.2 Existing Conditions

The spatial coverage of this Sub-Activity includes all the regions under NEDCo coverage. Vehicles, tools, and equipment will be incorporated into the existing NEDCo facilities and will be used in servicing the overall NEDCo service territory. No new construction is anticipated.

7.10.3 Environmental Impacts

Adverse environmental impacts will not result from this Sub-Activity. Having appropriate well-functioning vehicles and equipment should be a net positive impact to worker health and safety.

7.10.4 Socioeconomic Impacts

There are no adverse social impacts associated with this Sub-Activity. There should be a net positive impact on economic activity and employment because the new vehicles and equipment should allow the distribution companies to provide better and more reliable service, which in turn should enhance the overall ability of businesses to compete and succeed.

7.10.5 Mitigation

Policies and procedures for the maintenance of the new vehicles and equipment should be developed and implemented. The use of any new vehicles and equipment should be incorporated into a worker health and safety plan and implemented.

7.11 NEDCo-Engr-3A Replace Faulty and Aging Underground Conductors in Tamale and Sunyani

7.11.1 Sub-Activity Description

Intervention. The underground conductors employed in several population centers are aging and subject to frequent faults. When a fault occurs, a team from NEDCo is dispatched to locate it using specialized equipment. Once the fault is located, the area is excavated and a section of the cable is replaced with two splices. This process is time- consuming and leaves the cable de-energized for a long duration. In addition, each fault on the cable weakens the insulation at another location, which leads to increased probability of faults. There is usually a limit to the number of repaired faults on the cable before the entire cable must be replaced, and many of the existing conductors should be replaced.

Implementation A contractor will be hired to replace the 33 km of MV underground conductors that are causing the outages. The contractor's scope of work includes a detailed design with an operational plan to keep the affected areas energized while the cables are being replaced. The physical work will include excavation, installation of the new cable, and restoration of the area to previous condition.

7.11.2 Existing Conditions

This Sub-Activity involves replacing approximately 33 km of 11 kV underground conductors within the NEDCo operating territory, including the towns of Sunyani, Techiman, Bolgatanga, and Tamale. Specific locations of the cables to be replaced are not currently known. The density of development varies considerable across the proposed implementation area for this Sub-Activity, with Tamale being the largest and most densely populated area. Underground cables are typically used in areas where overhead lines are impractical, such as in high-density residential and commercial land uses. Underground cables are also used to cross roads and other features that are difficult to span with overhead lines. It is likely that existing underground cables to be replaced are located primarily in high-density development and other areas where overhead lines are not possible.

7.11.3 Environmental Impacts

Overall environmental impacts should be minimal because the replacement underground cable will be placed in the same trench areas as the existing cable. This should eliminate potential impacts to impacts to critical habitat, vegetation, wildlife and their habitats, and protected and internationally recognized areas.

Ground disturbance will be associated with the Sub-Activity, which has the potential to result in localized sedimentation from the disturbed soils and impacts to surface water drainages. However, these highly localized erosion risks can be mitigated using standard sedimentation control practices which should be included in the ESMP for the Sub-Activity.

The construction activities could result in temporary localized impacts to air quality and noise from transportation of workers and materials and operation of construction equipment. These impacts will be limited in intensity, area, and duration. Once work is completed, the new underground conductors will have no effect on visual resources. The construction activities will result in the generation of small quantities of wastes from the removal of old cable, clearing of concrete/asphalt and other potential materials from over the existing cable, equipment packaging, and other small quantity sources. Waste disposal should be addressed as part of the ESMP and disposed of in a proper disposal facility.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with the excavation works. These risks can be associated with traffic accidents as well as injuries during installation of conductors. Health and safety risks associated with the project can be effectively mitigated by developing and implementing an environmental health safety plan and providing adequate training. There should be no additional adverse environmental impacts after the construction phase.

7.11.4 Socioeconomic Impacts

Socioeconomic impacts associated with underground cables will be minimal. Although new land acquisition will not be required for the replacement of the underground cable, resettlement of businesses that have located over the existing buried cable illegally is possible. If businesses or other facilities have been located within the existing utility ROW, they will be relocated as necessary.

Temporary impacts to traffic may occur as a result of increased needs for the transport of workers and materials and the replacement of cable under roads. Potential risks to community health and safety will be related to construction hazards and possible interactions with construction workers. It will be important to make sure that excavations are properly marked and secured so that accidents involving the public do not occur. These potential health and safety risks should be addressed in the ESMP for the Sub-Activity.

7.11.5 Mitigation

Once the need for resettlement has been determined, an RAP for this Sub-Activity should be developed and implemented. Risks to human health and safety associated with the project can be effectively mitigated by developing and implementing an ESMP, including a worker health and safety plan that includes adequate training. These risks can be associated with traffic accidents as well as injuries during installation of the electrical interconnections. An ESMP that focuses on both worker safety and health and the safety and health of the public must be developed and implemented to minimize these risks. Compliance with safe driving procedures and obeying all applicable traffic laws must be emphasized.

7.12 NEDCo-Engr-29 Sectionalizing Study of MV Networks within NEDCo's territory

7.12.1 Sub-Activity Description

Intervention. System outages are affecting larger areas and more and more consumers. Frequent interruption on the lines affects all customers, who require a stable source of electricity. Historically, NEDCo has employed limited sectionalizing on its MV lines; rather, the approach has been to install costly switching stations to split 34.5 kV sub-transmission lines into 34.5 kV distribution lines.

A properly sectionalized distribution network will ensure that outages at the end of the lines and on side tap do not trip the breaker at the substation and take out the entire line, cutting power to customers who otherwise could have remained energized. Improved sectionalizing will reduce outage frequency (and duration as experienced by customers) and improve overall service quality.

Implementation. This Sub-Activity is linked to the completion of the GIS Sub-Activity. The GIS data will be used by a consultant to conduct a sectionalizing study of NEDCo's network. The study results will be used to locate reclosers, switches, and other sectionalizing devices in the MV network.

A contractor will be hired to implement the recommendations of the sectionalizing study (in a limited pilot at one substation) in accordance with NEDCo's specifications and standards. We assume that each feeder will require one recloser and four sectionalizers. All reclosers and sectionalizers will then be monitored and operated remotely. In addition, inline fuses will be installed as indicated by the study findings.

7.12.2 Existing Conditions

This Sub-Activity will require work at existing substations and installation of equipment on existing poles and represents a minor addition to existing distribution infrastructure. Existing conditions will differ, depending on the current location of the substation.

7.12.3 Environmental Impacts

All equipment installations will be accomplished within existing substations or on existing distribution poles and will not result in adverse impacts to the environment. As with any work-related activity, there will be some level of potential worker health and safety risk associated with the Sub-Activity. These impacts can be associated with traffic accidents as well as injuries during installation of the sectionalizing equipment. Health and safety risks associated with protection Sub-Activities can be effectively mitigated by developing and implementing an environmental, health, and safety plan and providing adequate training. There should be no adverse environmental impacts during operation of the protection Sub-Activities.

7.12.4 Socioeconomic Impacts

Social and economic impacts associated with this Sub-Activity will be minimal. Temporary impacts to traffic may occur as a result of the Sub-Activities. Potential impacts to community health and safety will be relatively minor and may include interactions with construction workers and safety issues associated with the installation of the sectionalizing equipment.

This Sub-Activity will reduce outage frequency and subsequently help improve economic activities.

7.12.5 Mitigation

Recommended mitigation includes the development and implementation of a health and safety plan as part of an overall ESMP for this Sub-Activity that focuses on worker safety, hygiene, and proper procedures for interacting with members of the public. Compliance with safe driving procedures, company policies, and obeying all applicable traffic laws should be emphasized.

7.13 NEDCo-Ops-02 Operations & Maintenance Materials

7.13.1 Sub-Activity Description

Intervention. NEDCo has a limited inventory of spare parts and materials with which to perform emergency and routine repairs and maintenance on distribution feeders, laterals, distribution transformers, and other equipment. This leads to inadequate repairs (such as bypassing protection equipment) and prolonged outages.

Implementation. This Sub-Activity will procure and distribute high-priority materials such as fuses, conductors, connectors, splices, and distribution transformers to all NEDCo service areas. The material will be stored in regional warehouses typically located at the substations and will be available to serve the area rapidly with the required material for safe and fast outage restoration.

7.13.2 Existing Conditions

The spatial coverage of this Sub-Activity is all the regions under NEDCo coverage. Materials will be stored at existing NEDCo warehouse facilities.

7.13.3 Environmental Impacts

No adverse environmental impacts are anticipated for this Sub-Activity. In contrast, it is expected that this Sub-Activity will improve the electricity facility through efficient and prompt fault management.

7.13.4 Socioeconomic Impacts

Socioeconomic impacts including gender impacts are expected to be positive because the provision of the high-priority materials would allow the distributing companies to provide better and more reliable service, which in turn should enhance the overall ability of businesses to compete.

7.13.5 Mitigation

No mitigation is necessary for this Sub-Activity. Rather, this Sub-Activity enhances the socioeconomic livelihoods of persons affected and positively affects gender, particularly in relation to marginalized groups engaged in small-scale informal activities requiring electricity.

7.14 NEDCo-Ops-03 Installation of Outage Reporting and Call Center System

7.14.1 Sub-Activity Description

Intervention. NEDCo needs an outage management system (OMS), which is a base requirement for a modern utility. Currently, the customer call center receives trouble calls, which are recorded into a flat database. For proper outage management, an OMS system should be based on system configuration from the GIS data and the CIS. Under a proper system, call center dispatches record information from the customer and assist the dispatched repair crews on proper course of action in the field. Once the repair crew restores service, the OMS records the duration of outage, cause, and remedy.

Implementation. Under this Sub-Activity, a contractor will be hired to procure and install an outage reporting and call center system as an intermediate step to a full, modern OMS. This system will provide call center functionality and will be integrated with the CIS. The system will be able to identify outage locations and causes, thereby reducing outage repair time. The call center software module will be procured and the call center staff will be trained in its use.

7.14.2 Existing Conditions

The outage reporting and call center system will be installed within an existing NEDCo facility, so no additional construction or renovation will be required.

7.14.3 Environmental Impacts

There will be no anticipated environmental impacts associated with this Sub-Activity.

7.14.4 Socioeconomic Impacts

There will be no anticipated social impacts associated with this Sub-Activity.

7.14.5 Mitigation

No mitigation is required other than implementing the Sub-activity in a manner that provides equal opportunities for NEDCo staff and contractors.

7.15 NEDCo-Engr-07 Shield Wire Conversion to 34.5 kV System in Techniman-Abofour

7.15.1 Sub-Activity Description

Intervention. NEDCo presently serves some rural villages that are adjacent to transmission corridors with single-phase power supplied via the shield wire on the transmission circuits. GRIDCo no longer allows this practice. The existing shield wire has exceeded its designed capacity leading to outages at peak hours due to the protection relay on the line tripping the breaker.

Implementation. A contractor will be hired to prepare the detailed design of the new MV line, which will be constructed primarily within the utility corridor along the Kumasi-Techiman highway from Techiman to Abofour, a distance of approximately 65 km. The existing side tap currently connected to the shield wire will be moved to be energized by the new MV line. This Sub-Activity will include the installation of approximately 50 km of new MV lines and the upgrade of approximately 120 km of MV lines. In addition, approximately 50 km of new LV lines and 150 km of upgraded LV lines will be installed. The MV line from Techiman to Abofour will be located within a 10-meter- wide ROW within the utility corridor following the Kumasi-Techiman highway. Approximately 55 new distribution transformers will also be installed, along with up to 600 new service connections. Construction of other MV and LV lines associated with this Sub-Activity will reinforce the existing distribution system and provide up to an additional 600 customer connections. Like the MV line from Techiman to Abofour, the other MV and LV interconnection lines will also be located primarily within utility corridors adjacent to existing roads. This Sub-Activity includes the procurement of poles, wires, insulators, and other electrical material to construct the new line.

Construction activities will include the following tasks:

- Identification of final centerline for distribution line
- Staking and surveying of line route
- Clearing the ROW of vegetation and structures as necessary
- Staging equipment and materials staging
- Erect distribution line structures
- String conductors
- Energize the lines

It is assumed that workers will stay in the local towns and that a worker's camp will not be required. A description of the process involved with the shield wire conversion is presented in Section 6.1.

7.15.2 Existing Conditions

The shield wire conversion Sub-Activity will be implemented in Techniman-Abofour area of the NEDCo service territory. The primary shield wire conversion MV line will follow along the existing Kumasi – Techiman highway, within the existing utility corridors on either side of the highway (see Figure 7-1 and 7-2). Although this line will generally follow the highway, a final routing will be required to establish the exact location of the line to minimize adverse impacts to engineering, environmental, and social constraints. Other associated MV and LV lines will also have to undergo detailed routing to minimize impacts to the same constraints. The route between Techiman and Abofour crosses through aproximately 14 small towns and villages and two forest reserves (see Figure 7-3). The proposed route crosses both developed and natural land uses, including residential, commercial, farming as well as open savannah, forested habitat, and streams.

The general area crossed by the new line is made up of two main vegetation types: moist semi-deciduous and dry semi-deciduous south-east sub-type of vegetation. The dry semi-deciduous vegetation is found around the Techiman area and is referred to as the Transition zone. Wildlife species such as antelopes, grasscutters, squirrels, and snakes have been sighted in the forest and also in the areas along the roadway, especially in the farm areas. The local people depend on these wildlife species for food and income.

The line crosses through two forest reserves, the Afrensu Brobuma forest reserve and the Opro River Forest reserve (Figure 7-3). The reserves are made up of both natural forest and plantation forests. The plantation forest has mainly teak while the natural forest has ceiber, *Celtis spp* and wawa as tree types.

Farming is the major occupation of most towns along the roadway. Both cash crops and food crops are produced. Cash crops include cocoa, palm oil, and cashews, while food crops include okro, maize, cassava, cocoyam, eggplant, peppers, tomatoes, and plantains. Obofuo is noted for having many banana farms whose products are mainly harvested and sold on the market.

Much of the area crossed by the line has not been surveyed for protected species, and only general information is available at the current time. In general however, trees and animals in the reserves are considered protected.

Major water bodies along the road ways are:

- River Offin, located just before the Od Offinso
- River Akumadan, located between Akumadan and Afrancho
- Rive Tano, located at Tanoso. The Tano basin water works depends on River Tano for water to serve the Tanoso area and also parts of Akumadan and Techiman with drinking water.

7.15.3 Environmental Impacts

Construction of the shield wire conversion Sub-Activity within the utility corridors along existing roads will minimize many of the potential environmental risks and impacts. However, it will be important that detailed routing of the new distribution lines take into account the minimization of environmental risks and impacts discussed below. A more-detailed environmental and social analysis of the selected detailed route specific assessment of Sub-Activity impacts should be undertaken once the final design of the distribution lines have been finalized.

There will be ground disturbance associated with installing the new distribution structures and the movement of construction vehicles and equipment. It is assumed that the existing roads will be used for access to the distribution structure locations. Impacts resulting from ground disturbance, including erosion and sedimentation of water bodies, should be controlled by minimizing disturbed areas, seeding and/or mulching of exposed soils, and using silt fences near surface water bodies. The ROW will cross several water bodies, so the final distribution line design should avoid placing structures either in the waterways or in the adjacent riparian habitat. The distribution lines should be able to span all of the waterways to be crossed to minimize direct impacts.

The utility corridors to be used for the new distribution lines cross a number of land uses, including developed residential and commercial, farm land, open savanna and forested areas. Vegetation removal and trimming will be required within the 10-meter ROW in some areas, which will result in impacts to vegetation, habitat, and wildlife. A detailed survey of land uses and habitat to be crossed by the new distribution line ROW should be conducted before construction begins to screen for areas of critical habitat, vegetation, wildlife or their habitat, or legally protected or internationally recognized areas. Because the distribution line ROWs will be located adjacent to existing roads, the areas to be crossed have already experienced a level of impact. It is recommended that a field survey be conducted of the proposed ROW for the MV line within the utility corridors to identify the presence of any protected species. If a protected species is found within the existing ROW, a relocation plan or other applicable mitigation measure should be developed and implemented before the start of construction. The survey should focus on areas of natural habitat crossed by the proposed new lines.

Air quality impacts will be limited to short-term increased exhaust from construction equipment and generation of dust. These impacts should be limited to the immediate work area as well as areas crossed by vehicle traffic used to transport equipment, materials, and workers. Impacts to air quality can be mitigated by using well-maintained vehicles to minimize exhaust emissions and by watering open areas prone to dust generation.

Construction of the shield wire conversion Sub-Activities will result in the generation of wastes from ROW clearing, equipment material packaging, sanitary waste from workers, and other small quantity sources. Waste disposal should be addressed as part of the ESMP developed for the Sub-Activity.

The construction of the distribution lines will have an impact on visual resources. As with any work-related activity, there will be some level of potential worker health and safety risk associated with this Sub-Activity. These impacts can be associated with working near MV distribution lines and traffic accidents or injuries during installation of the new poles, transformers, and conductors. Health and safety impacts from shield wire conversion projects can be effectively mitigated by developing and implementing a worker health safety plan and providing adequate training. There should be no additional adverse environmental impacts during operation of the newly constructed distribution lines.

7.15.4 Socioeconomic Impacts

A survey for potential cultural and sacred sites should be conducted as part of the detailed impact assessment for this Sub-Activity. If any such sites are identified, measures to protect them should be developed as part of the ESMP for this Sub-Activity.

The need for resettlement will depend upon the final route that is selected for the distribution lines. The general alignment for the ROW is to follow the existing Kumasi-Techiman highway from Techiman to Abofour. The route will traverse through 14 small towns and villages. Special care should be given to the alignment of the ROW in these areas to minimize resettlement, which can be accomplished by undergrounding the line, using existing pole locations in the towns, or routing the line around the towns. Although the distribution line will be located primarily within the utility corridors along the highway, there will be instances where farming activities in the area come close to the highway, potentially crossing into the utility corridor. In these cases, some farmland may be lost to the distribution line, requiring that compensation be provided for lost income. The final alignment and design for the shield wire conversion project should incorporate all reasonable measures to eliminate or minimize the potential need for any resettlement or economic disruption to existing adjacent businesses or farms.

Temporary impacts to traffic may occur as a result of increased transport of workers and materials. Potential impacts to community health and safety will be relatively minor and include interactions with construction workers and safety issues associated with construction activities along the transmission line ROWs. The shield wire conversion projects are designed to increase stability and reliability of the distribution system and should therefore have an overall positive impact on economic activity in the areas served. This Sub-Activity may also provide short-term employment opportunities during construction. Social impacts during operation should be minimal.

7.15.5 Mitigation

Recommended mitigation for the shield wire conversion Sub-Activity includes the use of environmental best management practices such as erosion controls during construction, and development and implementation of a health and safety plan that focuses on worker safety, hygiene, and proper procedures for interacting with members of the public. One the proposed ROW has been refined, surveys for protected species and their habitat should be conducted as well as surveys for cultural and sacred sites.

Efforts to minimize resettlement impacts should be incorporated into the final routing and designs of the distribution lines.

Compliance with safe driving procedures, company policies, and obeying all applicable traffic laws should be emphasized. Minimizing potential local power outages and communicating with local residents and commercial establishments about unavoidable power outages will be important. A comprehensive ESMP should be prepared that addresses both environmental and social risks and mitigation measures. The ESMP should also address worker health and safety issues associated with working around high voltage transmission lines.

