Power Distribution Feasibility Studies, Ghana

Phase II Feasibility Assessment

Electric Company of Ghana

Final

November 2014

ES062314053347WDC

Prepared for

U.S. Army Corps of Engineers, Europe District

U.S. Army Corps of Engineers, Europe Contract Number: W912GB-12-D-0020, Order

In Association with

The Millennium Challenge Corporation

Millennium Challenge Corporation
United States of America

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Reducing Poverty Through Growth

November 2014

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Executive Summary

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

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, an abbreviated load flow analysis and an evaluation of ECG's information and communication technology was conducted by a team from NRECA. The Burma Camp substation was selected for the analysis. The results showed lower than expected overall technical losses, but generally confirmed earlier reports showing poor power quality; technical losses primarily related to the low voltage system; and a general lack of standards. The analysis of the information systems confirmed the need for improved enterprise resource planning and recommends a more streamlined data management system.

Feasibility was assessed for 20 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. A program work plan is provided, including a preferred procurement strategy. This procurement strategy recommends that MCC engage a program manager, technical assistance contractor, and an engineer early to prepare the groundwork for effective management and coordination of follow-on activities.

In general, the proposed Sub-Activities will have relatively minor environmental and social impacts, which can be effectively mitigated. Based on the results of the environmental, social, and gender impact assessment, 14 of the 20 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 six 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, 13 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 ESIA required. Seven 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. Several of the Sub-Activities have 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 and, in some cases, financial and/or legal penalties can be imposed. This practice could result in negative impacts to the poor; it is recommended therefore that a program of mitigation measures be developed and implemented to facilitate the legal reconnection of the poor as appropriate.

All Sub-Activities were screened for their potential resettlement impacts. Seven Sub-Activities were identified as having the potential for involuntary resettlement, all of which involve the construction of substations and/or distribution lines. In line with current ECG 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 (RPF), was prepared in accordance with the requirements of IFC 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, $177 million (M) of MCC investments will provide $750M in benefits as measured by the net present value of future costs and benefits. At the same time, loss improvement investments alone are insufficient to achieve positive margins for ECG; ECG will require a tariff increase of 13 to 15 percent in 2015 to ensure future profitable performance. The economic model shows that the economic internal rate of return is greater than 10 percent, and the proposed performance improvement investments are warranted.

The sustainability assessment identified a of number internal, external, and management requirements that could hinder long-term program sustainability. Two critical external sustainability requirements include the need to eliminate GoG arrears and to revise the tariff structure to align to the cost of service. The other major sustainability risk relates to utility management support for significant organizational change. Without engagement and support of the ECG 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 to the loss management approach. Many of the Sub-Activities that are proposed aim to ensure that ECG management has the 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, and collection rate and outage information (System Average Interruption Duration Index [SAIDI] and System Average Interruption Frequency Index [SAIFI]) that should be tracked monthly. Enterprise resource planning is instrumental in ensuring that such data are automated and readily available for management review.

While the portfolio of activities and sub-activities presents great opportunities for ECG, there remain some challenging governance and management hurdles. Specifically, it is apparent that Ghanaian decision-makers have not fully embraced the idea of ensuring that ECG is a financially viable company. The Government will need to adopt some key changes in ECG governance for MCC investments to achieve the desired results. Concurrently, ECG is facing significant and sustained growth that may be difficult to manage. Sales have increased, on average, more than 6 percent per year since 2001, which further strains the utility. As it stands, ECG management and staff are not proactively responding to these issues. The organization does not use business intelligence data to make prioritized decisions nor does it have or use long-range plans.

The recommendation continues to be a regional integrated loss management focus to drive change. Without a comprehensive and focused loss management program driven at the lower levels, it is doubtful that ECG will be able to make the cultural shift required to achieve the aggressive loss targets needed to meet the growing demand and to ensure financial sustainability. Loss management, particularly control of non-technical losses and improvement of collections, needs to become the most important consideration for the board of directors and senior management, with resources and funds allocated to areas that will result in the highest efficiency improvements. This 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, the single minded pursuit of expansion needs to be curbed to allow ECG management to focus on improving efficiency. If the current emphasis on investment for expansion continues, the company’s deficit will continue to increase at the same rate as its customer growth. Investing in growth without improving corporate efficiency is more detrimental to ECG then not investing at all. ECG 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

A	amps
ALF	annual load factor
AMR	automatic meter reading
ATC&C	aggregated technical, commercial, and collection
BGC	bulk generation charge
BSP	bulk supply point
CDCHD	Cross Debt Clearing House Division
CIS	Customer Information System
CT	Current transformer
DMMS	disconnection monitoring and management system
DSC	distribution service charge
DSM	demand side management
ECG	Electricity Company of Ghana Limited
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EIRR	economic internal rate of return
EPA	Environmental Protection Agency of Ghana
ERP	enterprise resource 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
GECE	Global Energy Consulting Engineers
GHS	Ghanaian Currency Cedi
GIS	geographic information system
GoG	Government of Ghana
GPS	Global Positioning System
GRIDCo	Ghana Grid Company Limited
GWh	gigawatt hours
Gx	generation
HR	human resources
HV	high voltage
ICT	information and communication technology
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ILMP	Integrated Loss Management Program
km	kilometer(s)
kV	kilovolt(s)
kVA	kilovolt(s) ampere
kW	kilowatt
kWh	kilowatt hour(s)
LCU	loss control unit
LLF	loss load factor

LV	low voltage
M	million
m	meter(s)
MCC	Millennium Challenge Corporation
MDA	ministries, departments, and agencies
MiDA	Millennium Development Authority
MIS	management information system
MV	medium voltage
MWh	megawatt hours
NEDCo	Northern Electricity Distribution Company
NPV	net present value
NRECA	NRECA International Limited
O&M	operations and maintenance
OMS	outage management system
PAP	project affected person
PEA	Preliminary Environmental Assessment
PM	program management
PS	Performance Standard
PSP	private sector participant
PURC	Public Utilities Regulatory Commission
RAP	Resettlement Action Plan
RFP	request for proposal
ROW	right-of-way
RPF	Resettlement Policy Framework
RUS	Rural Utilities Service
SAD	Sub-Activity description
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	supervisory control and data acquisition
SLT	special load tariff
TA	technical assistance
T&M	time and materials
TOU	time of use
TSC	transmission service charge
Tx	transmission
USACE	U.S. Army Corps of Engineers
VOLL	Value of Lost Load
VRA	Volta River Authority

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 Limited (NRECA) , on behalf of GoG, to undertake the project screening and 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 ECG Financial and Operational Turnaround Project will provide support to ECG 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 ECG 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 necessary 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 & 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 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, is intended to be stand-alone descriptions and details of each Sub-Activity. Other appendices include:

A Consolidated Sub-Activity List and Results
B Loss Study Results – summary of loss results data
C Sub-Activity Descriptions
D Sub-Activity Unit Cost Analysis and Assumptions
E ECG Work Plan
F Environmental, Social, and Gender Impact Assessment
G Financial Analysis Summary
H Economic Analysis Summary
I ECG Procurement Plan

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 (ILMP) 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 ILMP 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, ILMP

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

> **Engineering** is responsible for evaluation of technical losses, design of loss reduction projects, and supervision of project implementation.
>
> **Operations** is responsible for distribution system reliability and outage management.
>
> **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.
>
> **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 (CIS), 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.), 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 a part of the solution to loss problems 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

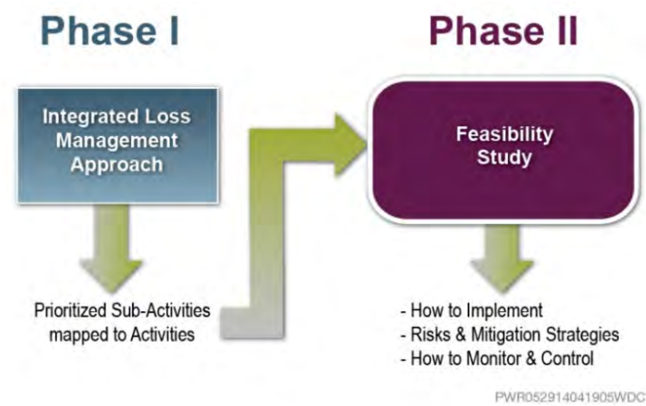
The Phase I Project Screening and Prioritization started with the assessment of roughly $800 million of Activities and Sub-Activities. Using the Integrated Loss Management model, the list was reduced to roughly $175 million of prioritized investments proposed for the Phase II Feasibility Study. The final result of the prioritization process concluded that ECG should focus on:

- Investment targeted in Accra East and Accra West, and then possibly Tema where ECG 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 net present value (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, resettlement, and sustainability risks; and a recommended monitoring and evaluation approach to ensure the program is meeting objectives.

FIGURE 2-2
Phase I and Phase II integration



It is apparent that the ILMP is oriented toward improved performance of the utility, both financially and operationally, and not towards growth through expansion. ECG'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 conducive 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:

- Carrying 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.
- Conducting 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 LV network apparatus.[1]

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 (GECE) study results that provided relative loss levels at ECG and NEDCo's substations (GECE, 2012). Within the Accra East region, Burma Camp substation was chosen for detailed modeling following discussions with ECG staff, who described it as the highest loss substation in the region. A team of ECG GIS technicians, supervised by NRECA personnel, 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 geo-database 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. Quality assurance was provided by the NRECA personnel.

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 Burma Camp and the ECG information systems and communication technology assessment.

3.2.1 Burma Camp 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

[1] 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 within the utilities to be used during the Compact implementation period and in future years to identify areas that require capital expenditures to further reduce system losses.

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
- 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 Burma Camp substation was carried out by mapping all the feeders in the distribution system fed by the substation using satellite receivers connected to the global positioning system (GPS). The data from the GPS units was transferred to a GIS, and then to a commercial load flow software called Milsoft Windmil. Milsoft 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 ECG Commercial Department, although a number of approximations were necessary to develop acceptable data. Feeder load data was obtained from the ECG Operations Department, although the nature of the data available also required approximations.