FIGURE 7-1
NEDCo-Engr-07 Shield Wire Conversion Map

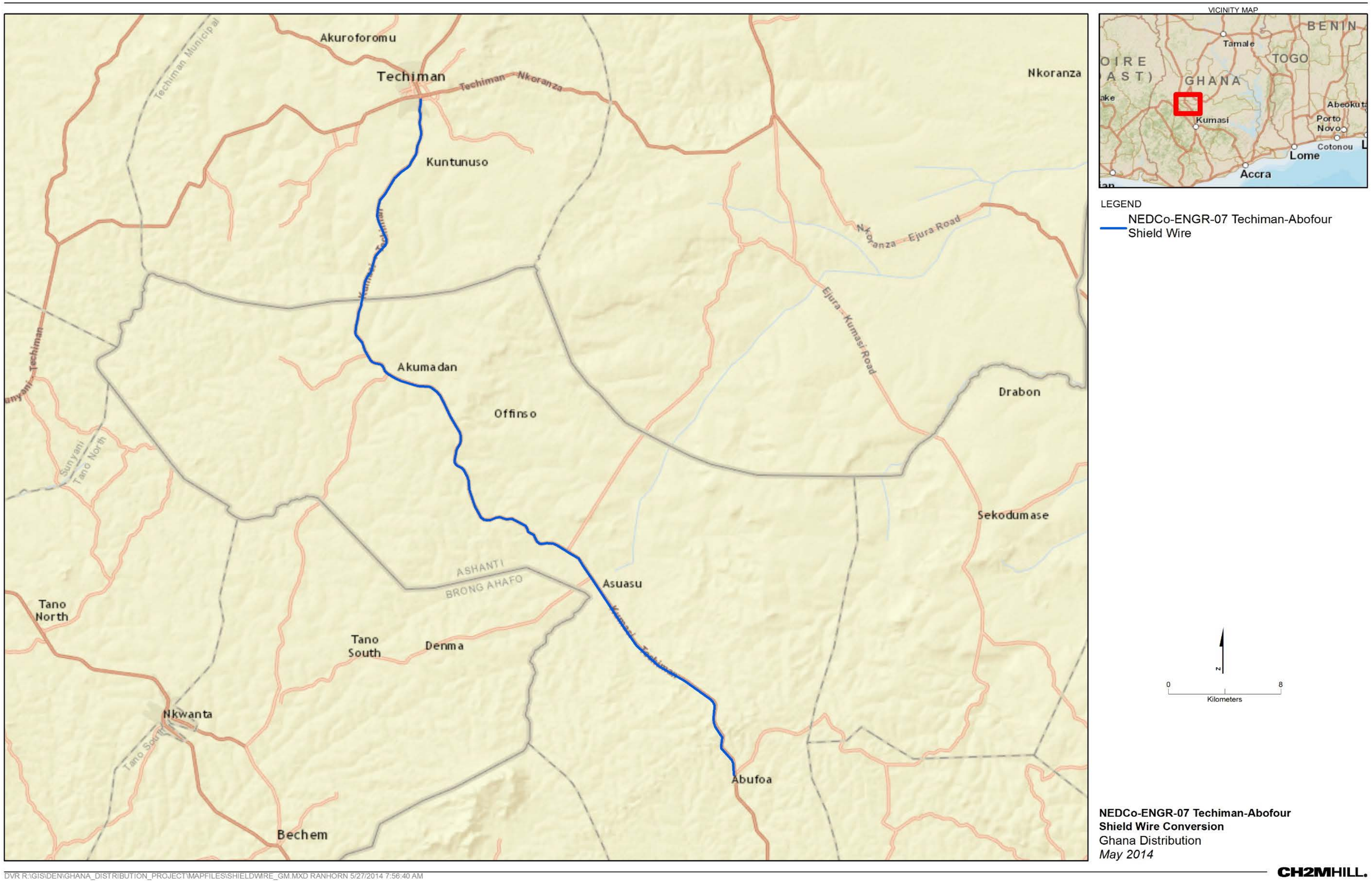


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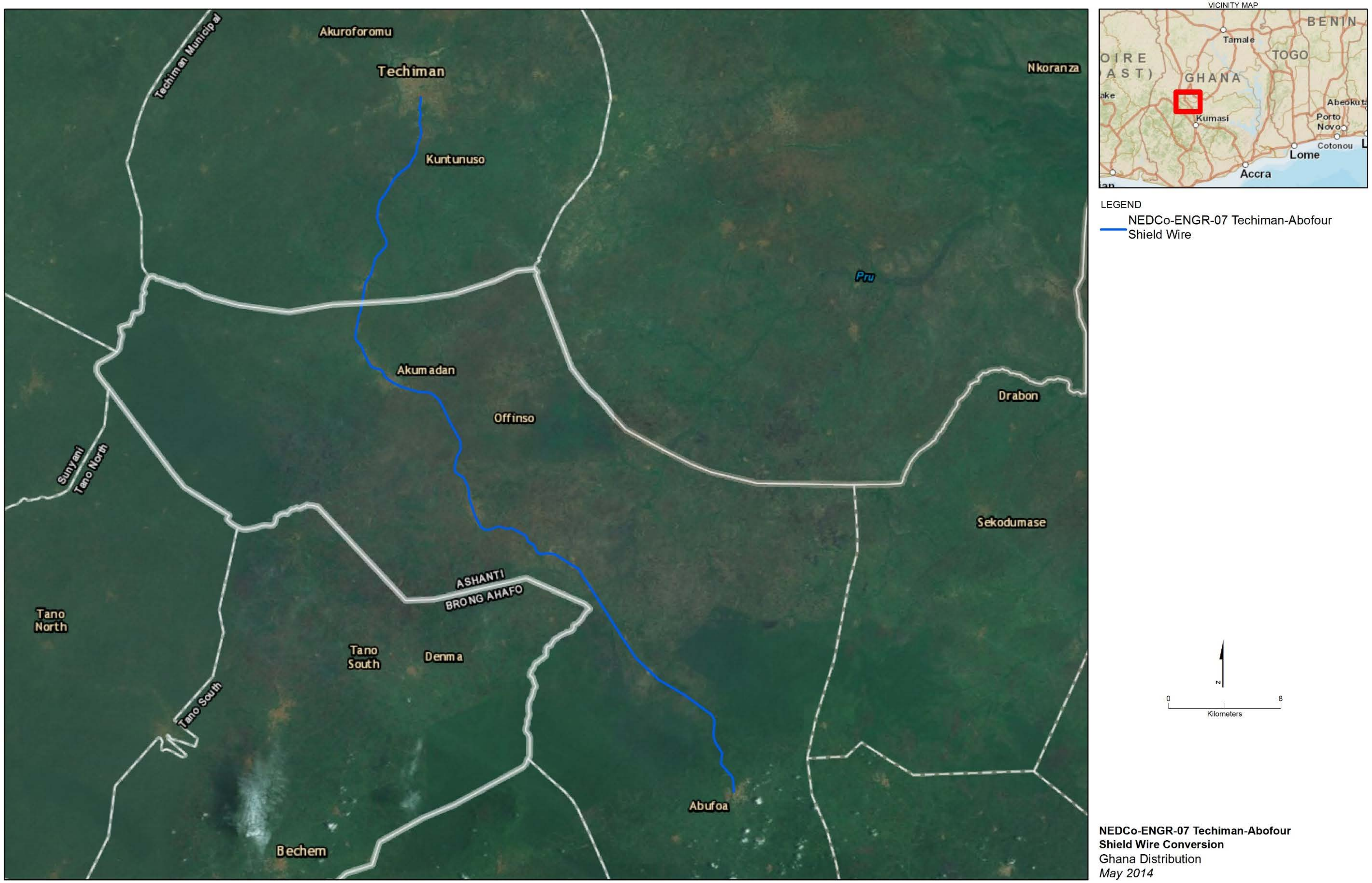
FIGURE 7-2
NEDCo-Engr-07 Shield Wire Conversion Aerial



NEDCo-ENGR-07 Techiman-Abofour
Shield Wire Conversion
Ghana Distribution
May 2014

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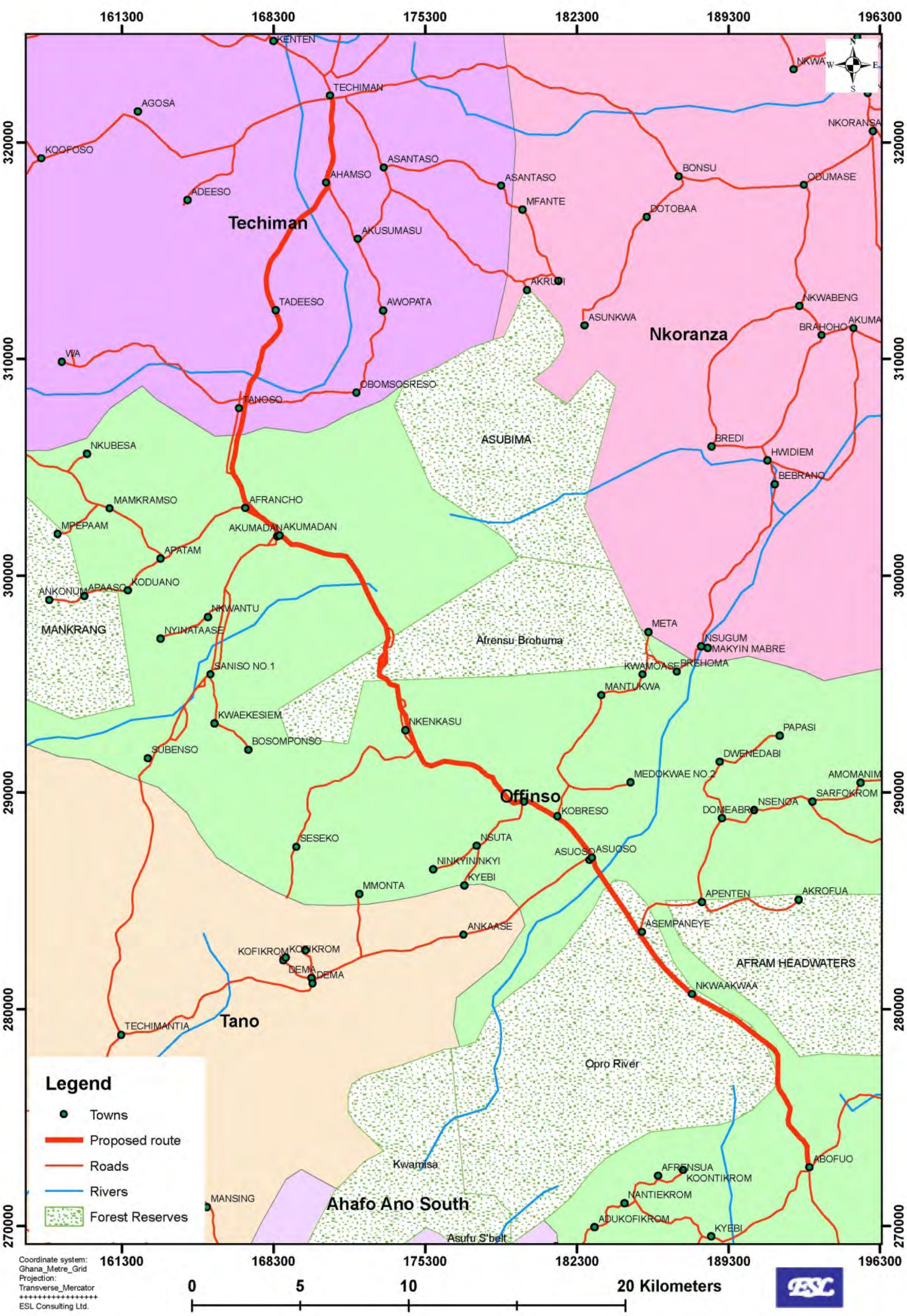
FIGURE 7-3
Sub-Regions and Forest Reserves Crossed by NEDCo-Engr-07 Shield Wire Conversion



7.16 NEDCo- Engr-08 Banvim 34.5/11 kV Primary Substation with Interconnecting 34.5 kV links, 11 kV Offloading Circuits, and LV Network

7.16.1 Sub-Activity Description

Intervention. Some of the NEDCo distribution feeders have been extended beyond their design limits, leading to deteriorating power quality, higher losses, and less capacity to meet load. The primary substations currently serving the Banvim area will soon become overloaded, based on the current demand forecast. To avoid rolling blackouts and improve power quality, a primary substation will be installed.

Implementation. A contractor will be hired to build a substation that conforms to the NEDCo's standard substation design. This activity includes installation of the following items: (1) a new primary substation, including transformer, switchyard, and control house on a fenced-in plot measuring 30 by 30 meters; (2) sub-transmission lines and interconnections to/from the new substation to the existing grid substation; (3) MV lines; and (4) LV distribution lines and distribution transformers. Additional descriptions of these facilities are provided in Section 6.1.

7.16.2 Existing Conditions

A 0.25-hectare parcel has been acquired by NEDCo from a willing seller for the project site (see Figures 7-4 and 7-5). The project site is open with some trees, and there are no buildings on the site. The substation site is in the southern area of Tamale in a relatively low-density residential area with some local agricultural activity. A sub-transmission line from the substation site to the existing Tamale BSP substation will cross a mixture of low-density residential, agricultural, and high-density residential land uses. Other MV and LV distribution lines will also be constructed as part of this Sub-Activity, but the location of thee lines has not been determined.

7.16.3 Environmental Impacts

Ground disturbance will be associated with construction of the primary substation and new 34.5 and 11 kV offloading lines. Construction of these facilities has the potential to result in sedimentation from disturbed soils and impacts to surface water drainages. However, these highly localized erosion risks can be mitigated by seeding and/or mulching exposed soils. Soil and groundwater also have the potential to be affected by improper disposal of construction-related chemicals, sanitary waste, and oil and grease from equipment maintenance. Mitigation measures for these potential impacts should be provided in the ESMP to be developed for the project. Final siting of the substation and line routes should be screened for any unknown environmentally sensitive areas.

Because there is little natural vegetation or habitat in the general area identified for the substation, it is unlikely that these resources will be affected by construction or operation of the substation. Detailed routes for the various associated distribution lines have not been identified at the current time; however, most of the land that could be crossed by the lines is either residential and commercial or agricultural in land use. The distribution lines will likely be routed within the utility corridors along existing roads to the extent practicable to minimize overall impacts to vegetation, habitat, and agricultural areas. A detailed analysis of the distribution line routes should be conducted as part of the siting process to prevent sensitive environmental areas from being adversely affected by the proposed development.

Construction of the new primary substation and distribution lines will result in temporary localized impacts to air quality and noise from transportation of workers and materials and operation of construction equipment. These impacts will be limited in intensity, area, and duration. The new substation and distribution lines will have an impact on visual resources in the immediate area. Construction of the substation and associated distribution lines will result in the generation of wastes from site clearing, equipment packaging, and other small quantity sources. Waste disposal should be addressed as part of the ESMP developed for the project.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with substation projects. These risks can be associated with traffic accidents as well as injuries during installation of the new substation and distribution lines. Health and safety risks associated with the projects can be effectively mitigated by developing and implementing an environmental, health, and safety plan and providing adequate training. There should be no additional adverse environmental impacts during operation of the substation and new distribution lines.

7.16.4 Socioeconomic Impacts

Land for the new substation has been acquired from a willing seller. It will be important to ensure that the requirements of PS 5 have been observed during land acquisition activities and that a fair market value be paid for the land. The new distribution lines will likely be located primarily within ROWs along existing roads. Most of the roads in the immediate area do not appear to be heavily populated with street hawkers or small local vendors within the utility ROW. Although the exact routes that will be used for the distribution lines have not been identified, there is a potential for some level of involuntary resettlement. Efforts to ensure the careful siting, layout, and final design of the substation and new distribution lines should take all reasonable efforts to minimize the number of involuntary resettlement and economic disruption cases. Construction of the substation and lines will result in short-term positive impacts on local economic activity and employment due to the need for construction and maintenance workers.

A screening for cultural resources in the area of the proposed substation and distribution lines should be undertaken as part of the site selection process. The screening process will include consultations with local elders and long-standing residents to assist in identifying any sites of cultural importance.

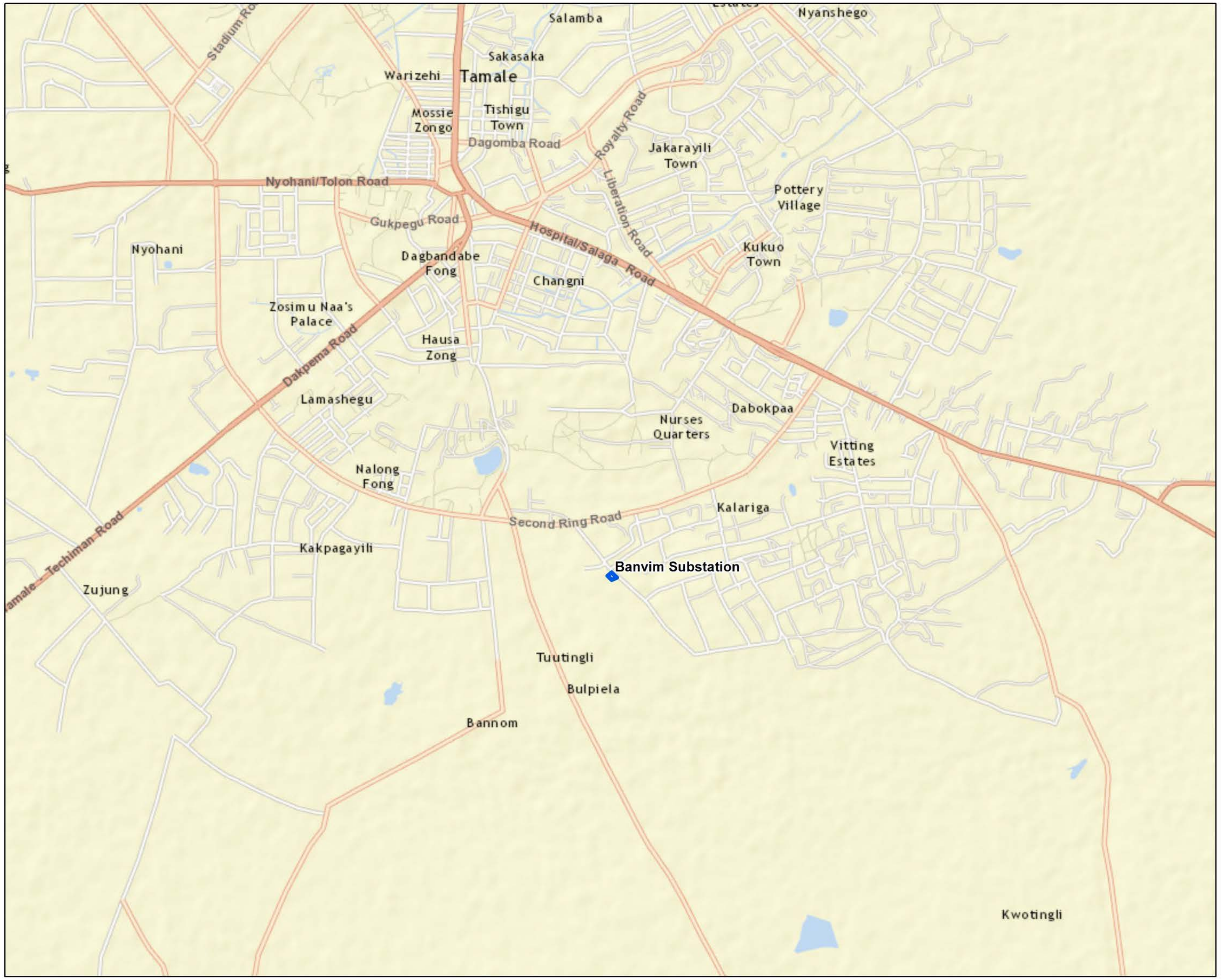
Temporary impacts to traffic may occur as a result of increased transport of workers and materials. Potential risks to community health and safety will be related to construction hazards, possible interactions with construction workers, and safety issues associated with construction activities at the substation and along the distribution line ROWs. These potential health and safety risks should be addressed in the ESMP developed for the Sub-Activities.

7.16.5 Mitigation

Careful site selection, layout, and final design of the substation and new distribution lines should avoid or minimize impacts to existing residents and commercial facilities. Cases of involuntary resettlement and/or economic displace should be appropriately compensated based on the guidelines set out by the GoG and the MCC. An appropriate RAP should be developed as needed.

Recommended construction impact mitigation includes the use of international BMPs for erosion control and replanting bare soils, especially on slopes and near sensitive habitats such as surface waters and wetlands. Mitigation for health and safety risks should include developing and implementing a worker health and safety plan as part of an overall ESMP for the Sub-Activity that focuses on worker safety, hygiene, and proper procedures for interacting with members of the public. Compliance with safe driving procedures, company policies, and obeying all applicable traffic laws should be emphasized. An RAP should be prepared if resettlement is required.

FIGURE 7-4
NEDCo- Engr-08 Banvim Primary Substation Map



VICINITY MAP

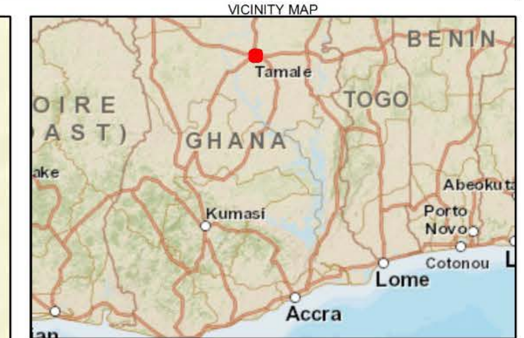


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FIGURE 7-5
NEDCo- Engr-08 Banvim Primary Substation Aerial

NEDCo-ENGR-08 Banvim Primary Substation
Ghana Distribution
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7.17 NEDCo- Engr-09 Islamic 34.5/11 kV Primary Substation with Interconnecting 34.5 kV Links, 11 kV Offloading Circuits, and LV Network

7.17.1 Sub-Activity Description

Intervention. Some of the NEDCo distribution feeders have been extended beyond their design limits, leading to deteriorating power quality, higher losses, and less capacity to meet load. The primary substations currently serving the Islamic area will soon become overloaded, based on current demand forecast. To avoid rolling blackouts, a primary substation will be installed.

Implementation A contractor will be hired to procure and build a substation that conforms to the NEDCo's standard substation design. This activity includes installation of the following items: (1) a new primary substation, including transformer, switchyard, and control house on a fenced-in plot; (2) sub-transmission lines and interconnections to/from the new substation to the existing grid substation; (3) MV lines; and (4) LV distribution line and distribution transformers.

7.17.2 Existing Conditions

A 0.43-hectare parcel has been acquired by NEDCo from a willing seller for the project site (See Figures 7-6 and 7-7). The project site is open, with very limited vegetation. The substation site is located northeast of Tamale in a rural area with scattered homes and fields. A sub-transmission line from the substation site to the existing Tamale BSP substation will cross a mixture of low-density residential, agricultural, and high- density residential land uses. Other MV and LV distribution lines will also be constructed as part of this Sub-Activity, but the location of thee lines has not been determined.

7.17.3 Environmental Impacts

Ground disturbance will be associated with construction of the primary substation and new 34.5 and 11 kV offloading lines. Construction of these facilities has the potential to result in sedimentation from disturbed soils and impacts to surface water drainages. However, these highly localized erosion risks can be mitigated by seeding and/or mulching exposed soils. Soil and groundwater also have the potential to be affected by improper disposal of construction-related chemicals, sanitary waste, and oil and grease from equipment maintenance. Mitigation measures for these potential impacts should be provided in the ESMP to be developed for the project. Final siting of the substation and line routes should be screened for any unknown environmentally sensitive areas.

The general area around the substation site consists of agricultural fields with scattered residences, and the density of residences and businesses increases toward Tamale. It is unlikely that much native vegetation remains on the substation site. Vegetation along the likely distribution line route also has been highly affected by agricultural, residential and commercial activities. The distribution lines will be primarily routed within the utility corridors along existing roads. This approach should help minimize overall impacts to vegetation, habitat, and agricultural areas. A detailed analysis of the distribution line routes should be conducted as part of the siting process to prevent sensitive environmental areas from being adversely affected by the proposed development.

Construction of the new primary substation and distribution lines will result in temporary localized impacts to air quality and noise from transportation of workers and materials and operation of construction equipment. These impacts will be limited in intensity, area, and duration. The new substation and distribution lines will have an impact on visual resources in the immediate area. Construction of the substation and associated distribution lines will result in the generation of wastes from site clearing, equipment packaging, and other small quantity sources. Waste disposal should be addressed as part of the ESMP developed for the project.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with substation projects. These risks can be associated with traffic accidents as well as injuries during installation of the new substation and distribution lines. Health and safety risks associated with the projects can be effectively mitigated by developing and implementing an environmental, health, and safety plan and providing adequate training. There should be no additional adverse environmental impacts during operation of the substation and new distribution lines.

7.17.4 Socioeconomic Impacts

Land for the new substation has been acquired from a willing seller. It will be important to ensure that the requirements of PS 5 have been observed during land acquisition activities and that a fair market value be paid for the land. The new distribution lines will likely be located primarily within ROWs along existing roads. Although the exact routes that will be used for the distribution lines have not been identified, it is possible that these lines will result in some level of involuntary resettlement. Efforts to ensure the careful siting, layout, and final design of the substation and new distribution lines should take all reasonable efforts to minimize the number of involuntary resettlement and economic disruption cases. Construction of the substation and lines will result in short-term positive impacts on local economic activity and employment due to the need for construction and maintenance workers.

A screening for cultural resources in the area of the proposed substation and distribution lines should be undertaken as part of the site selection process. The screening process will include consultations with local elders and long-standing residents to assist in identifying any sites of cultural importance.