The results of the modeling show that technical losses for the 33kV subtransmission system, the substation, the high voltage (HV) distribution network and the low voltage (LV) network served by Burma Camp substation, expressed in percent of total energy input at the bulk supply substation, are 8.3%, divided as follows:

- 33 kV subtransmission lines: 0.8%
- 33/11 kV transformers: 0.9%
- 11 kV distribution lines: 1.7%
- 11/0.415 kV distribution transformers: 1.5%
- 415 V low voltage distribution lines: 3.5%

The most significant contributor to system loss, accounting for 40% of the total, is loss in the LV system. These losses can be reduced by adding transformers and extending 11 kV lines 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% to 0.7%, making bifurcation of LV circuits the preferred method for reducing technical losses for ECG.

3.2.1.2 Background

The GECE loss study (National Technical Loss Study-Accra East Region, 2012) identified the Burma Camp substation as having above average losses, and it was chosen for further analysis under the load flow study. The Burma Camp substation serves a high density residential and commercial consumer area that employs underground 11 kV distribution feeders and overhead low voltage circuits. The substation itself is a 33/11 kV substation, with a total of seven active 33kV breaker positions, of which two are the principal feeds from Achimota 161/33kV bulk delivery substation. The remainder of the 33kV network is composed of lines that interconnect various intermediate substations and may act as loads or sources depending on the loading and resources of such substations. The two major 33 kV supply lines are from the Achimota bulk supply point (BSP). These consist of an 8.5 km 33 kV underground cable with a 500 mm^2 copper conductor and a combination overhead and underground lines totaling 5.7 km. The 4.2 km overhead portion has 240 mm^2 all aluminum conductors and the 1.5 km underground portion has 500 mm^2 copper conductors. Burma Camp is equipped with two 20/23 MVA transformers stepping down from 33 kV to the 11 kV distribution voltage. Each transformer is equipped with an on-load tap changer so that the 11 kV bus voltage can be regulated to a particular level without regard to the level of the 33 kV input voltage. For purposes of this analysis, 11 kV bus voltage is assumed to be held to 11 kV (1.0 per unit, or 100% of nominal), consistent with values observed in the substation record. The distribution system emanating from the Burma Camp substation consists of nine 11kV feeders composed of varying conductor sizes of mostly underground line, feeding relatively large

11/0.4kV three-phase distribution transformers. The LV network consists of overhead lines constructed mainly with 120mm^2 bare all aluminum conductors.

3.2.1.3 Prior Studies

The GECE study estimated annual energy losses for the 11kV feeders and distribution transformers at Burma Camp at 5.9% as compared with a network average of 4.5%. Also, the GECE study noted that two of the feeders served by the substation had energy losses of 12.3% and 10.2%, considerably higher than the 4.5% system average. The GECE study did not specifically examine the Burma Camp low voltage distribution network, but used a sample of the LV networks on 72 transformers to arrive at an estimate of energy losses for the Accra East and West LV network as a whole of 3.1%. Thus the GECE study predicted energy losses for the Burma Camp distribution network (11kV lines, distribution transformers, and LV lines) of 9.0%.

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

TABLE 3-1
Data for Burma Camp Substation From GECE Technical Loss Report 2012

Feeder Name	HV Length (km)	Transformer kVA	Estimated Peak kW
L01	5.86	5,360	2,012
L02	7.24	5,345	3,236
L03	31.3	5,710	4,267
L09	25.45	4,730	1,963
L12	1.24	2,000	1,214
L22	16.6	10,225	3,562
BC1	8.5	5,050	2,483
B/C3	9.11	5,510	3,901
B/C2	66.4	6,710	4,672
Total	**171.7**	**50,640**	**27,309**

kVA - kilovolt(s) ampere
kW - kilowatt

Total HV line length is 171.7 km and total installed distribution transformers amount to 50,640 kVA. Total load served at peak is approximately 27.3 megawatts, giving an average transformer loading of 54%.

3.2.1.4 The Burma Camp Loss Study

A GIS map was developed for all 11 kV feeders emanating from the Burma Camp substation. The GIS map included the collection of data for line conductors, line locations and segment lengths, and transformer capacities and locations. Feeder peak loading data was obtained from a combination of sources, including supervisory control and data acquisition (SCADA) records and peak-indicating substation meters. In the case of feeder L-05, mapping of the LV network included a count of consumers by class (e.g., residential, commercial, etc.) connected to each pole. A summary of the characteristics of the Burma Camp distribution network as obtained from the GIS mapping effort of 2014 is presented in Table 3-2.

TABLE 3-2
The Burma Camp Distribution Network as mapped 2014

Feeder Name	From GIS Field Survey			Estimated Feeder Peak kW
	HV Length (km)	LV Length (km)	Total Connected kVA	
Feeder L03	8.4		5,630	2,836
Feeder L04	13.1		17,520	5,139
Feeder L05	15.8	56.2	11,095	5,020
Feeder L06	2.5		2,500	1,773
Feeder L09	3.3		500	355
Feeder L10	8.4		13,955	6,201
Feeder L11	4.5		9,030	4,077
Feeder L12	6.2		6,700	3,012
Feeder L13	6.6		4,115	1,773
Total	**68.8**		**71,045**	**30,185**

It is apparent from comparison of the two tables that the configuration of the distribution system served by the Burma Camp substation has changed considerably since the GECE study of 2012. The total length of HV feeders has been reduced by 60%, and the installed capacity of transformers has increased by 40%. Demand on the substation has increased by only 10%. Given these substantial changes in configuration, the loss data for 2014 will likely be substantially different than that determined for 2012.

Collecting load data proved to be the most problematic part of the process because the Burma Camp substation is not manned and feeder metering does not provide a load profile, as a manually collected hourly substation data sheet would. Feeder peak loading data is instead obtained from peak-indicating meters in the substation which are read monthly. It was found through conversations with system personnel that feeder configuration changes are common and it appears that the feeder configuration that generated some of the peak data collected does not correspond to the configuration of the feeder when they were mapped. This resulted in some unrealistic results, such as a recorded peak on feeder L-09 of 4,760 kVA when the feeder, as mapped, has only a single 500 kVA transformer. The configuration represented by the GIS map was used because this configuration was known to have been in use on a long term basis. While not ideal, this approximation produced reasonable results.

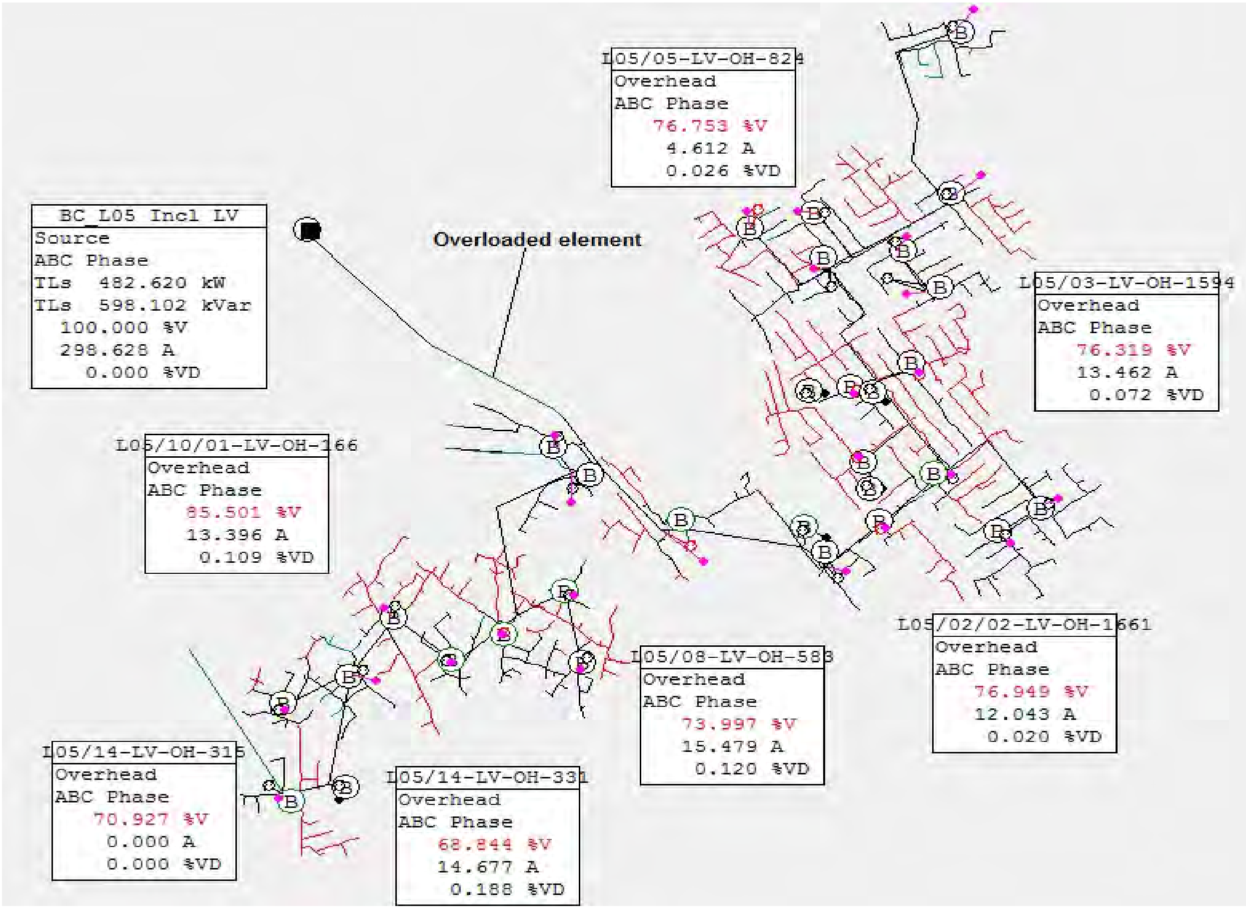
Similarly, loading data for each distribution transformer was not obtainable, because of lack of integration between the GIS established by the Commercial Department and the engineering circuit diagrams. The lack of integration between the commercial GIS and the engineering circuit diagrams affects the ability to directly use sales data from the commercial system in the Milsoft Windmil 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.