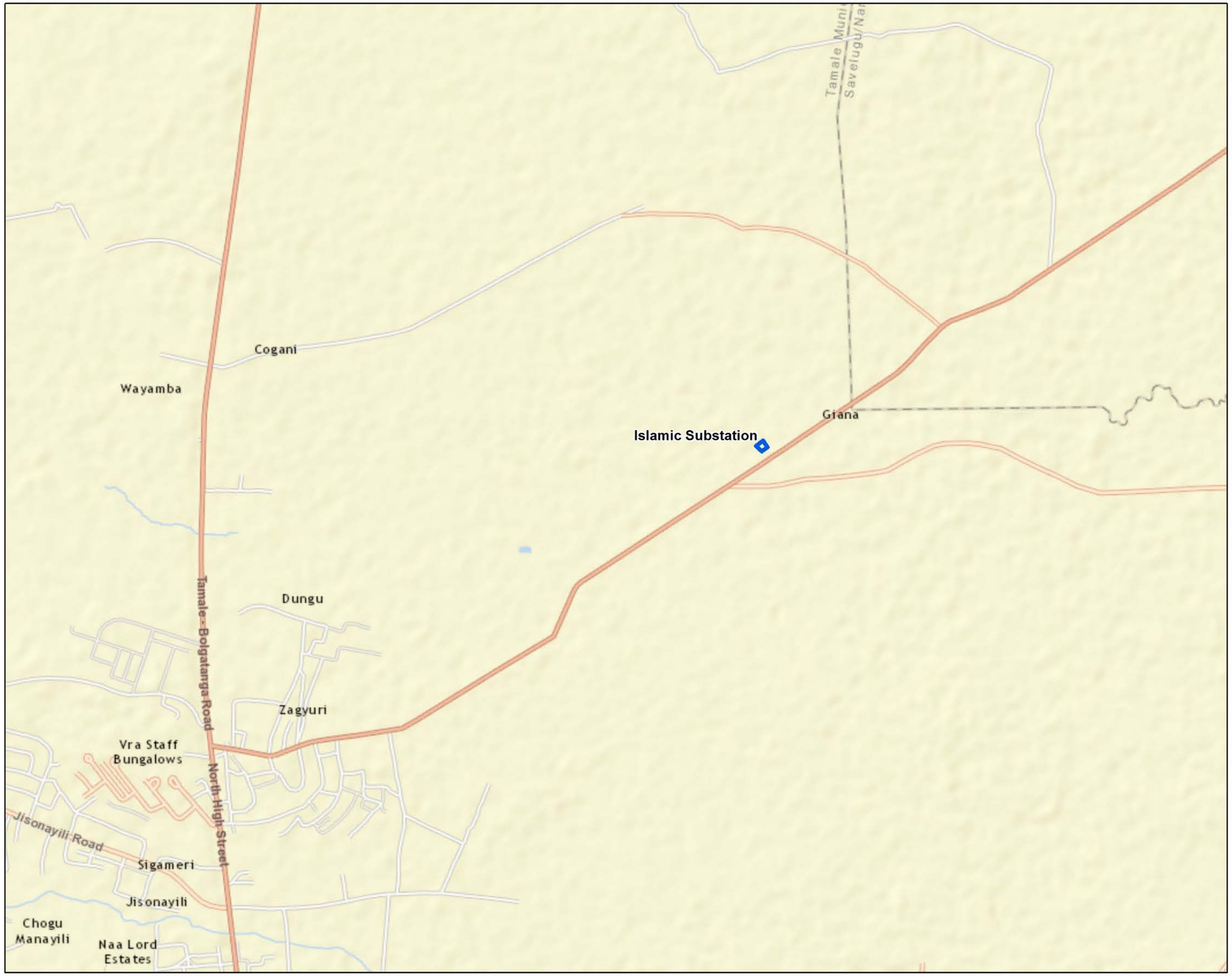
Temporary impacts to traffic may occur as a result of increased transport of workers and materials. Potential risks to community health and safety will be related to construction hazards, possible interactions with construction workers, and safety issues associated with construction activities at the substation and along the distribution line ROWs. These potential health and safety risks should be addressed in the ESMP developed for the Sub-Activities.

7.17.5 Mitigation

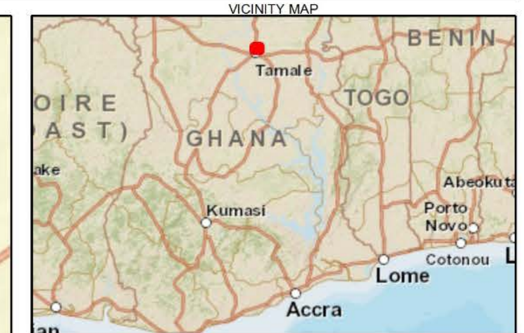
The proposed location of the substation should be evaluated against other possible locations to see if involuntary resettlement impacts can be minimized. Various line routes and construction methods should also be considered in order to minimize resettlement impacts. An appropriate RAP should be developed as needed.

Risks of human health and safety impacts associated with the project can be effectively mitigated by developing and implementing a worker health and safety plan that includes adequate training. These risks can be associated with traffic accidents as well as injuries during installation of the electrical interconnections. A health and safety plan that focuses on worker safety and health must be developed and implemented to minimize these risks. Compliance with safe driving procedures and all applicable traffic laws must be emphasized. Measures to protect the health and safety of members of the public should also be developed and implemented during construction. Cases of involuntary resettlement and/or economic displacement should be appropriately compensated based on the guidelines set out by the GoG and the MCC.

FIGURE 7-6
NEDCo- Engr-09 Islamic Primary Substation Map



VICINITY MAP



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NEDCo-ENGR-09 Islamic Substation

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FIGURE 7-7
NEDCo- Engr-09 Islamic Primary Substation Aerial

VICINITY MAP

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Ghana Distribution
May 2014

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7.18 NEDCo- Engr-11 Fiapre 34.5/11 kV Primary Substation with Interconnecting 34.5 kV links, 11 kV Offloading Circuits, and LV Network

7.18.1 Sub-Activity Description

Intervention. Some of the NEDCo distribution feeders have been extended beyond the design limits leading to deteriorating power quality, higher losses, and capacity to meet load. The primary substations currently serving the region will become overloaded based on current demand forecast. To avoid rolling blackouts, a primary substation will be installed.

Implementation. A contractor will be hired to procure and build a substation that conforms to the NEDCo's standard substation design. This activity includes installation of the following items: (1) a new primary substation including transformer, switchyard, and control house on a fenced-in plot; (2) subtransmission lines and interconnect to/from the new substation to the existing grid substation; (3) MV lines; and (4) LV distribution lines and distribution transformers.

7.18.2 Existing Conditions

This project site has not been specifically identified but is planned for the general area of Fiapre, which is characterized by both high-density and low-density suburban/rural and forested areas (see Figures 7-8 and 7-9). The substation site and interconnecting distribution lines could be located within a fairly large area of Fiapre, with land uses ranging from relatively high-density residential and commercial to rural and agricultural. No further information on any proposed site has been provided by NEDCo at the current time.

7.18.3 Environmental Impacts

Ground disturbance will be associated with construction of the primary substation and new 34.5 and 11 kV offloading lines. Construction of these facilities has the potential to result in sedimentation from disturbed soils and impacts to surface water drainages. However, these highly localized erosion risks can be mitigated by seeding and/or mulching exposed soils. Soil and groundwater also have the potential to be affected by improper disposal of construction-related chemicals, sanitary waste, and oil and grease from equipment maintenance. Mitigation measures for these potential impacts should be provided in the ESMP to be developed for the project. Final siting of the substation and line routes should be screened for any unknown environmentally sensitive areas.

Once a site for the proposed substation has been defined, a survey for vegetation and sensitive habitat and species should be conducted to better define potential impacts on these resources. The distribution lines will be primarily routed within the utility corridors along existing roads. This approach should help minimize overall impacts to vegetation, habitat, and agricultural areas. A detailed analysis of the distribution line routes should be conducted as part of the siting process to prevent sensitive environmental areas from being adversely affected by the proposed development. NEDCo generally locates distribution lines within the utility corridors along existing roads, so if this practice is in fact implemented in this case, impacts to critical habitat, vegetation, wildlife or their habitat, or legally protected or internationally recognized areas should be minimal.

Construction of the new primary substation and distribution lines will result in temporary localized impacts to air quality and noise from transportation of workers and materials and operation of construction equipment. These impacts will be limited in intensity, area, and duration. The new substation and distribution lines will have an impact on visibility. Construction of the substation and associated distribution lines will result in the generation of wastes from site clearing, equipment packaging, and other small quantity sources. Waste disposal should be addressed as part of the ESMP developed for the project.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with substation projects. These risks can be associated with traffic accidents as well as injuries during installation of the new substation and distribution lines. Health and safety risks associated with the projects can be effectively mitigated by developing and implementing an environmental, health, and safety plan and providing adequate training. There should be no additional adverse environmental impacts during operation of the substation and new distribution lines.

7.18.4 Socioeconomic Impacts

New land will be required for the substation. NEDCo typically purchases land outright for substations and does not go through an ROW; therefore, it is unlikely that and involuntary resettlement of residents or economic displacement will occur as a result of the substation. It will be important to ensure that the requirements of PS 5 are observed during land acquisition activities and that a fair market value is paid for the land. The new distribution lines will likely be located primarily within ROWs along existing roads. Because a specific site has not been located, a characterization of the adjacent roads is not possible. Within the broad area identified within which the Sub-Activity would be located, there are areas of dense residential and commercial development as well as areas of very low-density development. Although the exact routes for the distribution lines have not been identified, it is likely that these lines may result in some level of involuntary resettlement. Careful siting, layout, and final design of the substation and new distribution lines should include all reasonable efforts to minimize the number of involuntary resettlement and economic disruption cases. Construction of the substation and lines will result in short-term positive impacts on local economic activity and employment due to the need for construction and maintenance workers.

A screening for cultural resources in the area of the proposed substation should be undertaken as part of the site selection process. The screening process will include consultations with local elders and long-standing residents to assist in identifying any sites of cultural importance.

Temporary impacts to traffic may occur as a result of increased transport of workers and materials. Potential risks to community health and safety will be related to construction hazards, possible interactions with construction workers, and safety issues associated with construction activities at the substation and along the distribution line ROWs. These potential health and safety risks should be addressed in the ESMP developed for the Sub-Activities.

7.18.5 Mitigation

The proposed location of the substation should be evaluated against other possible locations to see if involuntary resettlement impacts can be minimized. Various line routes and construction methods should also be considered in an attempt to minimize resettlement impacts. Risks of human health and safety impacts associated with the project can be effectively mitigated by developing and implementing a worker health and safety plan that includes adequate training. These risks can be associated with traffic accidents as well as injuries during installation of the electrical interconnections. A health and safety plan that focuses on worker safety and health must be developed and implemented to minimize these risks. Compliance with safe driving procedures and obeying all applicable traffic laws must be emphasized. Measures to protect the health and safety of members of the public should also be planned and implemented during construction. Cases of involuntary resettlement and/or economic displacement should be appropriately compensated based on the guidelines set out by the GoG and the MCC. An appropriate RAP should be developed as needed.

FIGURE 7-8
NEDCo- Engr-11 Fiapre Primary Substation map

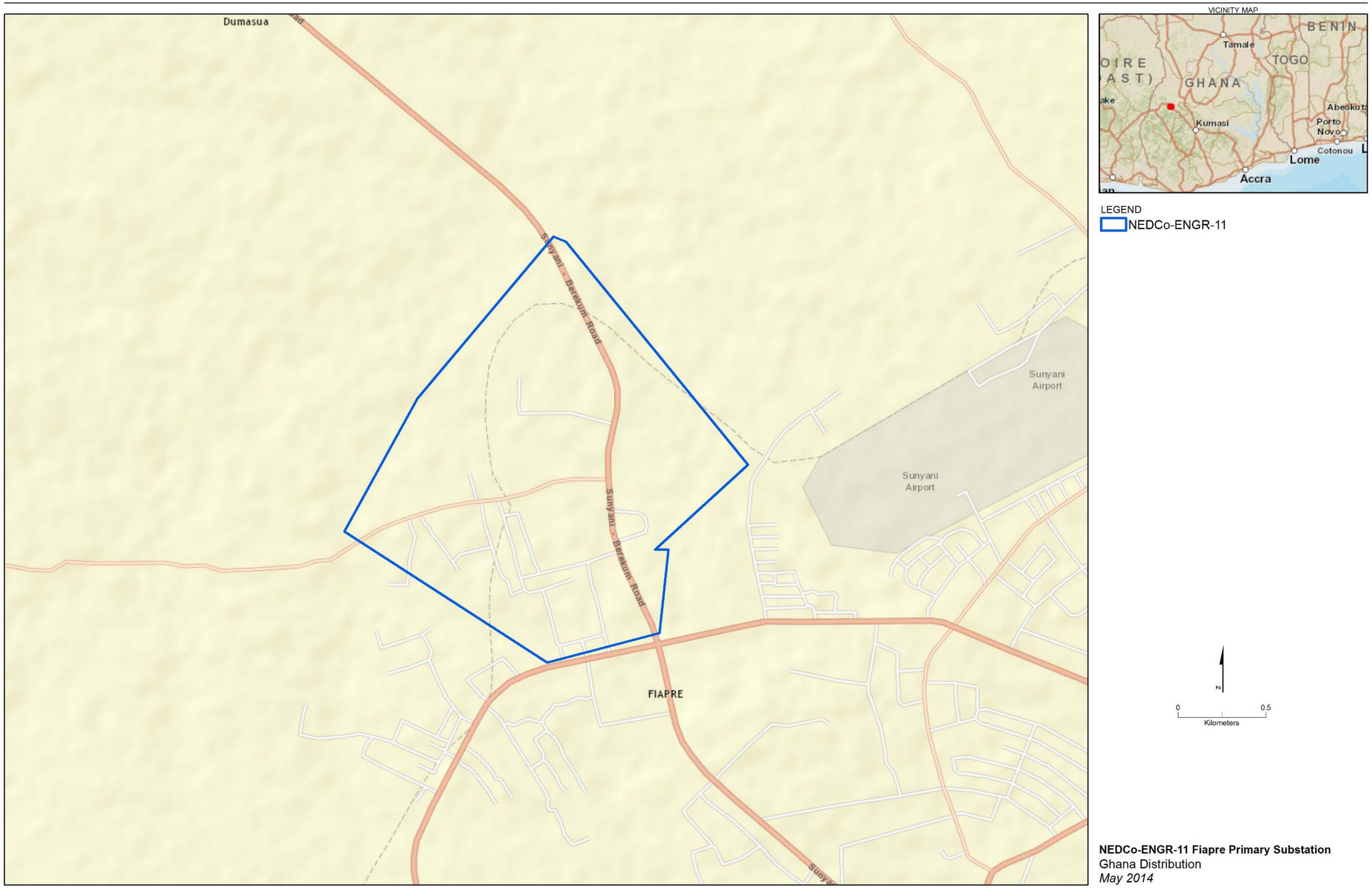
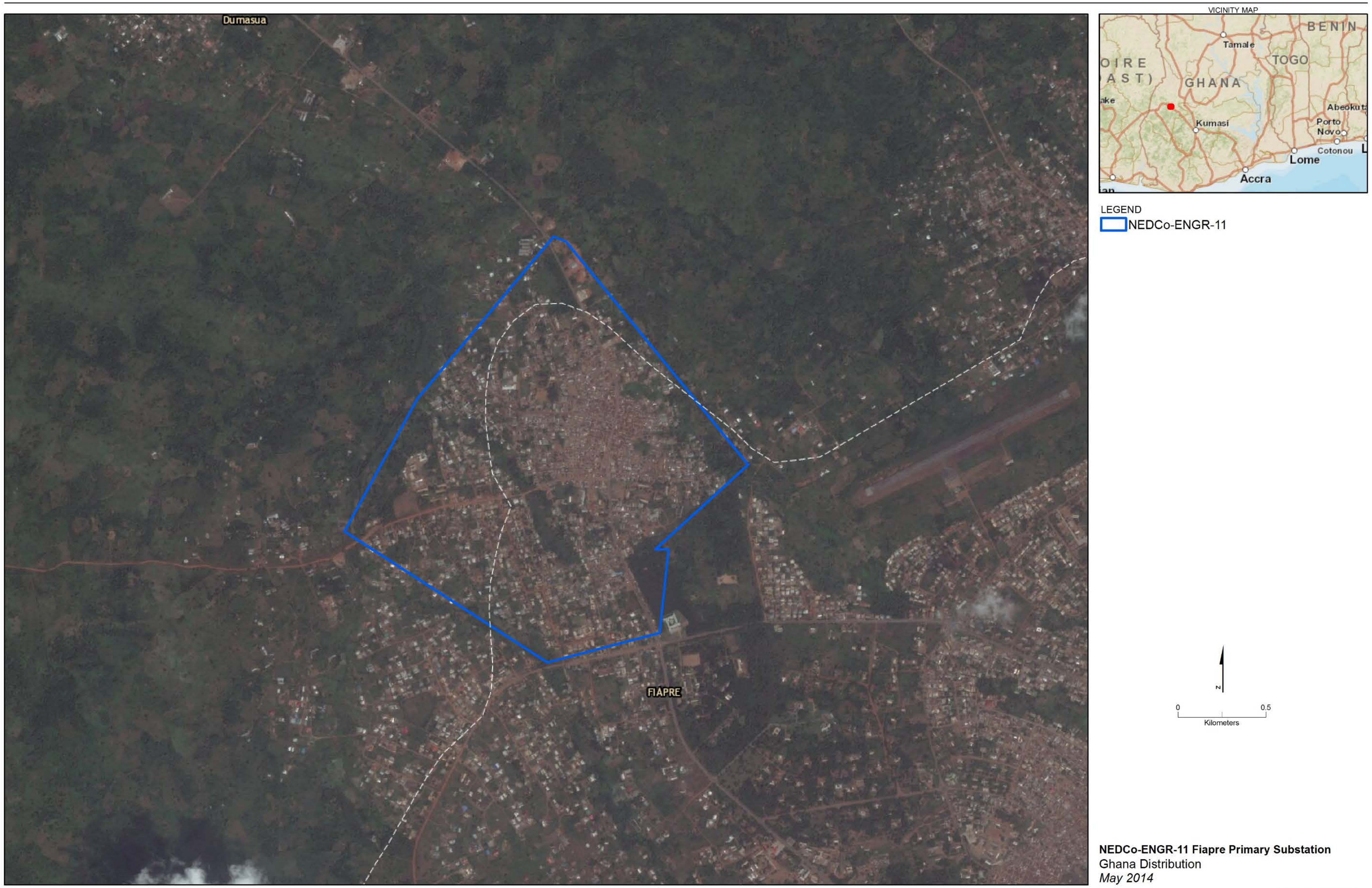


FIGURE 7-9
NEDCo- Engr-11 Fiapre Primary Substation Aerial



NEDCo-ENGR-11 Fiapre Primary Substation
Ghana Distribution
May 2014

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7.19 NEDCo- Engr-18 Reactive Power Compensation for Primary Substations and MV Lines

7.19.1 Sub-Activity Description

Intervention. Reactive power (defined as “var”) takes place on every alternating current power system where motors, inductors, and diodes shift the working or measured real power (watts) and creates a third component known as total power consumed (“va”); this imbalance is known as the power factor. By installing capacitors along the power system, this imbalance can be reduced so that watts and va become equal, thus reducing losses on the power system. Because power system daily loads fluctuate, the installed capacitors will need to be both fixed and switched installations.

Implementation. Once the Distribution Master Plan (Sub-Activity Service-04) and the engineering analysis have been completed, capacitor bank locations can be identified. The capacitor bank locations can be within a substation lot or placed along the 11 kV network. A new outdoor structure will hold the capacitors and the protective accessories for substation installation. For line capacitors, smaller banks of fixed capacitors will be installed directly on existing or replaced poles.

7.19.2 Existing Conditions

This Sub-Activity involves work within existing substations and along existing MV lines. Existing conditions surrounding the substations and MV lines will differ, depending on the current location of the substation. All work will be within existing substations or on poles along existing MV lines, so no new ROW will be required.

7.19.3 Environmental Impacts

Because all project activities will occur at existing NEDCo facilities, installation of the capacitor banks will result in minimal adverse impacts to the environment. Because all work will be done in existing substations or along existing MV lines, impacts to critical habitat, vegetation, wildlife and legally protected areas are not expected. Potential environmental impacts may include minor emission of dust from ground excavation to install underground cables to structures that will hold the capacitors. Topsoil will be temporarily disturbed when underground cables are laid. As with any work-related activity, there will be some level of potential worker health and safety risk associated with capacitor replacement. These impacts can be associated with traffic accidents as well as injuries during placement of the meters. Health and safety risks associated with meter replacement can be effectively mitigated by developing and implementing an environmental health safety plan and providing adequate training. There should be no additional adverse environmental impacts during operation of the meters.

7.19.4 Socioeconomic Impacts

Social impacts associated with meter placement will be minimal. There will be no land acquisition or economic displacement. There will be a small increase in traffic activity associated with the installation workers in residential and commercial areas. It will be important that all workers are well trained in the proper protocols for interacting with members of the public and in obeying all applicable traffic laws. There should be no adverse social or gender impacts during operation of the meters.

7.19.5 Mitigation

Recommended mitigation for capacitor bank installation includes by developing and implementing a health and safety plan as part of the overall ESMP for the Sub-Activity that focuses on worker safety, hygiene, and proper procedures for interacting with members of the public. Compliance with safe driving procedures, company policies, and obeying all applicable traffic laws should be emphasized.

7.20 NEDCo Engr-19A LV Feeder Bifurcation with MV Upgrade

7.20.1 Sub-Activity Description

Intervention. Technical losses within NEDCo are high. Technical losses on the distribution lines have an inverse exponential relationship with the voltage—that is, the higher the voltage the lower the losses. The ratio of MV:LV in has been reported in the Global Energy Consulting Engineers India loss study (2012) to be around 1:5 in the NEDCo system and should be reduced to levels used in developing countries. LV lengths will be customized for NEDCo from the Sub-Activity (Engr-22) to improve service quality and reliability while lowering technical losses. When LV lines are long and heavily loaded, their thermal losses become a large portion of the technical losses on the system. Moreover, the voltage level at the end of the long LV networks drops below allowable levels, which subsequently causes electric equipment to malfunction and/or degrade at an accelerated rate. The purpose of this project is to reduce the length of the LV circuits (segmenting a large circuits into multiple smaller ones) so that the LV trunk lines do not exceed a length that affects the quality of service to the customer and a technical loss threshold on the distribution system.

Implementation. NEDCo will design the line bifurcation upgrades. A contractor will be hired to execute on the design following the updated NEDCo construction standards (Sub-Activity Engr-22). The scope of work includes extending 55 km of 11 kV overhead (MV) lines, replacing the short pole currently carrying LV lines with taller poles, and installing additional transformers. A more complete description of this Sub-Activity is presented in Section 6.1.6, Low Voltage Feeder Bifurcation.

7.20.2 Existing Conditions

The bifurcation project will be implemented throughout the NEDCo area and will cross multiple land use types and communities. The bifurcated lines will be located in the same general ROW as the original LV lines.

7.20.3 Environmental Impacts

Because the bifurcation projects will require minimal construction of new facilities to replace existing structures, overall environmental impacts will be minimal. There will be some ground disturbance associated with replacing the distribution poles, which can be mitigated using standard mitigation measures. The existing conductors will be removed from the existing poles; the poles will be removed; and the new poles will be installed. The old poles will be returned to the storage yard for reuse or disposal. There will be potential for minimal amounts of erosion and impacts to nearby surface waters caused by soil disturbances if soils are not properly stabilized and seeded to restore vegetative cover. These impacts will be minor and should be mitigated through the use of good construction practices and environmental BMPs, such as use of erosion controls and re-seeding exposed soils. Because no ROW will be required, there will be no impacts to critical habitat, vegetation, wildlife or their habitat, or legally protected or internationally recognized areas.

Air quality impacts will be limited to short-term increased exhaust from construction equipment and generation of dust. It is likely that some of the poles that are replaced will not be reusable and will have to be disposed of properly, as well as other small quantities of waste generated during the construction process. As with any work-related activity, there will be some level of potential worker health and safety risk associated with intensification projects. These impacts can be associated with traffic accidents as well as injuries during installation of the new poles and conductors. Health and safety impacts from bifurcation projects can be effectively mitigated by developing and implementing a worker health safety plan and adequate training. There should be no additional adverse environmental impacts during operation of the bifurcated distribution lines.

7.20.4 Socioeconomic Impacts

The bifurcation Sub-Activity will occur within existing ROWs and will predominantly use existing pole locations, thereby minimizing the need for involuntary resettlement. However, a few small businesses and kiosks located close to existing poles may need to be moved or relocated if they either have been built around an existing pole or prevent access to a pole requiring replacement. For the same reason, some ancillary structures, such as hard standings, walls, and fences, may be damaged, resulting in some disruption to business operations. This disruption will be short-term and temporary because, in most cases, the damage will be capable of being repaired. Line-stringing operations associated with this Sub-Activity (and all overhead lines) are not expected to result in any involuntary resettlement or damage to property.

Overall, although some resettlement may be necessary, this will entail a low level of relocation, acquisition, and damage to property.

Temporary impacts to traffic and business operations may occur as a result of increased transport of workers and materials. Potential risks to community health and safety may arise from construction hazards, possible interactions with construction workers, and safety issues associated with construction activities at the substation sites during pole and line-stringing operations for the distribution lines. These health and safety risks, which will be short-lived and minor, will be addressed in the ESMP developed for the Sub-Activity.

The bifurcation Sub-Activities are designed to increase stability and reliability of the distribution system and should therefore have an overall positive impact on economic activity in the areas served. Due to the nature of the Sub-Activity, power outages may occur locally, but should be of relatively short duration because the Sub-Activity will typically cover only small distribution areas at a time. It will be important to communicate with affected residents and commercial establishments before any service disruption.

7.20.5 Mitigation

Recommended mitigation for the bifurcation Sub-Activity includes the use of environmental BMPs such as erosion controls during construction, and development and implementation of a health and safety plan that is part of an overall ESMP for the Sub-Activity that focuses on worker safety, hygiene, and proper procedures for interacting with members of the public. Compliance with safe driving procedures, company policies, and obeying all applicable traffic laws should be emphasized. Minimizing potential local power outages and communicating with local residents and commercial establishments about unavoidable power outages will be important. An RAP should be prepared if resettlement is required.

7.21 NEDCo Engr-22 Update Distribution Construction Standards Based on Current Low Loss Practices

7.21.1 Sub-Activity Description

Intervention. NEDCo currently has an engineering and construction standard that was inherited from VRA. Some of the standard specifications need to be updated (for example, move from open wire LV to multiplex LV cable to reduce illegal connections, or specification of lower-cost, new materials such as pre-form wire dead-ends). Other parts of the standard are not used or applied—for example, location of service connection, the single phase transformer installations, and the smaller transformers installation—when they should be.

Implementation. A contractor will be hired to review and update the engineering and construction standards in consultation with NEDCo. It also will be necessary to update NEDCo's service connections standards with a tamper- resistant, safe and economic design, for each customer category. To complete this task, the contractor will collect field information regarding the various structure types that require electric services (for example, mud huts, apartment complex, or mines). In consultation with NEDCo, the consultant will update the existing standards with a new design. The contractor will conduct training for NEDCo designers, planners and service inspectors on the updated material. Implementation and enforcement is anticipated to be the responsibility of NEDCo's management.

7.21.2 Existing Conditions

This Sub-Activity will be implemented by an outside contractor who will then work with NEDCO personnel within existing NEDCO infrastructure. No additional construction will be required.

7.21.3 Environmental Impacts

The project will not result in any environmental impacts.

7.21.4 Socioeconomic Impacts

The project will not result in any direct social impacts. The project should improve NEDCo construction standards, which will indirectly benefit both NEDCo and other stakeholders.

7.21.5 Mitigation

No mitigation is required other than implementing the project in a manner that provides equal opportunities for NEDCO staff and contractors.

SECTION 8

Other Potential Environmental and Social Issues

Section 7 identified the environmental and social impacts that are most likely to arise from Compact II activities. Other potential risks that are considered either unlikely to arise or are more general in nature in that they are non-activity specific are described in this section.

8.1 PS 2 – Labor and Working Conditions

Gaps have been identified between the requirements of this PS and current Ghanaian legislation, particularly with respect to the use of child or forced labor, including in supply chains. The likelihood of the use of child or forced labor by contractors is considered to be low. The likelihood of the use of child or forced labor in the supply chains that will be needed to supply the construction activities is not known.

The prevention of any potential contraventions to PS 2 requirements will be addressed through the adoption of the following measures:

- Including covenants in the Compact Agreements, especially those related to procurement, which forbid the use of child or forced labor by contractors, sub-contractors, and in supply chains.
- Working with NEDCO to ensure that similar conditions are incorporated in:
  - Standard NEDCO operating policies and procedures, if they are not already so included.
  - All contracts made by NEDCO under this Compact include requirements that contractors: (i) do not employ children or forced labor and sign a certification to this effect; (ii) ensure that they include these provisions in their agreements with sub-contractors; and (iii) undertake periodic monitoring of this requirement, followed up by reports to the Compact management team.
- Including a provision in the ESMP (see Section 10) to monitor the operation of these policies.

8.2 PS 4 – Community Health, Safety, and Security

Among other provisions, PS 4 requires that:

> *…the risks associated with use of security personnel used to safeguard staff or property are properly hired are assessed. Security arrangements should be guided by the principles of proportionality and good international practice, including practice consistent with the UN Code of Conduct for Law Enforcement Officials and UN Basic Principles on the Use of Force and Firearms by Law Enforcement Officials. Forces should not be implicated in past abuses, follow rules of conduct (including limitations to the use of force), receive adequate training, be monitored, and obey applicable laws. Establish a grievance mechanism, investigate allegations of unlawful or abusive acts where appropriate, take action as needed, and report unlawful and abusive acts to public authorities.*

The extent to which Ghanaian legislation in general or NEDCo operating procedures adhere to this requirement is not known. To ensure that the above requirements are adhered to and enforced, the following measures will be adopted:

- Including covenants in the Compact Agreements that cover the above requirements of PS 4
- Working with NEDCO to ensure that similar conditions are incorporated in:
  - Standard NEDCO operating policies and procedures, if they are not already so included.
  - All contracts made by NEDCO under this Compact include a requirement that contractors: (i) will adhere to these requirements; (ii) will include a similar condition in their agreements with sub-contractors; and

(iii) will investigate any reported contraventions of these requirements; and (iv) will report these (along with any actions taken) to the public authorities and the Compact management team.

- Reporting any such incidents to the public authorities, if this has not already been done by members of the public or contractors.
- Including provisions in the ESMP (see Section 10) to ensure that all reported contraventions are fully investigated.

8.3 PS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

There are gaps between the requirements of this PS and Ghana's current national policy, especially the absence of national policy regarding conversion or degradation of critical habitat. This aspect has not been examined in any depth because there is little likelihood of any of the proposed investments going into environmentally sensitive areas or affecting sensitive habitats.

Should any such habitats be identified as project locations, however, the requirements of PS 6 will be applied.

SECTION 9

Gender Assessment

9.1 General

This gender assessment is undertaken in accordance with the MCC gender policy, which states that:

> *The commitment of the Millennium Challenge Corporation to gender equality is grounded in our mission to promote economic growth and poverty reduction. MCC recognizes that many countries with high levels of gender inequality also experience high levels of poverty and that gender inequality can be a significant constraint to economic growth and poverty reduction. Therefore, in order to maximize the impact of Compacts on economic growth and poverty reduction, MCC requires that eligible countries analyze gender differences and inequalities to inform the development, design, implementation, monitoring, and evaluation of programs funded by MCC.*[5]

Access to reliable, clean, and low-cost energy enables individuals, households, employers, employees, and communities to maintain and enhance their quality of life. Expanded and improved electrification is crucial for household, productive, and social activities as well as effective education and health care services.

Compact II will result in a substantial increase in the availability and reliability of electricity supply throughout Accra and cities, villages, and towns in northern Ghana, thereby providing a major impetus to its national economic and social development.[6] To a large extent, these benefits will apply equally to men and women, and especially so in relation to work activities. Nevertheless, there will be situations where gender impacts will vary. This gender assessment examines situations where these differential impacts are most likely to occur.

Women use energy differently than men[7] and are key end-users of energy for household purposes. Women also participate strongly in the informal small scale commercial sector.[8] A number of studies highlight the link between energy and gender within an Africa context, and specific to Ghana.[9] Although these studies provide essential information, there is a dearth of secondary research providing sex-disaggregated energy data in Ghana and information related to energy purchase and use at the household level. As such, some of the referenced studies conclude that it is difficult to ascertain women's access to and impact from energy service in Ghana.

Findings from these studies include:

- Although improved energy may extend the working hours (and therefore working days) of women working outside of the home, at home the lack of electricity has a more significant impact on women because they must expend physical labor to complete household tasks.
- Key uses of reliable energy are for income-generating activities, to complete household responsibilities, generate informal sector products, and for use in the community and commercial sectors.
- Constraints that women may face include the availability and access to energy, to credit needed to launch or sustain/maintain enterprises, to prepayment cards, and to decision making involving household issues.

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5 MCC, 2011, Gender Policy, Washington; https://www.mcc.gov/documents/guidance/mcc-policy-gender.pdf

6 I.e., through the reduction of power outages that currently affect business and household activities alike.

7 Wamukonya, Njeri. 2002. A critical look at gender and energy mainstreaming in Africa; http://www.un.org/womenwatch/daw/forum-sustdev/Njeri-paper.pdf.

8 Over half of women in urban areas and over 20% in rural areas work as self-employed sole traders; Ghana Living Standards Survey, 2012, Labour Force Module; http://www.statsghana.gov.gh/docfiles/glss6/glss6_labour_force_4th_to_6th_cycle_report.pdf .

9 MCC, 2014, *Report on Electricity Availability, Reliability, and Economic Use in the Techiman Municipality of the Brong Ahafo Region of Ghana;* World Bank, 2012, *Energy, Gender, and Development: Where are the Linkages? Where is the Evidence?;* Quayson-Dadzie for MCC, 2012, *Customer Perception and Acceptability on the Use of Prepaid Metering System in Accra West Region of Electricity Company of Ghana - Social and Gender Analysis;* Energia Africa (International Network on Gender and Sustainable Energy), 2010. *Gender Assessment of the Ghana Energy Sector*; http://www.energia-africa.org/fileadmin/files/media/reports/Ghana/Ghana%20Audit%20final%20report.pdf

- Provision of improved and reliable energy presents various opportunities for women to increase their involvement in home-based income-generating enterprises.

9.2 Potential Gender-related Impacts relating to Compact II Sub-Activities

Summary information regarding summary gender-specific impacts that could arise from Compact II Sub-Activities is provided in Table 9-1, which emphasizes impacts that relate to women's roles in household and enterprise-related activities. Note that issues related to potential adverse impacts resulting from loss control activities have been addressed in Section 2.5.

TABLE 9-1
Potential Gender-related Impacts of Compact II Sub-Activities

Potential Impact	Possible/Likely Positive	Possible/Likely Negative
In 2008, 20% of urban households and 75% of rural households did not have use electricity for lighting. The substantial extension of electricity supplies will reduce this percentage and thereby engender a substantial positive impact for women[1]. By 2012, this national proportion had increased from 49% to 70%[2]. However, issues of reliability and frequent outages reduce the benefit of this increase in access to electricity.	XX	
Fuel wood and charcoal remain as primary energy sources in rural and urban areas in Ghana. A reduction in use of fuel wood would reduce indoor air pollution and labor expended (related to the arduous task of fuel wood collection and burning). Fuel wood is used for domestic purposes and women are responsible for gathering and using it. As such, increased availability and reliability of electricity supplies could lead to a reduction in pollution levels, improving health and reducing poverty given the increased time available for income generations[3]. However, current data indicate that few Ghanaians use electricity as a fuel source (liquid natural gas is much more prevalent) so there will be at most a slight positive impact[4].	X	
Women operating small businesses away from the home that use electricity will benefit from reduced outages and will have the potential to have longer opening hours.	XX	
Reliable energy supply will provide additional time that could be used for income-producing enterprises, which could improve socio-economic conditions[5]. Although studies specific to Ghana in this area do not exist, similar studies conducted in other countries show that the impact of reliable energy supply may have a positive impact on the allocation of time for women. The impacts relate to female heads of households having additional time available for income-generating activities in the evening[6] and spending less time cooking[7].	X	
Increased and improved street-lighting will provide for safer environments at night for women.	XX	
Increased reliability of indoor lighting will help children do their homework and therefore contribute to one of the primary aspirations of any mother.	X	
Related to prepayment meters: (i) there may be difficulty purchasing fuel cards due to number of vendors and hours of operation; (ii) there may be suspicion related to prepayment meters and adoption of a new technology; and (iii) women may have unequal/lesser access to currency, which would be needed to purchase prepayment cards.		X (but could be allayed by publicity campaigns)

Notes:

1 GLSS, 2008; http://www.statsghana.gov.gh/docfiles/glss5_report.pdf

2 GLSS, 2012; http://vibeghana.com/2014/08/30/56-3-per-cent-of-ghanaians-are-literate-glss-6/ (GLSS)

3 Millennium Challenge Corporation and Millennium Challenge Account Ghana Program, 2012. *Social and Gender Analysis,* FInal Draft.

4 GLSS, 2008, op. cit.

5 MCC, 2012, op. cit., Energia, op. cit. and USAID, 2011, Gender Assessment – Ghana; http://pdf.usaid.gov/pdf_docs/pnadz759.pdf.

6 Barkat et al, 2002, Barkat et al, 2002: 'Economic and Social Impact Evaluation Study of the Rural Electrification Programme in Bangladesh', Human Development Research Centre, Bangladesh. Available at http://pdf.usaid.gov/pdf_docs/PDABZ138.pdf.

7 Grogan L. and Sandanand A., 2009, Electrification and the Household; http://www.isid.ac.in/~pu/conference/dec_09_conf/Papers/AshaSadanand.pdf

9.4 Conclusions

The increased availability and reliability of electricity supplies resulting from Compact II will bring benefits to a significant proportion of Ghana's population, be they male, female, young, or old. By and large, these benefits will affect men and women in much the same way – by increasing their income-generating potential and reducing the negative impact of outages. They will also increase the quality of domestic living.

The differential gender impacts relate mainly to home activities, which are largely carried out by women who would thus benefit from improved lighting in the home for both domestic and small income-generating activities. Improved street-lighting will also increase their sense of security during the hours of darkness.

Potential negative impacts are hard to identify based on available information and revolve around the use of pre-payment cards and the introduction of new meters. These potential negative impacts can be mitigated through publicity campaigns.

The overall conclusion of this gender assessment is that increased availability and reliability of electricity supplies will bring significant benefits to women, as they will to most of the population, and that there will be little in the way of negative impacts.

SECTION 10

Draft Environmental and Social Management Plan

10.1 Overview

This draft ESMP defines the framework, program-level environmental and social control and mitigation measures, monitoring programs, and responsibilities to be included as appropriate in each Sub-Activity-specific ESMP. Although potential impacts and mitigation measures have been evaluated generically for the proposed NEDCo Sub-Activities, additional environmental and safety impact assessments should be conducted once specific site locations are identified and design specifications developed.

An ESMP identifies the EHS management strategies, measures, plans, and programs needed to avoid, minimize, mitigate, and monitor temporary and permanent Sub-Activity impacts to the natural environment, managed landscapes, and human communities. It details proactive facility planning/siting efforts, management systems, and impact/risk mitigation and monitoring activities to be continuously carried out to prevent or minimize physical, biological, cultural, and socioeconomic impacts, while protecting the occupational safety and health of employees. It proposes plans and actions to manage environmental risks and impacts from facility construction and operation, including institutional arrangements, environmental documentation procedures, NEDCo and contractor EHS responsibilities and training programs, and estimates of ESMP implementation costs. It is important that all employees and contractors involved with implementation of the various MCC-funded Sub-Activities comply with all relevant Ghanaian laws, IFC PS, World Bank EHS guidelines, ISO 14001, corporate EHS policies and procedures, all project-specific permits, and EHS requirements.

10.2 EHS Policy and Procedures

Through VRA, NEDCo has developed a corporate EHS policy and procedures aimed at safeguarding the environmental quality and mitigating or offsetting the adverse impacts to the environment from all its activities in conformance with national and international EHS protection standards and regulation in a sustainable manner. These policies and procedures, including EHS standard operating procedures (SOPs) and BMPs, will be revised and updated as needed to integrate additional elements of the ESMP related to the EHS impacts and risks from construction, operation and decommissioning of new or expanded facilities before operation. Individual components of the draft ESMP for MCC Ghana Compact II are discussed below and presented in Table 10-1.

10.2.1 ESMP Objectives and Targets

The objectives of the ESMP are to:

- Establish a conceptual framework and provide basic guidelines, policies, and procedures to be used in establishing, administering, maintaining, and educating the community about the environmental program, as may be required by the MCC, Ghana EPA, and the other relevant parties
- Detail work programs to prevent or reduce adverse environmental, health, and safety effects and risks
- Identify ESMP implementation responsibilities of the company and its contractors/consultants
- Confirm financial commitment to EHS management through budget estimates, schedules, staffing and training requirements, and other necessary support services to implement the mitigation measures

The targets of the ESMP are to:

- Comply with all applicable laws, regulations, ordinances, statutes, rules, and codes governing environmental requirements and conduct the works based on the requirements of all permits issued
- Provide all documentation required by all levels of governing authority concerning EHS requirements and sharing relevant operational EHS information with local communities
- Provide and maintain effective planning and field control measures for the construction activities

- Comply with the MCC requirements as established on the IFC PS

10.2.2 Environmental and Social Management System

To maintain control over and tracking of implementation of the Sub-Activities and also to ensure that commitments are acted upon in a comprehensive and acceptable manner, an ESMP, including training programs, will be developed as appropriate for the Sub-Activities. A single ESMS will be developed and implemented by NEDCo to effectively track and manage the individual ESMPs and will help to identify personnel, responsibilities, and training requirements for implementation of the ESMPs.

The Project Environmental and Social Management Team will be responsible for the following:

- Ensuring the projects' compliance with all relevant environmental, social, health and safety regulations
- Liaising with the community and all relevant regulatory bodies and organizations - EPA, Department of Urban Roads, project-affected persons, etc.
- Formulation and review of environmental and social policies and practices associated with projects, including EHS and public outreach programs designed to make the public aware of project construction activities (nature and timing) that may affect them.
- Liaising with relevant NEDCo departments on all health, environmental, safety, and social matters connected to the full life cycle of projects
- Assisting in the education and training of project staff in environmental, social, and safety awareness
- Undertaking environmental, public/worker health and social monitoring activities for projects

The budget for environmental and social management should be provided as part of project and corporate EHS funding for Sub-Activities.

The Environmental Officer assigned to the various Sub-Activities will have the following responsibilities:

- Monitoring all environmental and social programs for the operation phase of the project, including those related to biophysical and socioeconomic/cultural components
- Working closely and coordinating efforts with the MCC, EPA and other enforcement bodies to ensure full compliance with all legal and regulatory requirements
- Organizing activities to motivate and maintain the interest of the project staff in EHS and social issues and assisting to increase project staff awareness of environmental issues through training programs and review meetings
- Coordinating investigations into/of all types of accidents and environmental damages/releases
- Conducting environmental and social audits in accordance with project monitoring guidelines
- Working closely with contractors to ensure strict adherence to all monitoring and mitigation guidelines and recommendations for the project, including compliance with all heath, social, and safety guidelines outlined and strictly following NEDCo's environmental policy guidelines
- Developing a work plan for implementing the ESMP
- Making budgetary provisions for projects' EHS and public outreach programs.
- Establishing and running a reporting system on progress (or otherwise) in implementation and success of impact/risk mitigation measures (including contractor's obligations), training, etc.
- Producing publicly available environmental reports

10.2.3 ESMP Implementation Arrangement

Resources needed to implement the ESMP are personnel and funding. The key stakeholders in the ESMP implementation are NEDCo, contractors, consultants, EPA, and the MCC. NEDCo will provide personnel to achieve the following objectives:

- Propose management rules and specific measures that are compatible with sustainable development principles and environmental BMPs while implementing the project
- Promote awareness by its personnel and the general public regarding environmental protection
- Propose concrete means of applying the ESMP

NEDCo will be responsible for the budget, scheduling, and implementation of the ESMP, working in close collaboration with its contractors, Ghana EPA and the MCC and in coordination with community leaders as needed. The Ghana EPA will review and approve the ESMPs for projects with the potential to result in environmental impacts as required under Ghana regulations set out in the Environmental Impact Assessment Guidelines for the Energy Sector.

The environmental specialist or designated person at NEDCo will be responsible for implementing the ESMP, including conducting environmental impact monitoring and EHS compliance audits. His/her responsibilities shall include:

- Providing coordination and liaison with, and monitoring of the contractors
- Compiling and preparing periodic environmental reports for submission to the World Bank
- Reviewing of EHS audits and other environmental reports from consultants, in collaboration with EPA
- Monitoring and ensuring the success of EHS impact and risk minimization and mitigation efforts
- Responding to community and stakeholder EHS complaints, concerns, and information requests
- Managing data
- Performing Sub-Activity inspections

The MCC/MiDA has the overall responsibility to ensure that its safeguards policies are complied with. In addition, the MCC is responsible for the final review and clearance of the ESMP. During implementation, NEDCo will be responsible for ensuring that the project complies with the provisions of the ESMP. The MCC/MiDA will periodically review the implementation status of EHS safeguards.

10.2.4 Establishment of ESMS Grievance Redress Mechanism

The RPF contains a detailed specification for the establishment of a GRM to handle complaints and grievances relating to resettlement, the majority of which will arise during the implementation period, when compensation packages are being negotiated and disbursed, and PAPs have to leave their current residences or places of work.

The RPF also includes a referral mechanism for dealing with grievances that are either lodged with the Resettlement Management Team (RMT) but pertain to other issues (e.g., environmental or legal) or were lodged with others but haven been referred to the RMT for resolution.

The extension of the GRM to cover all social and environmental issues will be a key component of the ESMS. The overall GRM will address any sort of complaint or question that might come from an affected party.

The GRM will consist of a four-stage resolution procedure:

- Resolution by the person with whom the grievance is lodged.
- Resolution by an internal dispute system established within the team with whom the grievance is lodged.
- Resolution by a formally constituted Grievance Redress Committee, which will be a sub-committee of the overall project management committee.
- Resolution through the legal system.