Once the GIS data was collected, a power flow analysis was completed using Milsoft Windmil distribution modeling software. 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:

- Milsoft Windmil software simulates feeder peak loads, as allocated to system elements, and serves as the upper bound of loading. Accordingly, feeder loading data was adjusted to account for apparent differences between a mapped feeder configuration and the configuration that generated the recorded feeder peaks. These approximations were based on the assumption that the total peak load on the two power transformers was a reliable and reasonable value, and that the sum of feeder peaks would be close to the total peak recorded for the transformer.
- Because it was not possible to associate customers with the transformers that served them, load allocation for 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 load allocation of distribution transformers on the single feeder on which the LV network was mapped. This process consisted of allocating total feeder peak load prorated by the total energy (kWh) 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% 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 is allocated to the system elements in proportion to the energy consumed by 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 from ECG. As a result, the power factor at the consumer end was assumed to be 90%. This typically results in a power factor of 88% 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 Milsoft Windmil software is shown in Figure 3-1 for Feeder L-05, 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 model shows that voltages at the ends of the LV system are likely to be on the order of 70% of nominal voltages or less. It should be noted that in the United States, distribution planning criteria commonly requires voltages at the LV level to be greater than 90% of nominal. Therefore the simulated data 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
Burma Camp Distribution Model for Feeder L-05



This output shows that total feeder losses are 482.6 kW. Feeder load at the source is 298.6 A, corresponding to the allocated feeder peak of 300 A and a feeder load at the substation bus of 5,020 kW with a power factor of 88%. The data in the case report shows that this loss value is subdivided as follows:

HV conductor Loss: 130 kW

Transformer Loss:

No Load	25.1 kW
Load Loss	58.7 kW

LV conductor Loss: 269kW

Demand losses under this peak loading condition are 9.6% for the feeder conductor, distribution transformers and LV lines.

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= Loss Load Factor $=0.7*ALF^2 + 0.3*ALF$

Where

ALF= Annual Load Factor

ALF for the feeder is another item that cannot be derived directly from ECG data, due to the consideration 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. It is, therefore, necessary to make a reasonable assumption. There are no large consumers on the LV network and no direct connected consumers on the L0-5 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%.

At an assumed annual load factor of 50%, the resulting loss load factor is 32.5%. The loss analysis for this feeder is shown in Table 3-3. This table shows that average annual energy losses, calculated as a percentage of input to the feeder are 6.9%, with LV energy loss amounting to 3.5% or 51% of feeder losses.

TABLE 3-3
Feeder L-05 Losses

Feeder Type	HV Conductor Loss %	Transformer Loss %	LV Network Loss %	Feeder Annual Energy Loss %
Feeder L-05 Energy Loss	1.7%	1.8%	3.5%	6.9%

Note that the numbers may not add up due to rounding.

Because feeder L-05 is typical of the other feeders in the substation, it is reasonable to assume that LV losses on those feeders are equivalent to the results for feeder L-05. Given this assumption, the total loss analysis of the Burma Camp system, including the 33 kV lines and 33/11 kV substations is summarized in Table 3-4. As with feeder L-05, the individual values of loss for each system component, including 33 kV conductor, 33/11 kV transformers, etc. are obtained from the power flow report.

TABLE 3-4
Burma Camp Substation Loss Results

Sub transmission Annual Energy Loss %		**1.7%**
Transformer Loss %	0.9%	
33 kV Loss %	0.8%	
Distribution Annual Energy Loss %		**6.6%**
HV Conductor Loss %	1.7%	
Transformer Loss %	1.5%	
LV Network Loss %	3.5%	
Total System Energy Loss %		**8.3%**

Note that the numbers may not add up due to rounding.
Source: Milsoft Engineering Analysis - Windmil model

This table shows that the model simulated total losses associated with the Burma Camp substation to be 8.3% of the electricity delivered from the Achimota BSP to Burma Camp, and that LV losses are fully 40% of the losses on the entire system including sub-transmission indicating that the LV line lengths are too long, regardless of the large conductor sizes.

The value of 6.6% for distribution losses at Burma Camp shown in Table 3-4 should also be compared with the GECE determination of losses for Burma Camp substation of 9%. At first glance it seems that the changes in configuration of the feeders at Burma Camp between 2012 and 2014 have been successful at reducing loss by about 27%. It is, however, instructive to note that the assessment of LV loss in the GECE study of 3.1% closely matches the value of 3.5% obtained from the current modeling. This means that all of the reduction in loss between 2012 and 2014 has occurred due to changes in the 11 kV feeder configuration and that losses in the low voltage network have not been reduced, but rather may have increased slightly.

Note that the values cited in Table 3-3 and 3-4 are for technical loss only. Non-technical loss cannot be determined from available data, since consumers are not associated with feeders in the customer information system (CIS) and it is therefore not possible to determine what the level of billed sales is to the consumers on feeder L-05, or even on the Burma Camp substation. It is known that total losses of the Accra East region are in excess of 25%, so if technical loss is approximately 8.3%, then non-technical loss is 16.7%. It is clear that ECG has significant challenges in the reduction of non-technical loss.

It is uncertain whether the losses for the Burma Camp system are typical of losses for the entire ECG system. The Burma Camp substation was selected to examine a supposedly high loss substation area. To characterize the total system loss a random selection method to choose feeders is required. The GECE report showed overall Accra East distribution losses of 7.6% (4.53% for 11 kV lines and distribution transformers and 3.1% for LV distribution), and this value corresponds to the 6.6% of loss determined for the corresponding distribution system components at Burma Camp. At the minimum, these results indicate that Burma Camp is not a particularly high loss substation and may well be typical of the ECG system.