Other important features of the GRM are:

- Awareness of the GRM will be promoted throughout the project areas through public meetings, leaflets, the media, and local officials.
- Complaints lodged with team members not responsible for the type of grievance to which the complaint refers (e.g., construction damage claims lodged with a member of the resettlement team) will be referred to the Compact unit or outside agency for action.
- Copies of all grievances received will be submitted to the Environment and Social team[10] , which will maintain a comprehensive register. The register will indicate whether the grievance has been resolved and whether it has been referred to another team. The register will form the basis of monthly progress reports. If grievances are not resolved when they are lodged, the team dealing with the grievance will inform the Environmental and Social team once it has been resolved and appropriate action taken.
- The Environment and Social team will undertake periodic follow-ups with the team/ agency dealing with non-environmental / social grievances to ensure that action is being taken on unresolved grievances and that outstanding grievances are not threatening project implementation.

10.2.5 Environmental and Social Impacts Monitoring Plan

A monitoring plan will be developed with the objective of establishing appropriate criteria to verify the predicted impact of the project, and to detect any unforeseen impacts adjust the mitigation where needed at an early stage. The plan will ensure that mitigating measures are implemented during pre-construction, construction, operation, maintenance, and decommissioning. Specific objectives of the monitoring plan are to:

- Check the effectiveness of recommended mitigation measures
- Demonstrate that Sub-Activities are carried out in accordance with the prescribed mitigation measures and existing regulatory procedures
- Provide early warning signals whenever an impact indicator approaches a critical level

Oversight for the environmental and social management process will be the responsibility of the supervisory consultants in collaboration with appropriate management at NEDCo. Monitoring of impacts and auditing of EHS compliance (permits and policies) will be conducted during all phases of the project: design, construction, execution, operation, and maintenance.

The NEDCo implementation units will prepare a monitoring strategy that will encompass clear and definitive parameters to be monitored for each Sub-Activity, including impact monitoring and reporting proposed in the project permits and agreements with landowners, MCC, and other local stakeholders. The monitoring plan will be commensurate with the scale of development, the environmental and social sensitivity of the project setting, and the financial and technical means available for monitoring. The plan will identify and describe the indicators to be used, the frequency of monitoring, and the standard (baseline) against which the indicators will be measured for compliance with the ESMP.

The following indicators would be used to monitor the affected environment:

- Has the pre-project human and natural environmental state been maintained or improved along expanded ROWs, at the substation, or at other new/expanded facilities?
- Environmental impacts: loss of vegetation, soil erosion and land degradation, siltation impacts to surface water quality and/or wetlands, impacts to protected flora and fauna, impacts to cultural resources and land use
- Effectiveness and success of impact minimization and mitigation measures

[10] Not needed for grievances involving only requests for information that were dealt with when the grievance was lodged.

- Socioeconomic Indicators: population incomes, number of people provided with environmental training to implement commitments and ESMP, number of local workers used during the works

10.2.6 Environmental and Social Impact Monitoring Parameters

The monitoring parameters and the recommended frequency will be strictly adhered to. The parameters to be monitored will be based on the list below, with appropriate deference to Sub-Activity characteristics and location, in addition to any other EHS parameters specified in project permits:

- Cultural heritage
- Identification of project-affected persons and compensation payment
- Noise and vibration
- Air quality (emissions/ambient air/particulate matter)
- Traffic and transportation effects
- Public safety and occupational safety and health issues
- Waste management (solid and liquid waste)
- Water quality and resources (including groundwater)
- Landscape and visual intrusion
- Adverse impacts to flora and mortality of fauna
- Safety hazards
- Structural failures

The baselines established by the individual impact analyses will enable NEDCo to develop appropriate Sub-Activity-specific monitoring requirements and thresholds that will signal the need for corrective actions and the detection limits. The Environmental Monitoring Team members will be trained to understand and appreciate the choice of parameters, sampling sites, methods of sampling/measuring and analysis, and frequency of monitoring.

10.2.7 EHS Training and Development

NEDCo management is committed to promoting environmental awareness among all workers and contractors. Therefore, training in the EHS aspects of their work is required for all workers and contractors, and records of such training programs must be maintained. Training programs will include formal courses, workshops, lectures on environmental issues at general meetings, showing of environmental videos and slides, drills on oil/fuel/chemical spill prevention, emergency response, and management, as appropriate, as well as other on-the-job activities.

Formal training programs in all aspects of facility operation, maintenance, and management will be developed and implemented. Programs will be comprehensive and include training in EHS procedures to ensure safe and efficient construction, and operation and maintenance of the facilities. A training needs assessment matrix will be prepared that contains the relevant job functions and the various types of technical knowledge required to operate the ESMP. The overall objectives of the training needs assessment will be to:

- Identify the issues and procedures that employees need to be trained in and the key functional roles and operational responsibilities that will require specialized EHS training
- Fill out a training needs matrix to target the training to a specific audience
- Ensure that, as a minimum, all workers (including new recruits) receive basic training in environmental awareness and all elements of the ESMP

The environmental training and awareness program shall be established to enhance the understanding of all staff members, supervisors, workers, and subcontractors pertaining to ESMP and environmental impacts and mitigation measures. From the start of the work, NEDCo will undertake a continuous EHS improvement program with environmental education that is appropriately customized for the employees, including training in effective hazardous materials and waste handling and management procedures, and regular and frequent HIV/AIDS awareness. Environmental issues shall be discussed between superiors and their subordinates during the periodic EHS awareness meetings.

To ensure the successful implementation of all the environmental management programs, a training program is recommended for the Environmental Management Team and key contractor personnel. The first environmental training for existing employees shall be combined with EHS training for new recruits. The training program will cover the creation of environmental awareness and occupational safety and health issues. The main issues of concern will be developed for each Sub-Activity based on the nature of the specific tasks and site-specific conditions.

For all projects, areas earmarked for environmental awareness creation will include:

- Proper usage and definitions of basic environmental terminologies
- Environmental laws, regulations, and environmental compliance in Ghana
- MCC EHS and social policies, including the MCC-adopted IFC PS
- General environmental policies, procedures, BMPs, and availability of SOPs
- Introduction to environmental management planning
- Environmental impact and risk assessment
- Mitigation measures
- Environmental and social impact monitoring plans
- Internal and external EHS audits, including permit compliance and policy conformance

10.2.8 Information, Education and Communication

In addition to the provision for continuous public and worker education during the project and subsequent posting of “Warning Signs”, sustained information, education and communication programs to promote overall community safety shall be implemented on regular basis. These information, education and communication programs will be designed to remind NEDCo workers, contractors, and the community about project activities, risks and/or safety hazards that could endanger their lives, as well as the need to adhere to warning signs.

10.2.9 Proper and Adequate Records Keeping

NEDCo will keep a general register in the prescribed form required by the Factories, Offices and Shops Act of 1970 for the duration of the project. Records that will be kept, also prescribed by this law, will be specified in the ESMP for each project, based on the nature of the new or expanded facility and its environmental setting.

10.2.10 ESMP Budget and Schedule

It is assumed that NEDCo will engage or task an officer with supervising environmental management activities to ensure compliance and enforcement both during construction and thereafter for the operational life and decommissioning of the project. The responsible environmental manager or officer for each project shall develop a budget and schedule for implementing the ESMP, including the staffing and funding needed to develop any customized plans, procedures, and protocols that must be site- specific and designed to cost-effectively implement all elements of the ESMP.

TABLE 10-1
ESMP Elements

Project Phase and Activities	Potential Benefits, Impacts or Risks	Impact Avoidance, Minimization and Mitigation or Enhancement Measures	Responsibility	Frequency and Timing	Verifiable Indicators of ESMP Performance
Pre-Construction Planning, Siting and Design Activities					
Agency Consultation – Relevant for Category B Sub-Activities	Beneficial Impact: Facilitate approval of low impact project siting and design	Negotiate scope of PEA and siting, design, mitigation, EHS standards, monitoring requirements, and other permit conditions, to enhance project sustainability and acceptability	NEDCo with consultant support	During site selection and Design	Number of meetings Meeting minutes Agreement memoranda - Permit issuance
Community Consultation – Relevant for All Sub-Activities involving resettlement and the possibility of customer disconnection	Beneficial Impacts: Prevent community ignorance and fear; raise awareness; gain trust; dispel misinformation and identify concerns to resolve prior to construction and operation	Involve stakeholders in early Sub-Activity discussions and Inform all communities adjacent to project sites of project schedule/activities Obtain and apply feedback during siting and design of new/expanded facilities Inform potentially affected persons, if any, of entitlement to compensation and framework/process Disseminate relevant impact assessment findings	NEDCo with consultant support	Periodically -prior to site selection - during design and construction	Number of local consultative meetings held and minutes Number of local community complaints
Site Screening and Selection – New Facilities	Beneficial Impact: Selection of low impact sites and minimization of resettlement	Apply environmental sensitivity mapping to identify new facility sites with few or no sensitive human or ecological receptors. Minimize the need for resettlement.	NEDCo with consultant support	Prior to site selection and final design	Number of environmental issues Number of resettlement cases
EAs –Need based on Sub-Activity categorization by Ghana EPA and IFC PS1	Beneficial Impact: Impact avoidance and minimization. Obtain needed approvals.	Develop EA1, and PEA as required by Ghana EPA. Conduct appropriate level of impact analysis for IFC PS 1.	NEDCo with consultant support	During project design	Completed EA1, PEA, and ESIA documents as required for the various Sub-Activities.
Land Acquisition – Relevant for BSP, New Substations and Other New or Expanded Fixed Distribution Facilities	Adverse Impact: resettlement and/or economic displacement of business and individuals	Siting of facilities to minimize resettlement Purchase of land from willing sellers for substations Adequate compensation or payment to landowners or communities to minimize adverse socioeconomic impacts consistent with the requirements of IFC PS5 Assistance in finding new employment or relocating displaced business, with particular emphasis on vulnerable PAPs.	NEDCo with consultant support	Permanent Impact starts before construction	Purchase documentation for substations Records of land sale and compensation paid Records of success in new occupation/job Income data for relocated business
Wayleave Acquisition - for New or Wider Distribution Line ROWs	Adverse Impact: Loss of land use during construction and permanent land use changes/restrictions	Locate distribution lines within existing utility corridors along public roads. Select routes and design facilities to minimize permanent losses of or constraints on current land use Ensure that period of inaccessibility to land is as short a possible	NEDCo with consultant support	From Siting throughout Construction and Operations	Interviews with affected land owners and other community members

TABLE 10-1
ESMP Elements

Project Phase and Activities	Potential Benefits, Impacts or Risks	Impact Avoidance, Minimization and Mitigation or Enhancement Measures	Responsibility	Frequency and Timing	Verifiable Indicators of ESMP Performance
Worker Environmental, Health and Safety Awareness Training	Beneficial Impact: Reduction of work-related accidents, incidents, risks and adverse impacts to human health and the environment	EHS training of NEDCo Supervisors, site manager's staff and contractors, including training on ESMP implementation for all subprojects. Training to include EHS and social impact assessment, mitigation, monitoring, and audits or evaluation of compliance with permits and social/EHS safeguards.	NEDCo and Contractor with consultant support	Periodically throughout construction and operations Annual EHS Compliance Audits	NEDCo and contractor EHS training records Accident statistics Internal audits of ESMP implementation and permit compliance Agency notices of violations of permits
Education of Community on Public Health and Project EHS Impacts and Risks	Beneficial Impact: Awareness building for public health issues; increased local appreciation and reporting of EHS impacts and issues	Public workshops on occupational health, safety and environmental awareness; workshops need to include female participants. Public notification programs to make the community aware of construction operations likely to generate high noise levels and establishing procedures to handle complaints and coordination of disposal sites and haul routes with local officials is recommended.	NEDCo with consultant support	Prior to and periodically throughout construction	Accident statistics Community training records Records of child labor incidents Volunteer EHS activity to report project impacts and maintain landscape value and safety of ROW
Baseline Environmental Surveys – Appropriate Sub-Activities based on the need for Ghana and MCC impact assessment requirements	Beneficial Impact: Basis for confirming incremental impacts via monitoring	Baseline environmental quality, land use, and ecological data gathered during the EA1, EA2, PEA or ESIA should be commensurate with the specifics of the individual Sub-Activities to serve as basis for monitoring project's future incremental impacts both during construction and operations	NEDCo with consultant support	Before construction during the impact assessment preparation process	Baseline environmental documentation in the EA1, EA2, PEA or ESIA and permit applications
Sourcing of Construction Materials	Adverse Impact: Indirect impacts from supporting a non-sustainable activity	Obtain lumber from Forestry Commission-approved sawmills Avoid chain sawn timber Obtain aggregates from licensed quarries	NEDCo and Contractor	During bid preparation	Bid specifications and contracts for raw material sources
Develop or Update EHS Policy, BMPs and SOPs	Beneficial Impact: Foundation for ESMP implementation and permit compliance	Develop or update comprehensive NEDCo EHS policies, procedures, protocols, environmental BMP manuals, and training programs/modules needed to implement ESMP, permit requirements, and PEA/ESIA commitments	NEDCo	Before new facility operation	Written documents
All Construction and Operation Phases					
All Construction and operation phases	Adverse impact: potential use of child and forced labor, including in supply chains.	Include clauses prohibiting use of child / forced labor in all contracts signed between: (i) NEDCO and contractors; and (ii) between contractors and their sub-contractors/ suppliers.	NEDCO/ contractors	All phases	Signed contracts. Records of child labor incidents

TABLE 10-1
ESMP Elements

Project Phase and Activities	Potential Benefits, Impacts or Risks	Impact Avoidance, Minimization and Mitigation or Enhancement Measures	Responsibility	Frequency and Timing	Verifiable Indicators of ESMP Performance
All Construction and operation phases	Adverse impact: untrained or poorly briefed security personnel lead to unlawful or abusive acts.	Include clauses requiring security personnel to be adequately assessed and security arrangements to be guided by the principles of proportionality and good international practice in all contracts signed between: (i) NEDCO and contractors; and (ii) between contractors and their sub-contractors/ suppliers.	NEDCO/ contractors	All phases	Signed contracts. Records of contraventions
All construction activities	Adverse impact: short-lived disturbance to residents and workers during construction activities.	Widely publicize nature, timing, and duration of construction activities that could result in short- term disruption to local activities. Ensure presence of safety officers when construction requires temporary restrictions of activities on safety grounds, e.g., when poles are being erected and overhead lines are being strung/ re-strung or when trenches are being excavated.	NEDCO and Contractor	Throughout construction	Leaflets distributed. Complaints received from public and how resolved.
All construction activities	Adverse impact: grievances related to construction activities go unheeded, causing resentment and potential delays to project implementation.	Establishment of GRM	Environmental and Social management team	Throughout construction	Monitoring and reporting of grievances lodged and how resolved.
		Land Clearing, Excavation and Construction			
Temporary Employment of Local Labor	Beneficial Impact: Socio-economic benefits, local labor capacity building	Maximize temporary local employment (including women) on construction works as well as worker camps	NEDCo	Throughout construction	Local workforce employed as percentage of total local workforce Women employed as percentage of total local workforce
Site Clearing and Excavation for New Aboveground and Underground Structures	Adverse Impact: Permanent removal of native vegetation and displacement of fauna during and after land clearing, excavation and construction	Mark out minimum work areas for clearance and use small equipment or manual clearance methods Selective removal of tall trees near distribution lines and other vulnerable facilities, leaving saplings and shrubs for quick regeneration of native vegetation Prevent colonization by invasive species	NEDCo and Contractor	Construction and facility operation	Numbers, sizes and species of trees cut Acres of land cleared Photographs Environmental permit and EPA correspondence

TABLE 10-1
ESMP Elements

Project Phase and Activities	Potential Benefits, Impacts or Risks	Impact Avoidance, Minimization and Mitigation or Enhancement Measures	Responsibility	Frequency and Timing	Verifiable Indicators of ESMP Performance
Site Clearing and Excavation for New Aboveground and Underground Structures	Adverse Impact: Soil erosion and sedimentation impact on water quality, and aquatic or wetland flora and fauna Risks of impacts will be greatest for new BSPs and primary substations.	Minimize vegetation clearance and soil disturbances in riparian and habitat Avoid clearing and soil removal within 30 meters of stream and river banks Site should not be cleared and left unused for a long time, so vegetation clearing, topsoil removal, compacting, cutting and filling, and foundation construction should follow each other in close succession to avoid or minimize the incidence of erosion. Place erosion and sedimentation controls along the work site perimeter near water	NEDCo and Contractor	Construction – Daily Site Inspections and Reports	Daily site inspection logs indicating areas and types of vegetation cleared, area of soils exposed, and proximity to surface waters and wetlands, as well as incidence/locations of siltation of water bodies during construction Water quality data at construction sites
Site Clearing and Grading for Unpaved Access Roads, if Required	Adverse Impacts: Habitat loss, soil erosion, dust impact to air quality, water quality, public and worker health and safety	Locate distribution lines adjacent to existing roads to minimize the need for access roads. Avoid steep terrain during the transportation of construction materials by using alternative routes or use light vehicles where appropriate. Prevent surface water run-off over disturbed earth draining to water bodies by redirecting flow. Pave permanent access roads and spray water on temporary dirt roads to prevent erosion and dust impacts. Post traffic warnings in the local language and set/enforce speed limits.	NEDCo and contractor	Daily Inspection	Water quality Accident statistics Workers and public medical records of respiratory distress
Excavation for New Above Ground and Underground Structures	Adverse Impacts: Damage to cultural resources, sacred groves, and/or archaeological sites and artifacts Risks of impacts will be greatest for new BSP sand primary substations.	Site avoidance/selection via screening for cultural and archaeological sites Shovel tests by specialist personnel during the EA/ESIA at potential archaeological sites that cannot be avoided Implementation of chance finds procedure	NEDCo and contractor with consultant support	Before and during site excavation	Site Screening Reports –EA or ESIA Reports Tribal interviews Items of archaeological significance disturbed or destroyed
Use of Heavy Construction Equipment	Adverse Impacts: Air Quality (dust, fuel vapors, equipment and vehicle emissions), Worker and public health and safety risks, noise impacts; traffic nuisance to local community	Control speed of construction vehicles Use of Flagmen to direct traffic Prohibit vehicle idling and revving Spray Water for Dust Control during construction and dusty excavations Regular maintenance of equipment	Contractor	Daily inspection	Visible particulates in the air and eye irritation Increase in upper respiratory tract ailments Worker use of personal protective equipment (PPE) Complaints from local community regarding traffic, noise and dust

TABLE 10-1
ESMP Elements

Project Phase and Activities	Potential Benefits, Impacts or Risks	Impact Avoidance, Minimization and Mitigation or Enhancement Measures	Responsibility	Frequency and Timing	Verifiable Indicators of ESMP Performance
Storage and Dispensing of Chemicals, Construction Materials and Fuels	EHS Impacts/Risks: Public and worker health and safety; land/soil quality; ground and surface water quality; food chain and ecological contamination risks Risks are greatest for long-duration construction of new BSPs and primary substations	Provide lockable storage areas Require specialized training to dispense and work with hazardous material Provision of suitable PPE, including fit testing and medical fitness/surveillance Immediately clean up and report chemical, fuel and other hazardous material spills Keep Material Safety Data Sheets onsite Develop and follow spill prevention, control, and countermeasures plans and emergency response and preparedness plans and procedures that are specific to each project and its environmental setting Train workers and at-risk community members in relevant Incident reporting and emergency response procedures	NEDCo and contractor	Daily site inspections and annual refresher training Periodic public meetings and workshops on EHS issues and emergency response	Material inventories and handling records Spill reports and data on containment vs. environmental releases Emergency response plans and procedures Contractor hazardous materials management training records Minutes from public meetings and awareness sessions on EHS issues Emergency response and incident reporting procedures
Construction of Substation Foundations and Buildings for Other New Facilities	Health and Safety Risks: Electrocution Physical injury Risks are greatest for long--duration construction of new BSPs and primary substations	Temporarily or permanently cordon off work sites to prevent public access to work areas Soils extracted for the excavation of substation foundations to be used for backfilling and should not be left exposed to wind or water for long periods Supply and use of PPE including safety shoes/boots, gloves for mixing cement, dust protection during dry and dusty conditions or when working with hazardous materials Close excavations for substation foundations as soon as possible and/or provide guarding	Contractor	Daily inspection	No. and type of PPE purchased No. of workers wearing appropriate PPE Accident statistics Contractor Cost
Influx of Transient Workers	Public Health Risks: Introduction and/or local increases of diseases	Awareness campaigns on HIV/AIDS and other communicable diseases among workers and local community	NEDCo and contractor	Throughout construction	Epidemiological and medical records for contractors and local residents
Closure of Work Depots	Beneficial Impact: Removal of solid and sanitary wastes Restoration of a natural landscape	Remove all construction equipment, vehicles and material stockpiles Remove all solid and liquid wastes Remove all temporary buildings Remove all temporary access roads	Contractor	Upon completion of construction	Return of site to its original or improved landscape condition (if improvements are made to degraded sites)

TABLE 10-1
ESMP Elements

Project Phase and Activities	Potential Benefits, Impacts or Risks	Impact Avoidance, Minimization and Mitigation or Enhancement Measures	Responsibility	Frequency and Timing	Verifiable Indicators of ESMP Performance
Soil Stabilization and Replanting of Vegetation in Temporary Work Areas	Beneficial Impact: Enhancement of flora, fauna, soil conservation and habitat quality Control of exotic, invasive vegetation	Reseed or plant and mulch temporarily disturbed soils and degraded habitats with local (native) species common in the area to complement existing vegetation and Promote natural regeneration of the original plant community/ground cover Develop and implement plans and procedures for control and monitoring of invasive plant species within ROWs	NEDCo	Continuous process as construction works are completed	Planting plans with numbers and species of trees and shrubs planted Receipts from seed and plant vendors Photographs
Generation of Construction Wastes	Adverse Impacts: Releases or improper disposal of solid wastes	All solid wastes from construction sites should be collected centrally, quantified, removed regularly and disposed of at designated, licensed waste disposal facilities	NEDCo	Daily inspection and monthly reporting	Manifests and receipts for truck transport and landfill tipping fees Records of illegal dumping prosecutions
		OPERATION			
Employment of Local Labor	Beneficial Impact: Socioeconomic capacity building	Maximize permanent employment of local residents at substations or other facilities	NEDCo	Operational life	Number of newly hired local workers
Storage and Handling of Hazardous Materials for Operations and Maintenance	Adverse Impacts: Public and worker health and safety; soil, sediment and water quality; food chain contamination and ecological risks	Provide lockable storage areas Require specialized training to dispense and work with hazardous material Provision of suitable PPE, including fit testing and medical fitness/surveillance Immediately clean up and report chemical, fuel and other hazardous material spills Keep Material Safety Data Sheets onsite Develop and Follow SPCC Plans and Emergency Response and Preparedness Plans and Procedures that are specific to each project and its environmental setting Train workers and at-risk community members in relevant Incident Reporting and Emergency Response Procedures	NEDCo	Periodic site inspections and annual refresher training periodic public meetings and workshops on EHS issues and emergency response	Material inventories and handling records Spill reports and data on containment vs. environmental releases – monitoring data for soil, ground water, sediment and surface water quality Worker accident and injury statistics NEDCo hazardous materials management training records Minutes from public meetings and awareness sessions on EHS issues Emergency response and incident reporting procedures
Generation of Wastes from Operations and Maintenance	Adverse Impacts: Releases or improper disposal of solid wastes	All solid wastes from facilities should be collected centrally, quantified, removed regularly and disposed of at designated, licensed waste disposal facilities	NEDCo	Daily inspection and monthly reporting	Manifests and receipts for truck transport and landfill tipping fees Records of illegal dumping prosecutions

TABLE 10-1
ESMP Elements

Project Phase and Activities	Potential Benefits, Impacts or Risks	Impact Avoidance, Minimization and Mitigation or Enhancement Measures	Responsibility	Frequency and Timing	Verifiable Indicators of ESMP Performance
Generation of Wastes from Operations and Maintenance	Adverse Impacts: Releases of sanitary and liquid (gray water) wastes	All substation sites and worker occupied facilities will have sanitary facilities and septic tanks located at safe distances from surface waters, wetlands, groundwater supplies (wells) and gardens/crops	NEDCo	Periodic emptying throughout project	Contamination of water bodies Instances of water-borne disease
EHS Auditing of Permit and ESMP Compliance	Beneficial Impact: Awareness of EHS impacts/risks and implementation of corrective actions	Set up an audit program for all activities to assess compliance with facility permits, regulations, corporate EHS policies, commitments to stakeholders, mitigation measures in the EA/ESIA, and the ESMP	NEDCo and EPA	Annual internal and periodic third-party audits	
Environmental Inspection and Monitoring	Beneficial Impact: Maintain awareness of EHS impacts/risks	Routine EHS Inspections to Identify environmental impacts and public/worker hazards	NEDCo and EPA	Monthly with quarterly reports	Inspection logs Internal reports EPA correspondence
Social impact monitoring	Adverse impact: new metering and tariffs are not easily accepted by customers, and could have energy supply to low income groups.	Public awareness campaigns to publicize introduction of new meters, tariffs, and payment methods (e.g., pre-payment cards). Strengthening of NEDCo customer service department, with special emphasis on issues relating to vulnerable groups and, where appropriate, women.	NEDCo	Monthly with quarterly reports	Registers of publicity campaigns Internal reports
Vegetation Management in ROWs	Beneficial Impact: Enhancement of flora, fauna, soil conservation and habitat quality Control of exotic, invasive vegetation	Develop and implement plans and procedures for control and monitoring of Invasive Plant Species within ROWs and other managed facility landscapes	NEDCo	Monthly or as needed for safety	Inspection reports Mowing or herbicide application records Photographs
		DECOMMISSIONING			
Buildings	Environmental Risks: Improper Disposal of Demolition Debris and Hazardous Wastes Beneficial Impact: Aesthetic, Ecological or Land Use Benefits from Landscape Restoration	Buildings to be demolished where reuse not appropriate Recycle/reuse materials as appropriate Remove all facility equipment Remove all solid and liquid wastes Remove all access roads Revegetate sites	NEDCo	End of project life	Resale/reuse value Return of land to its quasi-original state Potential for restoration of higher-quality natural habitat than existed before project

TABLE 10-1
ESMP Elements

Project Phase and Activities	Potential Benefits, Impacts or Risks	Impact Avoidance, Minimization and Mitigation or Enhancement Measures	Responsibility	Frequency and Timing	Verifiable Indicators of ESMP Performance
Restoration and Replanting of Natural Habitat and/or Managed Landscape	Beneficial Impacts: Soil Stabilization and Habitat Restoration with Native Flora to Promote Faunal Recolonization of Site Control of Exotic, Invasive Vegetation	Re-plant degraded areas with local (native) species common in the area to complement natural vegetation degeneration to improve ground cover Develop and implement plans and procedures for removal of invasive plant species from sites/ROWs being restored	NEDCo and contractor	Following removal of fixed and/or linear facilities .	Site restoration plans Receipts from seed and nursery vendors Monitoring reports to comply with permits Site photographs
Management and Disposal of Chemicals and Hazardous Materials	EHS Impacts/Risks: Improper disposal and/or environmental release impacts to human and ecological receptors, including local food chains	Before dismantling, oil-containing equipment such as transformers and circuit breakers will be drained and their oil stored in drums for disposal at a licensed facility Any spills will be cleaned up according to the emergency response plan/procedures Soil contamination will be removed for proper disposal at a licensed facility	NEDCo and contractor	During removal of fixed and/or linear facilities	Onsite Inventory of Hazardous Wastes Manifests and chain of custody documentation for waste removal, transport and disposal at licensed facility

Appendix G
Financial Analysis Summary

NEDCo Financial Model - Version D

Financial Summary (GHS 000)

	Historical	Year Projected																			
Category	[2012]	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Operating Revenue	151,821	162,258	280,521	333,880	404,371	423,609	454,554	483,010	513,489	541,908	571,221	601,430	627,451	652,716	677,879	700,723	722,593	743,346	764,374	786,003	807,124
Cost of Wholesale Power	89,920	100,857	143,262	171,482	207,800	217,709	233,650	248,309	264,010	278,650	293,751	309,313	322,717	335,731	348,694	360,461	371,727	382,416	393,248	404,389	415,269
Gross Margins	61,901	61,400	137,259	162,398	196,571	205,900	220,904	234,701	249,479	263,258	277,470	292,117	304,734	316,984	329,185	340,262	350,867	360,929	371,126	381,614	391,855
Operating Costs																					
O&M and Distribution Expenses	47,713	57,930	74,458	90,986	107,514	124,043	140,571	157,099	173,627	190,155	206,683	223,211	239,739	256,267	272,795	289,323	305,851	322,379	338,907	355,435	371,963
Administration Expenses	27,521	28,506	31,018	33,637	36,357	38,142	39,958	41,793	43,634	45,468	47,281	49,062	50,798	52,485	54,226	55,605	57,019	58,469	59,956	61,481	63,045
Total	75,234	86,436	105,476	124,624	143,871	162,184	180,528	198,891	217,260	235,622	253,964	272,272	290,537	308,752	327,021	344,928	362,870	380,848	398,863	416,916	435,008
Depreciation	49,751	49,643	51,130	52,735	54,453	56,276	58,202	60,223	62,336	64,536	66,818	69,178	71,613	74,119	76,692	79,329	82,027	84,782	87,592	90,454	93,365
Financing Costs	-	510	1,335	2,160	2,985	3,810	4,635	5,460	6,285	7,110	7,935	8,760	9,585	10,410	11,235	12,060	12,885	13,710	14,535	15,360	16,185
Operating Profit/Loss	(63,084)	(75,189)	(20,682)	(17,121)	(4,738)	(16,370)	(22,461)	(29,874)	(36,403)	(44,010)	(51,246)	(58,093)	(67,001)	(76,297)	(85,763)	(96,055)	(106,915)	(118,411)	(129,864)	(141,116)	(152,703)
Non-Operating Income/Expenses	1,246	1,332	2,302	2,740	3,319	3,477	3,731	3,964	4,214	4,447	4,688	4,936	5,150	5,357	5,563	5,751	5,930	6,101	6,273	6,451	6,624
Net Profit/Loss	(61,838)	(73,857)	(18,380)	(14,381)	(1,419)	(12,894)	(18,731)	(25,909)	(32,188)	(39,563)	(46,558)	(53,157)	(61,852)	(70,940)	(80,200)	(90,304)	(100,985)	(112,310)	(123,591)	(134,665)	(146,078)
Collection Losses	(48,850)	(52,229)	(90,545)	(107,831)	(130,668)	(136,899)	(146,923)	(156,140)	(166,014)	(175,220)	(184,715)	(194,501)	(202,929)	(211,113)	(219,264)	(226,664)	(233,747)	(240,469)	(247,280)	(254,286)	(261,127)
Net Profit / Loss after Collection Losses	(110,688)	(126,087)	(108,924)	(122,212)	(132,087)	(149,793)	(165,653)	(182,050)	(198,202)	(214,782)	(231,273)	(247,658)	(264,781)	(282,054)	(299,464)	(316,968)	(334,732)	(352,779)	(370,871)	(388,951)	(407,206)

NEDCo Financial Model - Alternate D-1, with Implementation of SADs

Financial Summary (GHS 000)

	Year																				
	Historical	Projected																			
Category	[2012]	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Operating Revenue	151,821	162,258	280,521	336,049	409,526	431,661	465,930	495,106	526,357	556,863	586,986	621,803	648,706	678,923	705,098	728,862	751,611	773,198	795,072	817,570	839,540
Cost of Wholesale Power - Revised	89,920	100,857	143,262	170,422	205,260	213,768	228,079	240,954	254,683	267,265	280,111	293,343	304,306	316,693	328,920	340,020	350,647	360,730	370,948	381,457	391,719
Gross Margins	61,901	61,400	137,259	165,627	204,266	217,893	237,851	254,152	271,674	289,597	306,875	328,460	344,400	362,230	376,178	388,841	400,964	412,467	424,124	436,113	447,821
Operating Costs																					
O&M and Distribution Expenses	47,713	57,930	74,458	90,986	107,514	124,043	140,571	157,099	173,627	190,155	206,683	223,211	239,739	256,267	272,795	289,323	305,851	322,379	338,907	355,435	371,963
Administration Expenses	27,521	28,506	31,018	33,637	36,357	38,142	39,958	41,793	43,634	45,468	47,281	49,062	50,798	52,485	54,226	55,605	57,019	58,469	59,956	61,481	63,045
Total	75,234	86,436	105,476	124,624	143,871	162,184	180,528	198,891	217,260	235,622	253,964	272,272	290,537	308,752	327,021	344,928	362,870	380,848	398,863	416,916	435,008
Depreciation	49,751	49,643	51,130	52,735	54,453	56,276	58,202	60,223	62,336	64,536	66,818	69,178	71,613	74,119	76,692	79,329	82,027	84,782	87,592	90,454	93,365
Financing Costs	-	510	1,335	2,160	2,985	3,810	4,635	5,460	6,285	7,110	7,935	8,760	9,585	10,410	11,235	12,060	12,885	13,710	14,535	15,360	16,185
Operating Profit/Loss	(63,084)	(75,189)	(20,682)	(13,891)	2,957	(4,377)	(5,514)	(10,422)	(14,208)	(17,671)	(21,841)	(21,751)	(27,335)	(31,051)	(38,770)	(47,476)	(56,818)	(66,873)	(76,866)	(86,617)	(96,737)
Non-Operating Income/Expenses	1,246	1,332	2,302	2,758	3,361	3,543	3,824	4,063	4,320	4,570	4,817	5,103	5,324	5,572	5,787	5,982	6,168	6,346	6,525	6,710	6,890
Net Profit/Loss	(61,838)	(73,857)	(18,380)	(11,133)	6,318	(834)	(1,690)	(6,359)	(9,888)	(13,100)	(17,024)	(16,648)	(22,011)	(25,479)	(32,983)	(41,494)	(50,649)	(60,527)	(70,341)	(79,907)	(89,847)
Collection Losses - Revised	(48,850)	(52,229)	(90,545)	(99,991)	(111,915)	(107,214)	(104,125)	(110,659)	(117,657)	(122,266)	(123,033)	(124,137)	(123,040)	(122,002)	(119,673)	(116,435)	(112,569)	(108,086)	(103,208)	(112,256)	(115,276)
Net Profit / Loss after Collection Losses	(110,688)	(126,087)	(108,924)	(111,125)	(105,597)	(108,049)	(105,815)	(117,017)	(127,545)	(135,367)	(140,057)	(140,784)	(145,051)	(147,481)	(152,656)	(157,929)	(163,218)	(168,613)	(173,549)	(192,163)	(205,123)

Appendix H
Economic Analysis Summary

SECTION 1

Modeling Approach and Assumptions

This section introduces the economic model that was used to assess the benefits in the power sector arising from the proposed Sub-Activities. The approach used in this case was a partial equilibrium method that calculates the costs and benefits of a proposed Activity in terms of the opportunity costs of the resources involved in the electricity supply sector only.[1] Primary benefits and costs were calculated using this opportunity cost approach. Secondary benefits were imputed to the extent that certain kinds of valuations – new service, restoration of lost load, etc. – represent activities that occur outside the electricity supply industry. The model used present value methods to put all of the proposed investments on an equivalent temporal footing.

The economic models were paired directly with the Sub-Activity description workbooks prepared to describe the costs, characteristics, and expected benefits for each of the potential investments. There are 20 individual projects for the Electricity Compnay of Ghana (ECG) and 21 for the Northern Electric Distribution Company (NEDCo). Both models contain detailed descriptions of each proposed intervention, its costs, and the expected benefits. The interventions are summarized on one sheet in each model that reports the Economic Internal Rate of Return (EIRR) and net present value (NPV) for each proposed project and the total EIRR and NPV for the entire package of projects. Results have been calculated with and without the electricity access projects in each service area.

1.1 Valuation of Costs and Benefits

The financial analysis of the proposed investments used prices that are, were, or will be charged to electricity consumers to value new electricity supply, lost service, and improved technical and commercial performance. The economic analysis valued the benefits differently. Benefits were evaluated in each of four categories:

1. Access – new customer connections
2. Technical loss reduction
3. Non-technical loss reduction, which includes both management and operational loss categories as well as collection efficiency
4. Service continuity or outage reductions

Each of the benefit categories was valued separately.

1. **Access benefits** were valued on a willingness–to-pay (WTP) basis. Because there is no currently accepted empirical finding on this matter, values ranging from 30 percent below an economically efficient tariff to what consumers in Ghana currently pay for charged-up automotive batteries were used. The cost of supplying this additional energy was netted out from WTP. Recent evidence supports

[1] The Millennium Challenge Corporation (MCC) will be performing a general equilibrium simulation of the proposed investments that will capture additional impacts throughout Ghana's economy.

a positive economic value for increased electricity access in sub-Saharan Africa, and therefore, a value for WTP that is at or above the economic supply cost of electricity.[2,3]

This finding is supported anecdotally in Ghana from recent experience with private business initiatives to establish mini-grids in Ghanaian villages, based on cash payments for supply from distributed photovoltaic (PV) arrays on small towers. The village operations, on the ground since the fourth quarter 2013, are collecting on average GH¢ 1-1.2 per kWh equivalent, about what the households were previously spending for kerosene and charging services.

2. **Technical loss reductions** were valued at the opportunity cost measure of the saved energy and capacity. As with the WTP, this number is not known precisely. However, the correct value occupies a narrower range than the WTP for new service or the value of lost load (VOLL) (see below) that values outages. Successful reductions in technical losses reduce fuel use and overloading of network assets and generally fall between the current bulk tariff plus the transmission charge and the shadow price of additional generation as calculated using a least-cost expansion model of Ghana's power system.

3. **Non-technical loss reductions** were valued at an imputed price. Because the electricity for which ECG and NEDCo do not bill or collect is in fact used in the economy, it would be inappropriate to use the cost of supply or WTP as a benefit. Instead, the team used a number that represents the value created per kWh by the other three activity categories, on the presumption that the additional revenues from reducing commercial losses and improving collections can be reinvested in the other three areas. The value used is GH¢0.12/kWh (US$0.05). The greater the returns to other investment categories, the lower this imputed value and vice-versa.[4]

4. **Service continuity/outage reductions** represent the final category of benefits. Reducing either or both of the frequency and duration of outages can be valued using another subjective measure, the VOLL. Studies of the VOLL[5] have generally been made in countries where (i) system reliability and power quality are good; (ii) most firms and households do not own backup generators; and (iii) many industries operate with continuous process technologies, requiring extremely constant power supply and quality. None of these conditions applies to Ghana.[6] VOLL will be different for households and manufacturing companies. Consequently, the VOLL values were split between the household fraction and the commercial fraction. In the case of households, the WTP for that scenario was used. For firms, a range of values, starting at the economic cost of supply, ranging as high as an estimated value for VOLL was

2 See Taryn Dinkelman, "The Effects of Rural Electrification on Employment: New Evidence from South Africa", American Economic Review December 2011 Vol. 101(7). The author finds that electrification increases production in the home as well as away from the home. This finding is the basis for a WTP value that may be above the economic cost of electricity supply and the observed WTP very high prices for energy services where electricity is not available.

3 While in Ghana recently, the team's economist met with a number of small companies that operate sham grids based on PV. These companies are able to charge prices based on value of service rather than cost of service, and generally expect that customers will pay for electricity what they previously paid for kerosene. With highly efficient lighting and other devices, these payments translate to effective prices per kilowatt hour (kWh) in excess of $1.00.

4 Improved technical performance reduces the expected returns to non-technical performance improvements because the level of losses overall will fall and additional funds spent will produce less savings. On the other hand, if technical loss reduction is not effective, then any additional funds invested in non-technical loss reduction will be all the more important.

5 Two recent studies are a meta-analysis of VOLL by London Economics, "Estimating the Value of Lost Load", 2013; and a country-specific study by London Economics for the UK, "The Value of Lost Load (VoLL) for Electricity in Great Britain", 2013. Both studies noted significant differentials between estimated VOLL for residential and commercial/industrial customers. The authors note that the presence of standby generation lowers the VOLL substantially.

6 As with WTP, there are no reliable measures of backup generator ownership and usage in Ghana. However, in neighboring Nigeria, backup generator ownership in one district ranges from about 60 percent for smaller residential and commercial users to more than 70 percent for industrial users. See NRECA, "Aba Electric Consumer Census 2009", page 14. As noted in the London Economic study, such a level of standby generator ownership puts both a floor and a cap on the calculated VOLL.

used in MCC's computable general equilibrium model for Ghana. The outage benefit was reduced by the marginal cost of supply to service the additional demand.

Costs for the proposed investments are net of all import duties and taxes. The costs of providing the new service are not the approved electricity tariff, but rather the opportunity costs of additional electricity supply. Supplying electricity for additional hours to relieve outages also entails a cost (fuel, transmission losses) and was valued accordingly.

The values for the supply of electricity were derived from work performed for MCC on the value chain in the electricity sector, and represent the results of an electricity sector simulation model that calculates least-cost generation mixes, subject to constraints and prices under a variety of conditions.[7]

1.2 Operation of the Economic Assessment Model(s)

To assess each proposed investment from an economic perspective, a number of modifications were made to the activity description workbook. These modifications were numerous, mostly involving the valuation of benefit and cost streams. Other changes in the EGC_Sub-Activity Description (SAD) model included the addition of parameters that could account for changes in the effectiveness of the proposed interventions.

A new sheet was added to the ECG_SAD workbook containing the parameters and controls that were used to modify the operation of the model. One set of parameters covers such basics as discount rates and foreign exchange and is shown in Exhibit 1. A second set of modifications (see Exhibit 2) permits the user to construct scenarios out of combinations of parameter values, all controlled with *Index* functions. The information behind the parameter values is documented in Appendix C.

The color code for the cells on this sheet is straightforward: A user may input values into cells that are light blue. Cells that are light green contain data and should be approached cautiously but may be modified. Cells that are light red have been calculated from other inputs and should not be modified.

EXHIBIT 1

General Parameters and Inputs

Discount Rate	**11.1%**
BCG	**$0.0839**
Forex rate	**2.4**
Tx Losses	**5%**
Decay Factor (not used)[8]	**0.10%**
Retail tariff GH¢) used	**0.427**
Electricity average annual demand growth 2015-2025	**5.18%**
Electricity Load Factor (not used)	**73%**
Standby Power Cost (US$/kWh)	**0.60**

Scenarios are put together by combining a number of key attributes of each project – cost, performance, valuation of electricity – as shown in Exhibit 2 (greyed-out areas are not used in this model version). The actual parameter values used will be modified in some cases according to the specifics of a scenario.

7 These results are contained in the memorandum provided to MCC on the gas-electricity value chain, *GVC-2015 with Tariff Analysis.docx*. Detailed results for generation and network costs are shown for a variety of supply-demand cases, and regulatory and oil pricing scenarios.

8 In some cases it is appropriate to include a decay factor for the effectiveness of investments of behavioral/managerial changes. This factor was not applied in the current analysis, although experience in Ghana indicates that it might be appropriate.

The user is allowed to vary the key parameter values with simple toggle inputs. The effects of changing parameter values can be tested either individually or as a package in one of five scenarios constructed for assessing the sensitivity of investment results to changes in operating performance, economic conditions and valuation choices.

Other values in the model include prices for various parameters, including, VOLL, value of electricity to new users, bulk generation charge (BGC), economic cost, and cost of marginal generation (see Exhibit 3).

Following the conventions of the model, a user can insert new values for BGC, value of new electricity service, VOLL, operation and maintenance costs, and value of marginal generation.

To make version control more straightforward, the scenarios are controlled with a toggle that allows the user to switch from one scenario to another, maintaining version and parameter consistency. This version control module is shown in Exhibit 4.

Because the model is controlled largely by these index menus,[9] this module allows the user to vary parameter values without entering data or assumptions directly into calculation cells.

EXHIBIT 2

Scenario Parameters

Electricity Pricing and Valuation Scenarios		
Bulk Generation Charge	2	1 is current BGC, 2 is efficient economic BGC, 3 is shadow price of additional generation, 4 is worst case
Distribution Service Charge	1	1 is current DSC, 2 is partial adjustment for losses, 3 is full adjustment for losses, 4 is worst case
Value of Electricity to New Users	1	1 is economic cost of Gx + Tx + Dx, 2 is 33% below economic cost of supply, 3 is 15% above economic cost of supply, 4 is ~ price paid for charged automotive batteries
Value of Lost Load	2	1 is economic cost of Gx + Tx + Dx, 2 is cost of standby generation for 50% of customers, retail tariff for other 50%, 3 is value for choice 2 + ~15%, 4 is value used in CGE model
Cost of Investment and Operations	3	1 is cost below projections, 2 is planned costs, 3 is small cost overrun, 4 is larger cost overrun

Efficiency Parameters and Scenarios	Accra	Tema	All others			
Technical Efficiency By Region	14.0%	15.0%	15.0%			
Technical Efficiency Goals by Region	10.0%	12.0%	14.0%			
Non-Technical Efficiency By Region	19.5%	13.7%	6.9%			
Non-Technical Efficiency Goals By Region	15.5%	10.0%	6.5%			
Collection Efficiency By Region	83.5%	91.7%	77.9%			
Collection Efficiency Targets by Region	95.0%	95.0%	90.0%			
Outage Improvement Targets (full value)	45.0%	40.0%	35.0%			
Retail Fraction of Lost Load Valuation	65%	1	65%	50%	40%	30%
Technical Efficiency Scenarios	90%	3	105%	100%	90%	75%	50%
Non-Technical Efficiency Scenarios	90%	3	105%	100%	90%	75%	50%
Access Scenarios	90%	3	105%	100%	90%	75%	0%
Service Continuity Scenarios	90%	3	105%	100%	90%	75%	50%

9 In Excel, index menus restrict the user to the set of values assigned to the index database. This permits version control and consistency. There is also a version of the model that uses Excel's macro language to compute more quickly the results of multiple scenarios for the 20 ECG projects and 21 NEDCo projects.