3.2.1.5 Bifurcation to Reduce LV Losses

As noted, only one feeder, L-05 was mapped completely, including the LV system. A hypothetical test was conducted to reduce the LV losses on feeder L-05 by reducing loading on LV conductors. This test was based on bifurcation of the LV sectors by inserting new 100 kVA and 200 kVA transformers and extending HV laterals to the new transformers. No changes in the LV network were assumed; there were neither existing conductors nor transformers replaced in the model. The test carried out on feeder L-05 resulted in installation of seven new transformers, increasing the total number of transformers from 31 to 38. A total of 4.3 km of new HV line was added, increasing the amount of HV line on the feeder from 15.8 to 20 km. The added HV line was assumed to be an overhead line, using 50 mm^2 conductors and constructed on poles that replace the existing LV poles on the same routes. The results of this experiment in terms of loss reduction are shown in Table 3-5.

TABLE 3-5
Feeder L-05 Loss Summary with and without Bifurcation

Feeder Type	HV Conductor Loss %	Transformer Loss %	LV Network Loss %	Feeder Annual Energy Loss %
Feeder L-05 Energy Loss Base Case	1.7%	1.8%	3.5%	**6.9%**
Feeder L-05 Energy Loss after Bifurcation	1.5%	1.9%	0.7%	**4.1%**

This table compares the loss outcome of the Base Case (existing conditions) with the results of the experiment in bifurcation of the LV sectors. It is apparent that the result has been a significant reduction in LV losses, from 3.5% to 0.7%. This has been accompanied by a small reduction in HV conductor loss, and a small increase in total transformer loss. The reduction in 11 kV conductor loss is due to the reduction in source load on the feeder (consumer load remains unchanged in the two cases), resulting from the reduction in loss. The increase in transformer loss is the result of the increased number of transformers with their no-load loss. It should be noted that, on average, the transformers on this feeder were operating at only about 52% of their rated capacity before bifurcation, so the loss savings is not due to any reduction in transformer overloads. Also, the conductors used on the LV network are in general very large, so there was no question of conductor overloads in the Base Case. An additional benefit of bifurcation is an improvement in consumer voltages. All consumer voltages are above 90%, as compared with voltages as low as 68% in the Base Case.

3.2.1.6 Conclusions

The results of this experiment indicate the following:

- Addition of a relatively small amount of HV line and inserting a small number of transformers results in a significant improvement in technical loss for the LV system. The LV line length per transformer is shortened and more power is carried at HV rather than at LV.
- Large conductor sizes, as employed in the Base Case LV lines, are not the key to good LV loss performance. Bifurcation, as presented here is a retrofit technology, but if the system were designed

with more HV laterals, smaller transformers, and minimal LV line, it would be possible to reduce LV conductor size on future construction, at a considerable cost savings. The Sub-Activity that includes updating the distribution construction standards and regional master plan will respond to these issues.

A comparison between the technical losses for the Burma Camp substation distribution system as calculated by GECE in 2012 with the Base Case system analyzed here shows that there has been a reduction in loss from 9% to 6.9% due to changes in the HV system, but that LV loss has actually increased from 3.1% to 3.5%. The proposal to bifurcate the LV system, adding HV laterals and more and smaller transformers will address this increase.

3.2.2 Software System Analysis

CH2M HILL reviewed the software systems used by the ECG utility through discussions with the ICT group and commercial staff at the utility as well as a review of the Wipro report for ECG (Wipro, 2012). Table 3-6 summarizes the software applications in place in ECG at this time. Not all of these applications are actually in service (such as the Facilplus GIS system-item 13), but it was not possible to determine the status of all of the packages. Almost all of them have been installed to respond to specific needs and none of them are integrated, nor do any of them use a common database. This includes software that share a common function such as the Bill Payment System for posting payments under the postpaid metering system, and the CBIS which is the postpaid billing system. There are also three separate systems with separate databases for administering the prepayment metering system supplied by three separate vendors in different parts of the utility service area. These separate prepayment systems were provided by the vendors of the meters and have varying capabilities and reporting capabilities. The proliferation of unrelated bits of software intended for specific purposes only is a serious problem that not only generates inefficiency through the need for repetitive data entry, but introduces errors and makes it difficult to extract a consolidated report on any issue for consideration by management. It is clear that ECG lacks an enterprise resource solution for managing information.

TABLE 3-6
Software Systems Installed in ECG

No.	System/Service	Description
1	Directory Service	Identity, authentication and IT resource management
2	E-mail System	MS Exchange System for managing corporate mail flow and collaborate service
3	Intranet System	Internal collaborative system for information sharing
4	Internet Services	
5	Voice over Internet Protocol (VoIP) Telephony	Bridging of PABXs over corporate network for toll bypass
6	Instant Messaging System	System for internal chatting, file transfer and information sharing
7	MMS (Materials Management Sys.)	Materials Management, Stock Control, Supply chain
8	IMS	System for logging customer complaints
9	Bill Payment System	System for Post-paid customer bill payments
10	Proma Soft	Software for Projects Management
11	Fleet Management System	Transport and Fleet Management
12	Corporate Website	System for corporate external website
13	Facilplus	GIS system for electrical network assets management
14	Persol (Payroll)	Payroll application