EXHIBIT 3

Key Parameters for Electricity Valuation

Calculation of Cost & Value of Electricity: Parameters, Scenarios, and Data

Tariffs Effective 1st December, 2011 to October 2013	
Composite BGC – VRA & Asogli (GHp/kWh)	0.100943
TSC (GHS/kWh)	0.024842
DSC (GHS/kWh)	0.097564
O&M rate	0.009281417
Fixed O&M (from IFC Financial Model)	0.08
Exchange Rate	2.4
Collection Eff.	95%
Discount Rate	11.1%
Composite value of lost load	0.58

BGC Used	0.333	3	0.20136	0.240	0.3335	0.420
DSC Used	0.21500	4	0.15068	0.175	0.195	0.215
"Value" of Electricity Used	0.305	2	0.5790	0.305	0.45	0.75
Value of lost Load	0.579009	1	0.5790	0.696	1.43	3.24
Cost of Operations and Investment	1.3	4	0.95	1.00	1.05	1.25
Variable Marginal Cost of Gx and Tx	0.310	1	0.31	0.20	0.12	0.08

Effective 1st January, 2014 *or* Prices Used in Economic Analysis	
Composite BGC – VRA & Asogli (GHp/kWh)	0.3335
TSC (GHS/kWh)	0.030553
DSC (GHS/kWh)	0.215
Increase in Tarrif	259%
Increase in DSC	220%
Value/weighted non-SLT Tariff (2013)	137%

Allocation of VOLL	Retail Valuation	VOLL
	65%	35%

Include Access Projects?	1

EXHIBIT 4

Scenario Control Module

Scenario Parameter Values						Scenario Selected	P90	5
Parameteter	P90	P50	P10	Best	Worst	Values for Scenario Choices		
Bulk Generation Charge	2	2	2	1	3		3	
Distribution Service Charge	1	1	2	3	4		4	
Value of Electricity to New Users	1	1	3	4	2		2	
Value of Lost Load	2	2	3	4	1		1	
Cost of Investment and Operations	3	3	2	1	4		4	
Retail Fraction of Lost Load Valuation	1	2	3	4	1		1	
Technical Efficiency Scenarios	3	2	2	1	4		4	
Non-Technical Efficiency	3	2	2	1	4		4	
Access Scenarios	3	2	2	1	4		4	
Service Continuity Scenarios	3	2	2	1	4		4	
Variable Marginal Cost of Gx and Tx	2	2	3	4	1		1	

		P90	P50	P10	Best	Worst
With Access Projects	EIRR %	25.78%	29.34%	45.53%	108.14%	#NUM!
	NPV (US$)	$167,983,248	$211,030,659	$398,481,913	$1,564,968,093	-$300,752,003

		P90	P50	P10	Best	Worst
Without Access Projects	EIRR %	21.35%	25.04%	41.96%	87.68%	12.38%
	NPV (US$)	$68,237,351	$93,935,722	$210,970,697	$526,729,867	$5,129,748

SECTION 2

Results of the Economic Rate of Return Analysis

2.1 NEDCo

The results for the sets of packages were described in Section 4.5 of the main report. This section shows the results for each investment in each of the ten scenarios (Exhibit 5 and Exhibit 6). Only a handful of the NEDCo investments are feasible without access, as shown below.

EXHIBIT 5

Economic Modeling Results: Without Access Scenarios by Project, NEDCo

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	NPV	EIRR	NPV	EIRR	NPV	EIRR	NPV	EIRR	NPV	EIRR
NEDCo-Comm-01: Service connection materials	($6,165,548)	#NUM!	($6,165,548)	#NUM!	($5,929,747)	#NUM!	($5,693,946)	#NUM!	($7,121,803)	#NUM!
NEDCo-Comm-03: Customer census and normalization of existing service connections	($8,954,688)	-22%	($8,198,489)	-11%	($7,658,712)	-10%	($6,974,698)	-8%	($11,085,787)	#NUM!
NEDCo-Comm-04: Enterprise customer information system and integration with existing enterprise applications	$1,930,100	17%	$3,345,934	20%	$3,635,794	21%	$4,215,672	23%	$743,255	13%
NEDCo-Engr-03A: Replace faulty and aging underground conductors	($6,590,290)	#NUM!	($6,577,772)	#NUM!	($6,259,458)	#NUM!	($5,944,947)	#NUM!	($7,850,934)	#NUM!
NEDCo-Engr-07: Shield wire conversion to 34.5 kV system Techniman-Ahafour	($6,206,122)	#NUM!	($6,206,122)	#NUM!	($5,910,890)	#NUM!	($5,615,657)	#NUM!	($7,387,052)	#NUM!
NEDCo-Engr-08: Install Banvim primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	($4,379,439)	#NUM!	($4,255,565)	#NUM!	($4,030,215)	#NUM!	($3,780,091)	#NUM!	($5,287,077)	#NUM!
NEDCo-Engr-09: Install Islamic primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	($4,306,110)	#NUM!	($4,185,552)	#NUM!	($3,963,855)	#NUM!	($3,711,972)	#NUM!	($5,192,898)	#NUM!
ECG-Engr-11: Install Fiapre primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	($3,980,540)	#NUM!	($3,859,982)	#NUM!	($3,651,185)	#NUM!	($3,418,276)	#NUM!	($4,803,579)	#NUM!

EXHIBIT 5

Economic Modeling Results: Without Access Scenarios by Project, NEDCo

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
NEDCo-Engr-18: Reactive power compensation for primary substations and MV lines	$566,723	15%	$1,603,694	21%	$1,725,343	22%	$2,043,937	24%	$80,125	12%
NEDCo-Engr-19A: Low voltage feeder bifurcation with medium voltage upgrade	($2,607,133)	6%	($132,194)	11%	$347,414	12%	$1,322,010	13%	($4,515,611)	3%
NEDCo-Engr-22: Update distribution construction standards based on current low loss practices	($238,785)	-3%	($177,323)	2%	($154,171)	3%	($125,728)	4%	($317,388)	-6%
NEDCo-Engr-24: Metering at critical nodes of the distribution system	($769,918)	2%	($672,947)	3%	($590,473)	4%	($488,604)	5%	($1,106,952)	-1%
NEDCo-Engr-29: Sectionalizing study of MV networks within NEDCo's territory	($1,915,222)	#NUM!	($843,099)	#NUM!	$6,520,682	157%	$30,700,092	677%	($5,122,239)	#NUM!
NEDCo-Ops-02: Procure operations and maintenance materials	($372,223)	#NUM!	($75,684)	#NUM!	$1,955,014	446%	$8,634,743	1777%	($1,226,980)	#NUM!
NEDCo-Ops-03: Installation of outage reporting and call center system	$806,795	55%	$1,065,551	67%	$2,846,204	147%	$8,683,533	394%	$19,309	12%
NEDCo-Ict-01: Communication network	$2,725,938	106%	$2,786,881	108%	$2,867,808	116%	$3,115,884	130%	$2,620,507	89%
NEDCo-Ict-04: Data center at VRA or Sunyani	$363,785	16%	$424,728	17%	$553,635	19%	$834,561	24%	$96,695	12%

EXHIBIT 5

Economic Modeling Results: Without Access Scenarios by Project, NEDCo

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
NEDCo-Service-01A: Construction of customer service centers	($1,744,371)	4%	($943,683)	8%	($690,411)	8%	($277,001)	10%	($2,757,460)	1%
NEDCo-Service-02A: Procurement of vehicles, tools and equipment	($6,622,668)	#NUM!	($5,811,494)	#NUM!	($5,099,745)	#NUM!	($3,203,118)	-13%	($7,863,754)	#NUM!
NEDCo-Service-05: Technical Assistance Program	($3,571,724)	-2%	($3,277,177)	-1%	($2,961,512)	0%	($2,432,783)	2%	($4,590,278)	-4%
NEDCo-Service-06: Distribution System Master Plan	$344,763	22%	$359,954	23%	$381,804	24%	$406,693	25%	$257,363	18%
	$(51,686,676)	**-4.34%**	**$(41,795,891)**	**-0.99%**	**$(26,066,675)**	**2.47%**	**$18,290,302**	**9.94%**	**($23,824,838)**	**8.97%**

Notes:

#NUM! indicates an invisible number

EXHIBIT 6

Economic Modeling Results: With Access Scenarios by Project, NEDCo

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
NEDCo-Comm-01: Service connection materials	$12,271,927	51%	$14,320,535	57%	$21,414,500	80%	$127,640,936	415%	($56,156,443)	#NUM!
NEDCo-Comm-03: Customer census and normalization of existing service connections	($8,954,688)	-22%	($8,198,489)	-11%	($7,658,712)	-10%	($6,974,698)	-8%	($11,085,787)	#NUM!
NEDCo-Comm-04: Enterprise customer information system and integration with existing enterprise applications	$1,930,100	17%	$3,345,934	20%	$3,635,794	21%	$4,215,672	23%	$743,255	13%
NEDCo-Engr-03A: Replace faulty and aging underground conductors	$8,610,422	27%	$10,311,908	29%	$16,284,412	39%	$103,982,533	135%	($48,277,373)	#NUM!
NEDCo-Engr-07: Shield wire conversion to 34.5 kV system Techniman-Ahafour	$5,205,456	23%	$6,473,409	26%	$11,013,391	35%	$76,909,815	122%	($37,736,251)	#NUM!
NEDCo-Engr-08: Install Banvim primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	$9,106,971	35%	$10,729,335	39%	$15,971,207	50%	$93,750,012	170%	($41,154,313)	#NUM!
NEDCo-Engr-09: Install Islamic primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	$8,819,335	36%	$10,398,276	39%	$15,502,228	51%	$91,207,731	172%	($40,100,144)	#NUM!

EXHIBIT 6

Economic Modeling Results: With Access Scenarios by Project, NEDCo

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
ECG-Engr-11: Install Fiapre primary substation with interconnecting sub-T lines, MV offloading circuits and LV network	$9,144,905	38%	$10,723,846	41%	$15,814,898	54%	$91,501,427	182%	($39,710,825)	#NUM!
NEDCo-Engr-18: Reactive power compensation for primary substations and MV lines	$566,723	15%	$1,603,694	21%	$1,725,343	22%	$2,043,937	24%	$80,125	12%
NEDCo-Engr-19A: Low voltage feeder bifurcation with medium voltage upgrade	($2,607,133)	6%	($132,194)	11%	$347,414	12%	$1,322,010	13%	($4,515,611)	3%
NEDCo-Engr-22: Update distribution construction standards based on current low loss practices	($238,785)	-3%	($177,323)	2%	($154,171)	3%	($125,728)	4%	($317,388)	-6%
NEDCo-Engr-24: Metering at critical nodes of the distribution system	($769,918)	2%	($672,947)	3%	($590,473)	4%	($488,604)	5%	($1,106,952)	-1%
NEDCo-Engr-29: Sectionalizing study of MV networks within NEDCo's territory	($1,915,222)	#NUM!	($843,099)	#NUM!	$6,520,682	157%	$30,700,092	677%	($5,122,239)	#NUM!
NEDCo-Ops-02: Procure operations and maintenance materials	($372,223)	#NUM!	($75,684)	#NUM!	$1,955,014	446%	$8,634,743	1777%	($1,226,980)	#NUM!
NEDCo-Ops-03: Installation of outage reporting and call center system	$806,795	55%	$1,065,551	67%	$2,846,204	147%	$8,683,533	394%	$19,309	12%

EXHIBIT 6

Economic Modeling Results: With Access Scenarios by Project, NEDCo

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
NEDCo-Ict-01: Communication network	$2,725,938	106%	$2,786,881	108%	$2,867,808	116%	$3,115,884	130%	$2,620,507	89%
NEDCo-Ict-04: Data center at VRA or Sunyani	$363,785	16%	$424,728	17%	$553,635	19%	$834,561	24%	$96,695	12%
NEDCo-Service-01A: Construction of customer service centers	($1,744,371)	4%	($943,683)	8%	($690,411)	8%	($277,001)	10%	($2,757,460)	1%
NEDCo-Service-02A: Procurement of vehicles, tools and equipment	($6,622,668)	#NUM!	($5,811,494)	#NUM!	($5,099,745)	#NUM!	($3,203,118)	-13%	($7,863,754)	#NUM!
NEDCo-Service-05: Technical Assistance Program	($3,571,724)	-2%	($3,277,177)	-1%	($2,961,512)	0%	($2,432,783)	2%	($4,590,278)	-4%
NEDCo-Service-06: Distribution System Master Plan	$1,171,721	46%	$1,278,796	49%	$1,608,249	61%	$6,387,029	214%	($1,941,939)	#NUM!
Total Proposed Investment NPV and EIRR	**$33,927,347**	**12.57%**	**$53,330,802**	**14.82%**	**$100,905,755**	**19.91%**	**$637,427,982**	**53.38%**	**($342,367,741)**	#NUM!

Notes:

#NUM! indicates an invisible number

2.2 Alternative Measures for Valuing Outages

The consultants were asked to provide MCC with alternative methods of valuing outage reductions. In the MCC computable general equilibrium model, a value of US$1.35/kWh was used. For reasons explained in Section 4.5 of the main report, this valuation may not be appropriate for all customers in all parts of Ghana. Alternative methods provided a range of answers to the question about valuation. These figures ranged from roughly twice the current economic cost of service to supplies that are even greater than the figure used in the CGE modeling.

Four alternative measures of the value of reducing outages were requested by MCC. These measures are:

- Standby diesel generation
- Charged-up car batteries – from grid and from generator
- Distributed solar photovoltaic generation with battery backup
- Kerosene for lighting

2.2.1 Standby Diesel

Equipment: A 10 kilowatt (kW) diesel generator at $1050/kW, with 29 percent efficiency, 5 percent of electricity consumed in losses, 15 percent installation cost,

Fuel: crude oil at $105/barrel (bbl) => diesel at ~$22/ GJ

Operation: 10 percent capacity factor (876 hours/year operation)

Cost of generation: Financial (after-tax) - $0.7697/kWh
Economic - $0.5958/kWh

Note: natural gas standby generators will cost about 30-35 percent less per kWh because both the equipment and the fuel are less costly. However, these are not yet available for use in Ghana due to current the gas supply limitations.

2.2.2 Solar

Equipment: A 10 kW PV generator with battery backup at $2500/kW, 20 percent of electricity consumed in charging battery, 10 percent installation cost;

Fuel: N/A

Operation: 14 percent capacity factor (calculated value for Ghana)

Cost of generation: Financial (after-tax) - $0.6555/kWh
Economic - $0.4983/kWh

2.2.3 Batteries

Equipment: A 100 Ah marine battery requires charger and inverter

Fuel: 20 percent loss of input energy in charging

Operation: 15-25 percent capacity factor

Cost of equipment only: Financial (after-tax) - $0.175-0.20/kWh
Economic - $0.13-0.15/kWh

2.2.3.1 Case 1: Charge from Grid

Cost of power input: $0.16/kWh at 80 percent efficiency = $0.20/kWh

Markup/delivery: 50 percent

Cost of supply: Financial (after-tax) - $0.475-0.50/kWh
Economic - $0.43-0.45/kWh

2.2.3.2 Case 2: Charge from Diesel Genset

Cost of power input: Financial - \$0.7697/kWh @ 80 percent efficiency = \$0.962/kWh
Economic - \$0.5958/kWh @ 80 percent efficiency = \$0.745/kWh

Markup/delivery: 50 percent

Cost of supply: Financial (after-tax) - \$1.62-1.65/kWh
Economic - \$1.25-1.30/kWh

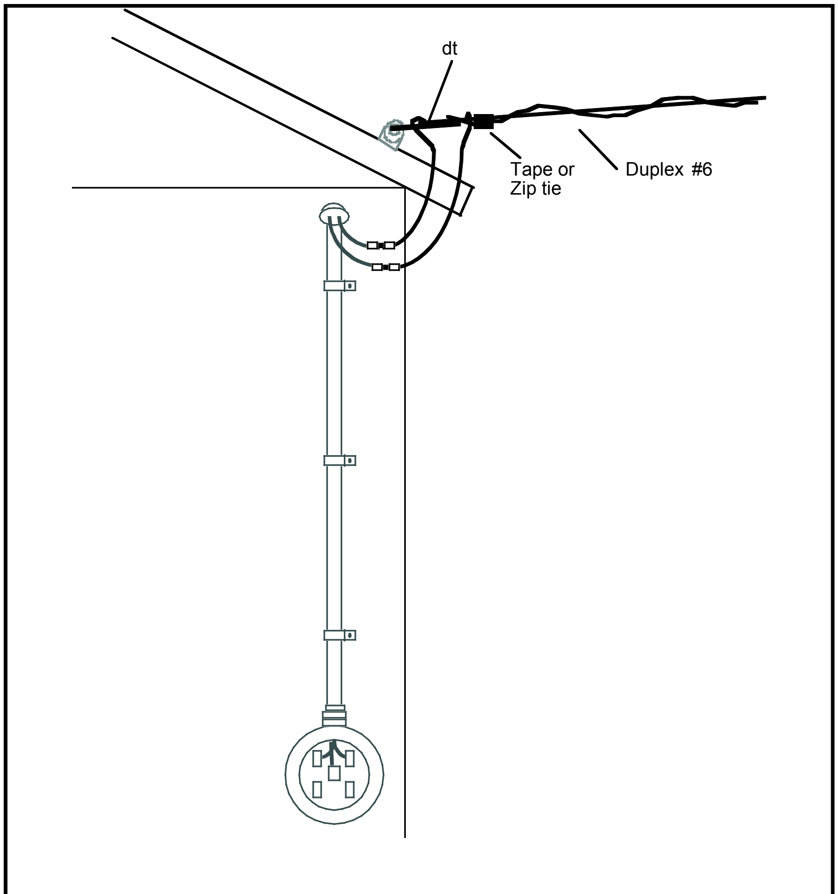
Appendix I
Illustrations and Examples of Proposed Activities

SECTION 1

Illustrations

Service Entrance Design Examples

As indicated in the sub activities a service standard should be developed for each type of structure and customer. When designing a service entrance, care should be taken to ensure that all wires before the meter are clearly visible and/ or protected against diversions. Below are some example of installations.



CODE	ITEM	Qty.	Description	CODE	ITEM	Qty.	Description
SG4500	dt	1	Preformed Service Deadead				
ES4W4W	p	2	Compression Connector #6-#6				

N¼	REV.	FECHA	POR	
				Service 50 a. 240 v.
1	1.01	14/5/93	NRECA	
2	2.0	20/11/94	NRECA	Design: M. Manon
3	2.5	18/5/05	NRECA	Drawing: M. Manon
				Revised: M. Manon
				Approved:

K10-1

FIGURE 1
Service entrance with a weather head and drip loop.

FIGURE 2

Meter box mounted on the pole with din rail style meter. All the wires coming out of the box are already metered.

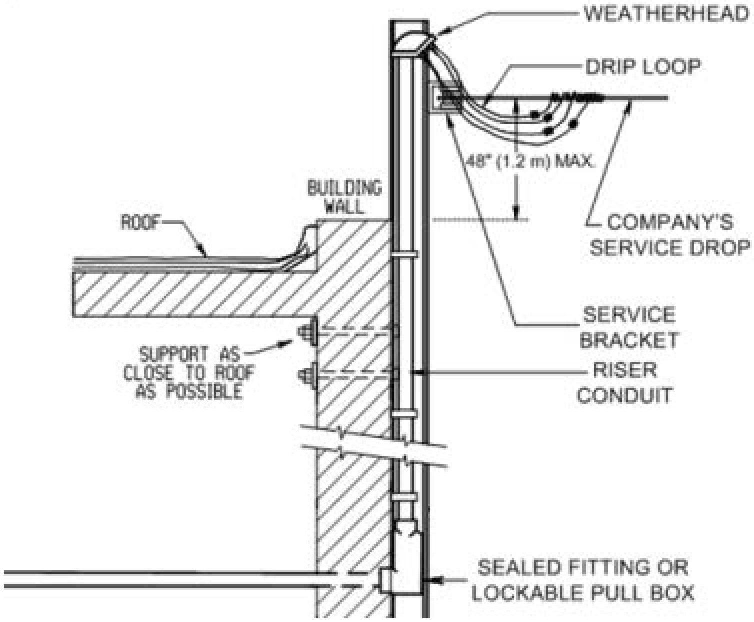
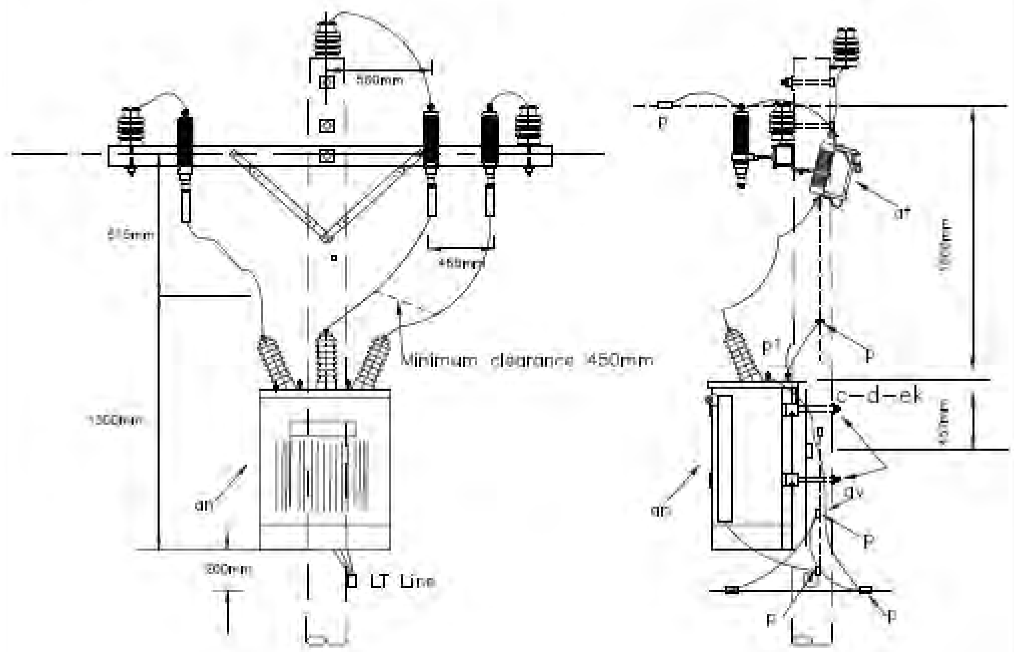


FIGURE 3

Service entrance to along with meters located on poles

Bifurcation



ITEM	QTY.	MATERIAL	ITEM	QTY.	MATERIAL
			ae	3	Surge Arrester polymer housed, gap type, 33kV UR, 27kV UC with bracket and isolator
c	1	Bolt, Machine,M16x325mm,rolled threads,Grade 5.8, galv.	af	3	Fused cutout,100A, 27kV, 170kV BIL, 10kA, with crossarm bracket for 90x115mm crossarm
c	2	Bolt, Machine,M16x250mm,rolled threads,Grade 5.8, galv.			
d	6	Washer,Square, 50x50 x5mm,galvanized,17mm hole	av	15m	Bare and insulated jumper conductor Aluminium,size as required
p	8	Compression connector,aluminium, H-block, sizes as required	bu	1	Tank grounding connector
p1	3	Single hole compression lug with hole size for transformer bushing stud	ek	3	Type MF Locknuts M16
an	1	Three phase transformer 33kV_415/240 up to 50kVA			

Maximum Transverse Load: 3336N/Insulator Angle: 0 – 5 NRECA International Ltd.	33 kV, THREE–PHASE TRANSFORMER CROSSARM CONSTRUCTION SINGLE PRIMARY SUPPORT	DATE: OCT/2012 ZG312

FIGURE 4
NRECA Design in Tanzania for three phases low cost transformer structure

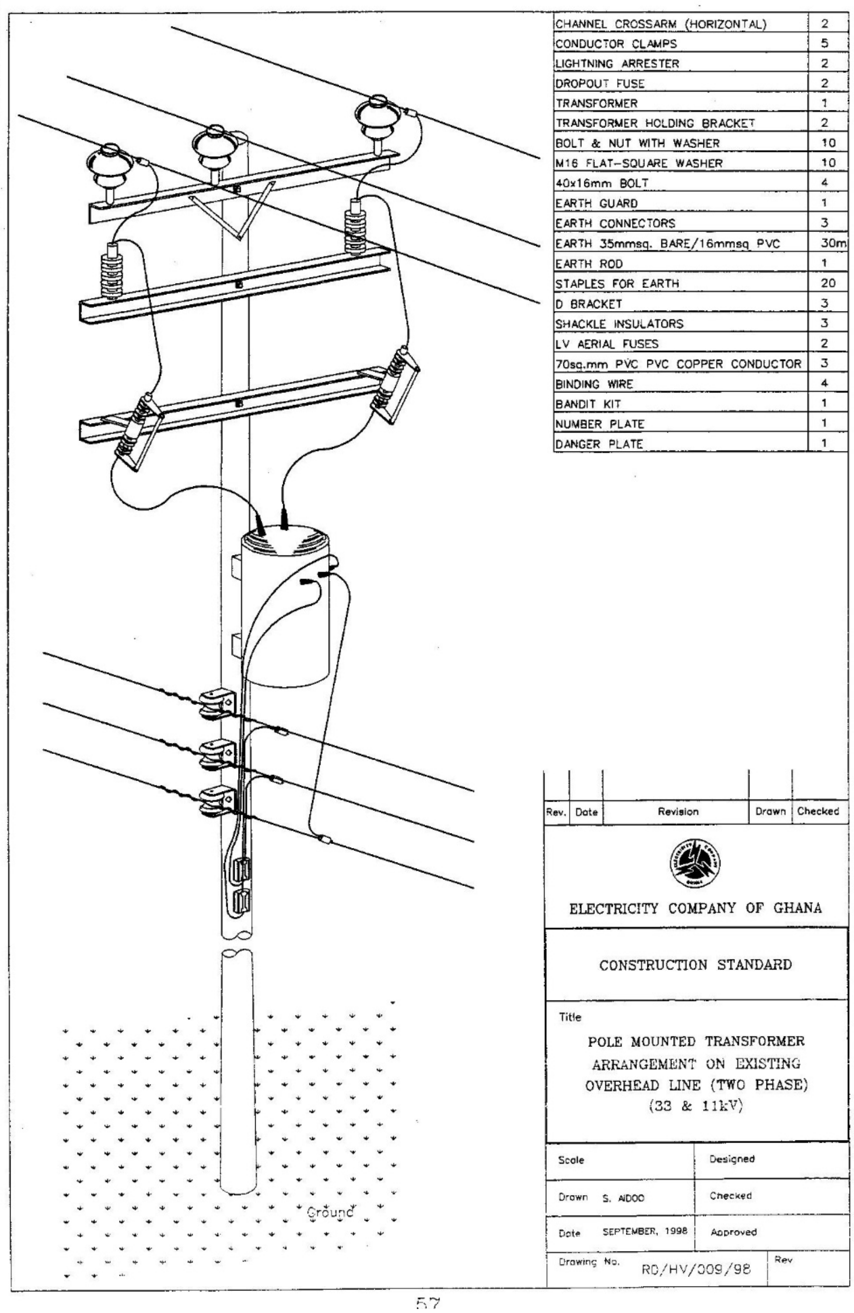


FIGURE 5

ECG single phase transformer pole standard

FIGURE 6
Multiplex bundled cable proposed to be used in place of the current open wire standard on LV networks

Primary Node Metering

FIGURE 7
MV PT and CT metering cluster on pole

Substation

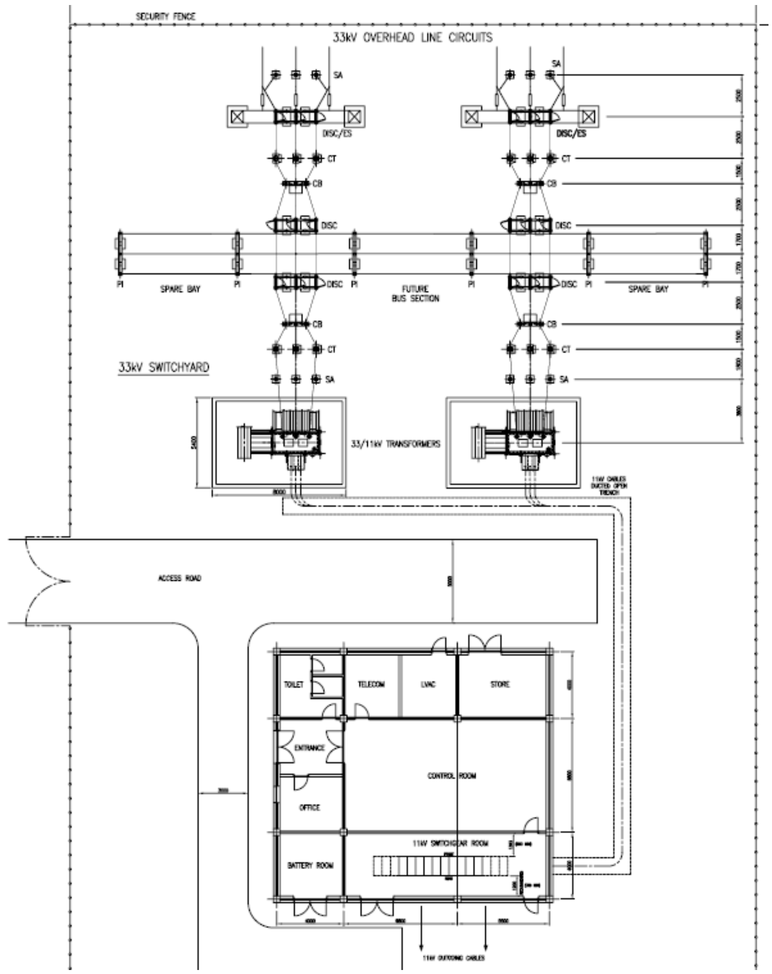


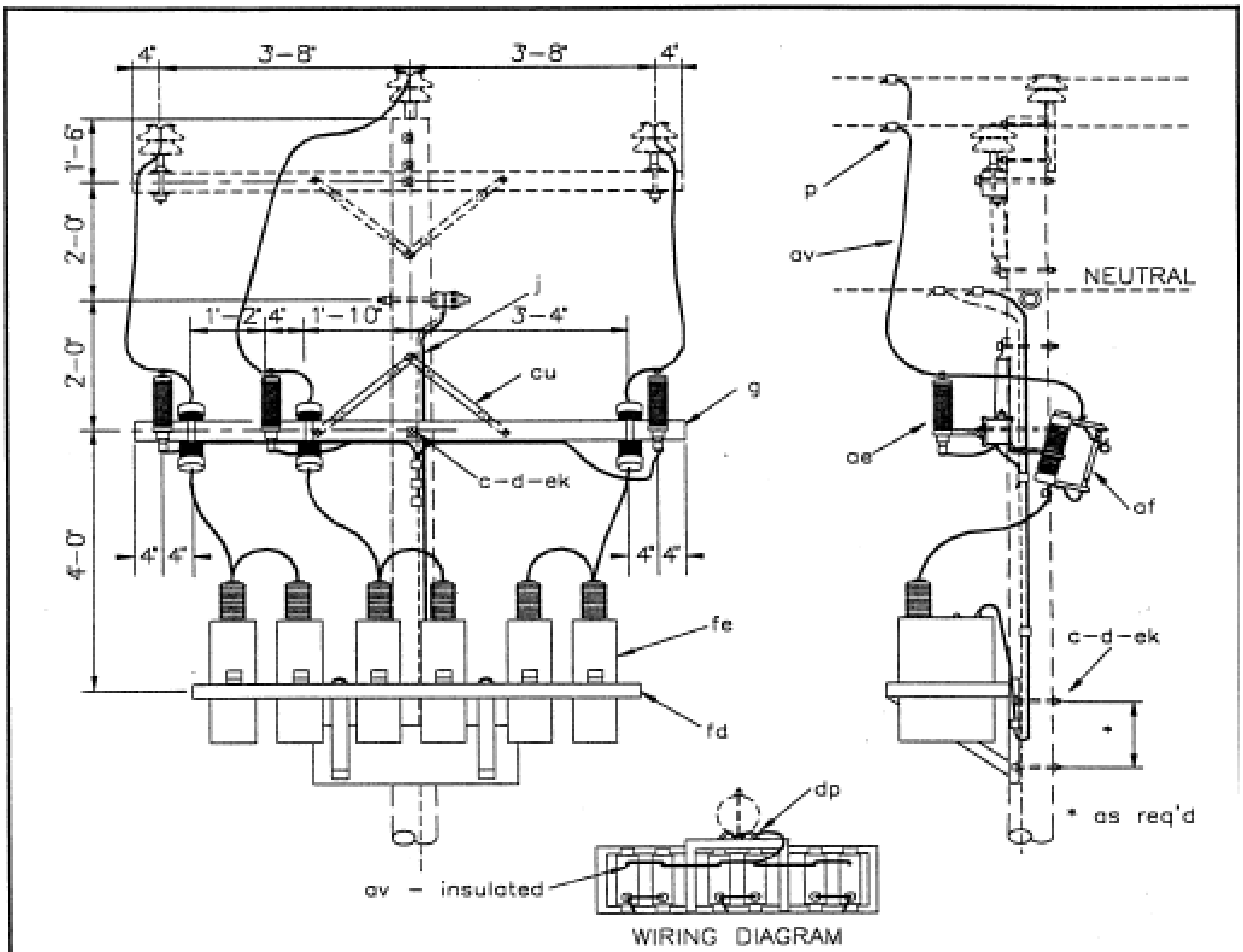
FIGURE 8

Typical indoor primary substation with metal-clad switchgear and OH incoming sub-T

FIGURE 9
Typical indoor primary substation with metal-clad switchgear and underground incoming sub-T

FIGURE 10
Typical Primary Substation combined with a BSP in non-urban areas

Typical Capacitor Installation



NOTE:
1. Specify insulating caps for primary terminal bushings.
2. For two–phase assemblies, omit capacitors and other material on center phase; designate assembly as "VY3.2".

ITEM	QTY	MATERIAL
c	3	Bolt, machine, 5/8" x req'd length
d	4	Washer, square, 2 1/4"
g	1	Crossarm, 3 5/8" X 4 5/8" X 8–0"
i	2	Bolt, carriage, 3/8" x 4 1/2"
j	1	Screw, lag, 1/2" x 4"
p		Connectors, as req'd
p		Connectors, compression, as req'd
ae	3	Arrester, surge (18 kV)
af	3	Cutout, dist., loadbreak, (27 kV)

ITEM	QTY	MATERIAL
av		Jumpers, bare, stranded, as req'd
av		Jumpers, insulated, as req'd
cu	2	Brace, 28"
dp	1	Clamp, ground wire
ek	5	Locknuts
fc		Capacitor, shunt, 24.9/14.4 kV
		(specify number and kVAR)
fd	1	Hanger, capacitor

THREE PHASE CAPACITOR BANK

DEC 1998	3 – PHASE PRIMARY	
RUS	24.9/14.4 kV	VY3.3

FIGURE 11
Typical capacitor installation on a pole

FIGURE 12
Typical capacitor installation at substation

Appendix J
NEDCo Procurement Plan

NEDCo Procurement Plan

Priority	Sub-Activity Name	Procurement Requirement	Pre-Design Requirements (basis for RFP)	Procurement Bundling	Procurement Method
1	**NEDCo-Service-05: Technical Assistance Program**				
The hiring of the technical assistance team is critical to helping NEDCo focus early on the task at hand and to be sure the critical path of the SAD's are followed in sequence. Will provide support in developing key RFPs specifically in the areas of master planning, engineering standards and ICT systems			*MiDA and NEDCo to develop scope of services.*	N/A	Best-Value selection. Time and materials contract.
	LABOR:	Advisory Team will assist owners PMU			
2	**NEDCo-Comm-03: Customer census and normalization of existing service connections**				
The customer census and completion of the GIS will provide the required list of service locations that need normalized by a contractor. The completed GIS will allow for population of the CIS with correct consumer service locations and give the engineering consultant to initial work on the distribution master plan and begin the required changes to the distribution material and construction standards.			*MiDA, Program Management Contractor and Technical Assistance Contractor to verify scope and parameters.*		
	LABOR:	Field Data Collection Consulting Firm		N/A	Best-value selection. Unit-rate contact based upon volume
	LABOR:	Normalization Installation		NEDCo-Engr-24 and Engr-19A and Comm-03 (Service Normalization) are bundled.	Lowest Price Technical Acceptable. Unit Rate Contract
	MATERIALS:	Equipment for Service normalization		All material could be bundled into a blanket purchase agreement and conduct material-provided contract.	Lowest price technically Acceptable. Possibly blanket purchase agreement material contract for term
3	**NEDCo-Comm-04: Enterprise customer information system and integration with existing enterprise applications**				
4	**NEDCo-Ict-01: Communication network**				
5	**NEDCo-Ict-04: Data center at VRA or Sunyani**				

NEDCo Procurement Plan

Priority	Sub-Activity Name	Procurement Requirement	Pre-Design Requirements (basis for RFP)	Procurement Bundling	Procurement Method
The CIS & ICT applications as outlined in a NEDCo staff document have listed the details of implementing the CIS from VRA to NEDCo facilities. Communications network needs to accompany the CIS for centralization of the work process. Choosing a new CIS platform is key element to populating the data from the field verified information obtained from the GIS & customer census.			*MiDA, Program Management Contractor and Technical Assistance Contractor to establish ITC requirements based upon eSolutions report*		
	LABOR:	CIS firm		N/A (Specialized firm)	Best-value selection. May procure as fixed price (installation and training) and T/M for consulting services
	MATERIALS:	Server & communications equipment		May be bundled with other communication equipment or Communication design and development services may be procured as a system design-build	Lowest Price Technical Acceptable. Fixed price contract
	LABOR:	Communications & Data center firm			Best-value selection. May procure as fixed price (installation and T/M for consulting services) or Fixed price design build with materials
6	**NEDCo-Service-06: Distribution System Master Plan**				
Engineering modeling can begin on the completed GIS substations and feeders. The technical advisor will assist NEDCo staff to determine the corrective course of action to reduce losses through bifurcation and service normalization. Usage data will be extracted from the CIS to populate the model ensuring the integration of CIS to the GIS and engineering software. <u>note: ECG & NEDCo Master Plan can be bid together.</u>			*Program Management Contractor and MiDA should work with NEDCo to verify plan requirements.*	All Engineering Activities to be bundled including NEDCo-Service-05; NEDCo-Engr-22; Engineering for NEDCo-Eng-18; NEDCo-Eng-19; NEDCo-Ops-03	Best-Value selection. Time and materials contract.
	Engineering team and Technical Advisor:				
	LABOR:	Engineering Firm for master plan development			
7	**NEDCo-Engr-22: Update distribution construction standards based on current low loss practices**				

NEDCo Procurement Plan

Priority	Sub-Activity Name	Procurement Requirement	Pre-Design Requirements (basis for RFP)	Procurement Bundling	Procurement Method
A review of construction & material standards can begin since the system modeling has started. Information from the modeling will assist the consultant to develop new guidelines. Technical advisor and a team from NEDCo will ensure these new standards are implemented. <u>Note: ECG & NEDCo Master Plan can be bid together.</u>				All Engineering Activities to be bundled including NEDCo-Service-05; NEDCo-Engr-22; Engineering for NEDCo-Eng-18; NEDCo-Eng-19; NEDCo-Ops-03	Best-Value selection. Time and materials contract.
	LABOR:	Consultant - engineering firm			
8	**NEDCo-Engr-03A: Replace faulty and aging underground conductors**				
This is a replacement project of faulty underground conductor.			*Engineering modeling should verify conductor loading and system perimeters before replacement begins. Also requires construction standards*		
	MATERIALS:			All material could be bundled into a blanket purchase agreement and conduct material-provided contract.	Lowest price technically Acceptable. Possibly blanket purchase agreement material contract for term
	LABOR:			Bundle with shield wire conversion NEDCo-Eng-07	Lowest Price Technical Acceptable. Unit-rate contract
9	**NEDCo-Engr-24: Metering at critical nodes of the distribution system**				
10	**NEDCo-Engr-19A: Low voltage feeder bifurcation with medium voltage upgrade**				
NEDCo-Engr-24 and NEDCo-Engr-19A could be handled under a labor only unit base contract. The prior work completed from the GIS, customer census and design standards allow for a unit price. By the time the RFP is drafted the customer census & GIS work should be 50% complete with field collection to give base unit quantities for evaluation.			*'Engineering & technical advisor to review project standards for service normalization*	All Engineering Activities to be bundled including NEDCo-Service-05; NEDCo-Engr-22; Engineering for NEDCo-Eng-18; NEDCo-Eng-19; NEDCo-Ops-03	
	MATERIALS:			All material could be bundled into a blanket purchase agreement and conduct material-provided contract.	Lowest price technically Acceptable. Possibly blanket purchase agreement

NEDCo Procurement Plan

Priority	Sub-Activity Name	Procurement Requirement	Pre-Design Requirements (basis for RFP)	Procurement Bundling	Procurement Method
					material contract for term
	LABOR:			NEDCo-Engr-24 and Engr-19A and Comm-03 (Service Normalization) are bundled.	Lowest Price Technical Acceptable. Unit-rate contract
11	**NEDCo-Engr-07: Shield wire conversion to 34.5 kV system Techniman-Ahafour**				
NEDCo should start the design and relocation of the new line and prepare a detailed project unit list to MiDA by Nov 15. The project quantities can be used to develop a unit price contract. Estimated material quantities can be provided to MiDA by Jun 15 for equipment and material purchases with delivery based on award date of labor contract and start date.			NEDCo Staff to develop staking sheets for MiDA and technical advisor team review		
	MATERIALS:			All material could be bundled into a blanket purchase agreement and conduct material-provided contract.	Lowest price technically Acceptable. Possibly blanket purchase agreement material contract for term
	LABOR:	Labor Only Unit Price Contract		Bundle with shield wire conversion NEDCo-Eng-07	Lowest Price Technical Acceptable. Unit-rate contract
12	**NEDCo-Service-02A: Procurement of vehicles, tools and equipment**				
NEDCo staff and advisory team need to develop the list of Personal Protective Equipment (PPE) operations personal required to meet the budget for 100 operations staff. The same team needs to assess vehicle requirements and training for bucket truck operations. Recommend review of ECG current delivery of line and bucket trucks from Altec.			Advisor team and NEDCo senior management	These materials will likely come from multiple suppliers. May be appropriate to bundle with the electrical equipment blanket	Lowest price technically Acceptable. Possibly blanket purchase agreement material contract for term

NEDCo Procurement Plan

Priority	Sub-Activity Name	Procurement Requirement	Pre-Design Requirements (basis for RFP)	Procurement Bundling	Procurement Method
	MATERIALS:			purchase agreement for ease in procurement and issue RFP with multiple vendors	
13	**NEDCo-Comm-01: Service connection materials**				
18	**NEDCo-Ops-02: Procure operations and maintenance materials**				
NEDCo Engineering and Operations staff will work with Technical Advisor to determine material types and quantities.			Advisor team and NEDCo staff development	All material could be bundled into a blanket purchase agreement and conduct material-provided contract.	Lowest price technically Acceptable. Possibly blanket purchase agreement material contract for term
	MATERIALS:				
14	**NEDCo-Service-01A: Construction of customer service centers**				
Implementation of this SAD can start once the CIS, data center and communications requirements have been established.			NEDCo Staff and Advisor team to work on schedule for the 20 service center upgrades		
	Labor/Materials	Contractor supplied local material for service center upgrades		N/A	Lowest price, technically acceptable. Fixed price contract
15	**NEDCo-Engr-18: Reactive power compensation for primary substations and MV lines**				
16	**NEDCo-Engr-29: Sectionalizing study of MV networks within NEDCo's territory**				
17	**NEDCo-Ops-03: Installation of outage reporting and call center system**				
These projects can be grouped for equipment and unit price labor contract. Completion of Distribution Master Plan will provide the necessary details for capacitor and sectionalizing equipment placement. GIS and CIS should be completed to integrate with OMS system.			*NEDCo Engineering and Operations Staff and Technical Advisor develop requirements*	All Engineering Activities to be bundled including NEDCo-Service-05; NEDCo-Engr-22; Engineering for NEDCo-Eng-18; NEDCo-Eng-19; NEDCo-Ops-03	

NEDCo Procurement Plan

<table>
<tr><th>Priority</th><th>Sub-Activity Name</th><th>Procurement Requirement</th><th>Pre-Design Requirements (basis for RFP)</th><th>Procurement Bundling</th><th>Procurement Method</th></tr>
<tr><td></td><td>Vendor</td><td>OMS Vendor</td><td rowspan="3"></td><td>N/A (Specialized firm)</td><td>Best Value Selection; Fixed Price Contract</td></tr>
<tr><td></td><td>MATERIALS:</td><td></td><td>All material could be bundled into a blanket purchase agreement and conduct material-provided contract.</td><td>Lowest price technically Acceptable. Possibly blanket purchase agreement material contract for term</td></tr>
<tr><td></td><td>LABOR:</td><td></td><td>Labor is bundled for Eng-18 and Eng-29 and installation of outage equipment</td><td>Lowest Price Technical Acceptable. Unit-rate contract</td></tr>
<tr><td colspan="3">These projects were given to the CH2M Hill team from NEDCo Engineering Staff. There was not time to fully evaluation whether these projects are required today and part of the current distribution master plan. Once the master plan is completed justification for these projects will become apparent or may delay the project for future years. Procurement of these projects should not start till January 2017.</td><td rowspan="4">Will require completion of the master plan and the construction standards to include standard substation design, and resettlement action framework. Master Plan will provide suggested areas for location of substations, but final site selection will occur as part of project implementation. Specific resettlement plans will await site definition</td><td rowspan="4">All Substations Bundled together.</td><td rowspan="4">Lowest price technically Acceptable. Possibly blanket purchase agreement material contract for term</td></tr>
<tr><td>19</td><td colspan="2">NEDCo-Engr-08: Install Banvim primary substation with interconnecting sub-T lines, MV offloading circuits and LV network</td></tr>
<tr><td>20</td><td colspan="2">NEDCo-Engr-09: Install Islamic primary substation with interconnecting sub-T lines, MV offloading circuits and LV network</td></tr>
<tr><td>21</td><td colspan="2">NEDCo-Engr-11: Install Fiapre primary substation with interconnecting sub-T lines, MV offloading circuits and LV network</td></tr>
</table>