TABLE 3-6
Software Systems Installed in ECG

No.	System/Service	Description
15	Human Capital Management (HR)	Human resources (HR) application
16	HR	New HR application complementing the Persol HR system
17	Capital Contribution	Managing contribution of customers toward network expansion
18	Telephony /PABX	Traditional Telephony Services
19	Prepayment BOT	Prepayment project taking over the current billing system in Accra West Region
20	Prepayment PNS	Prepayment billing system operating in part of Accra and Kumasi
21	Prepayment E-Cash	Prepayment billing system operating in part of T/R, W/R, E/R, V/R & Accra
22	SUN System Accounting	Regional based accounting application
23	CBIS	Post Paid billing system
24	Transflow	Bill Payment System integrated with banking application for postpaid customers primarily used by Banks
25	New application processing Software	System for processing new service requests from customers
26	SLT (Industrial Billing)	Flat file data base for capturing and billing industrial energy customers
27	SCADA System	System for data acquisition, control of primary substations and control of rural lines
28	DMMS	Disconnection Monitoring and Management System

Recommendations are noted below and address ECG's ICT needs. Specifically Wipro suggests that ECG needs an Enterprise Resource Planning solution (ERP) and recommends that ECG take a phased approach to move towards an enterprise environment. Wipro suggests that ECG follow a three-year phased implementation plan that consists of the following activities:

1. Foundational functions: Wipro recommends ECG first target core financial management and supply chain functions for the ERP.
2. Foundational function: Next, Wipro recommends that ECG target developing business intelligence and analytics.
3. Customer Information System (CIS)
4. Energy and capital management: This function refers to tracking energy flows through the ERP; it will need to be integrated with a GIS and with strategic metering initiatives.
5. Enhancement of enterprise management: This process was reported to have begun in the first quarter of 2014 and continuing through the first quarter of 2015. We would observe that enterprise enhancement is a continuing process – that it should be seen as an on-going process that is adopted as a continuing goal of the ICT group at ECG.
6. Human resource management: This is shown as beginning in the third quarter of 2014 and completed at the end of 2014. Human resource information systems are usually preceded with a review and often, a

redesign of the existing HR systems, so we would suggest that this process will likely require an 18-month implementation period.

As the above summary states, the Wipro report presents an overall ICT implementation strategy without providing detailed examination of the specific tasks and obstacles that are likely to be encountered. The process described by the Wipro report has already begun. According to ECG, implementation of the INDRA software began in February 2014, current status of the deployment in October 2014 is about 40% of the total system. The beta test is scheduled for March 2015 and the expected live date is May 2015. The full procurement and subsequent deployment of the INDRA CIS will take over two years to complete.

At the same time, the slow progress will likely have an overall positive effect in the roll out of many of the proposed Sub-Activity ICT upgrades and the need for a phased and coordinated implementation. The current delay will likely foster better integration of Sub-Activities.

One critical consideration is that the CIS must be able to integrate the diverse postpaid and prepaid metering systems that are currently employed by ECG. It is further recommended that ECG begin its initial rollout phase of the CIS to correspond with the implementation of the GIS and customer census as described in Sub-Activity (Engr-01) to ensure that accurate customer data is included in the system.

One further option that ECG should consider is to minimize the hardware requirements that were proposed by Wipro by taking advantage of virtualization and service provider-based solutions such as Amazon EC2 and Google Compute engine. Hosted service prices are quite competitive and provide the distinct benefit that the service providers are responsible for hardware and firmware upgrades, not the client. While user fees are significant, the lifecycle costs are generally lower than a solution that requires ECG to procure and manage hardware on site.

CH2M HILL has proposed inclusion of a data center for ECG in a Sub-Activity investment, but reduced its size to accommodate data-intensive applications to only GIS and business-essential applications that need to be accessible even when the Internet is down. ECG does own some private communication lines between its offices and is not completely reliant on the Internet for interoffice communications. Furthermore, ECG is developing an agreement with a fiber-optic communications provider to provide right-of-way (ROW) access in exchange for service usage.

3.3 Conclusions

The Burma Camp substation area was chosen as a high technical loss area on the basis of the 2012 GECE loss study. Because of changes in HV configurations between 2012 and the present, losses at Burma Camp are calculated to be lower than expected and may well now be typical of the ECG system as a whole. In general the load flow analysis demonstrated that for Burma Camp:

- Power quality is poor given that the power flow model shows voltages at the ends of the LV system to be 70% of the nominal voltages. Most of the voltage drop is in the LV system.
- Losses in the LV system account for 42% of total system losses, which the Line Bifurcation Sub-Activity will improve.
- Other contributors to total system loss are 33 kV subtransmission (20%), HV line loss (20%) and distribution transformers (18%). The Bulk Supply Point Sub-activity will address subtransmission losses, while the five Primary Substation (33/11kV substations) will address the HV line loss.
- A change in construction standards to emphasize the use of HV laterals, small transformers and smaller conductors on LV lines will reduce cost and improve losses throughout ECG.
- An analysis of the ECG software system confirmed that an ERP is essential for ECG to ensure system data is readily available for effective management. Furthermore, ECG should consider a more streamlined data management system. It is critical that distribution system ICT integration experience is considered

for both the Technical Assistance and Program Management key staff to ensure effective procurement and deployment of the proposed improvements.

SECTION 4

Technical Assessment of Commercial and Network Improvements (Task 3 & 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 various 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 a number of the subtasks and their methodologies were common to both tasks, they are presented below in this section. For the purpose of the Feasibility Study, Task 3 included two Activities: 1) Institutional Support and 2) Reduction in Commercial Losses and Improvement of Revenue Collection Rates. Task 4 addressed two Activities: 1) Reinforcement of Distribution Network and 2) Network Control. A description of the methodologies for Tasks 3 and 4 are presented below.

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 could be 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 SADs 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 include a description of their contribution to overall loss improvements, implementation 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 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 with respect to MCC Ghana Compact II (Compact II) 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 Compact II.
- 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 existing 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 were consistent with the ECG’s internal practices.

The MCC principal requirements for program execution were carefully reviewed to evaluate the ease of implementation for the various Sub-Activities. Requirements that were analyzed were as follows: to achieve an economic rate of return of greater than 10 percent, to be consistent with program logic, to be completed within the 5-year time frame, to align with pro-poor growth strategies, to be consistent with policy reform objectives, to be maintainable post-Compact, to sustain the environment, and to scale easily. 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 were similar to the proposed Sub-Activities. The costs were further verified using a US-based cost database.

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 outage management system (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.

The Sub-Activities identified and evaluated in Phase II all employ systems that have been used by ECG for many years and meet applicable international standards. Therefore, except for the LV feeder bifurcation and substations, these Sub-Activities will generally not require changes in engineering design standards.

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 establishing a well-defined set of baseline conditions before the investment portfolio is implemented. Although ECG 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 baseline 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. Feasibility results associated with Task 3 and 4 Sub-Activities are found in Appendix C (Sub-Activity descriptions). 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 Sub-Activities 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; and 4) Improve overall institutional loss management practices. The problem statement for each SAD responds to one of these four loss categories. Specific baseline requirements focus on the identified ATC&C information. These baselines were described in Phase 1 and are the proposed baselines presented in Section 9.

The 2008 ECG Master Plan (developed with 2007 data) focused primarily on establishing new BSPs, improving distribution reliability and expansion of network access. The Master Plan did not specifically focus on commercial performance improvement interventions or directly respond to overall technical loss reduction. As such, ECG invested in the construction of a BSP at Kpong and also implemented many access expansion projects. However, the projects identified in the Master Plan are not consistent with current and future load growth projections. For example, current projections indicate a need for new BSPs in quantities and locations not yet identified in the Master Plan. This demonstrates minimal overlap, between the 2008 ECG Master Plan and the focus of the proposed Sub-Activities in the MCC report.

As part of the Phase I report, ECG identified a list of recommended activities intended to improve system performance. The total capital cost of these activities is approximately $800 million (2014 U.S. dollars).

During the Phase I evaluation, additional technical and commercial investment opportunities were identified that would round out a comprehensive integrated loss management approach for sector improvement.

All activities were initially prioritized without regard to total cost but rather foundational activities and then by net present value. However, MCC then provided cost guidelines to further guide the prioritization process and establish a cut-off point. A summary of Sub-Activity descriptions further evaluated based upon MCC requirements is provided in Table 4-1, which includes a number of projects beyond MCC's current budget.

TABLE 4-1
Prioritized Sub-Activities

Sub-Activity Name	Activity	Foundational (Yes/No)	Cost	Duration (Month)	NPV
ECG-Comm-04: Replacement of legacy meters with prepayment meters	Commercial Losses Reduction and Collection Efficiency Improvement	Y	$ 18,779,000	39	$ 112,282,000
ECG-Comm-01: Normalization of existing services to comply with improved service connection standard	Commercial Losses Reduction and Collection Efficiency Improvement	Y	$ 12,614,000	52	$ 71,692,000
ECG-Service-01: Installation of ERP system and integration with existing enterprise applications	Institutional Support	Y	$ 4,838,000	26	$ 24,710,000
ECG-Engr-01: Distribution system survey, GIS system development, and customer census	Institutional Support	Y	$ 2,481,000	22	$ 23,515,000
ECG-Comm-10: Strengthening loss control program	Commercial Losses Reduction and Collection Efficiency Improvement	Y	$ 1,065,000	23	$ 16,910,000
ECG-Ict-01: Data center and communication network	Institutional Support	Y	$ 1,760,000	22	$ 12,791,000
ECG-Comm-07: Metering at critical nodes of the distribution system	Commercial Losses Reduction and Collection Efficiency Improvement	Y	$ 7,063,000	39	$ 6,913,000
ECG-Service-03: Technical Assistance Program	Institutional Support	Y	$ 9,900,000	54	$ 2,838,000
ECG-Ops-01: Outage management system	Outages Reduction	Y	$ 2,132,000	21	$ 680,000
ECG-Engr-39: Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion	Outages Reduction	Y	$ 6,392,000	39	$ 1,013,000
ECG-Engr-42: Update distribution construction standards based on current low loss practices	Technical Losses Reduction	Y	$ 256,000	10	$ 778,000
ECG-Engr-36: LV feeder bifurcation with MV upgrade	Technical Losses Reduction	N	$ 49,389,000	58	$ 25,440,000

TABLE 4-1
Prioritized Sub-Activities

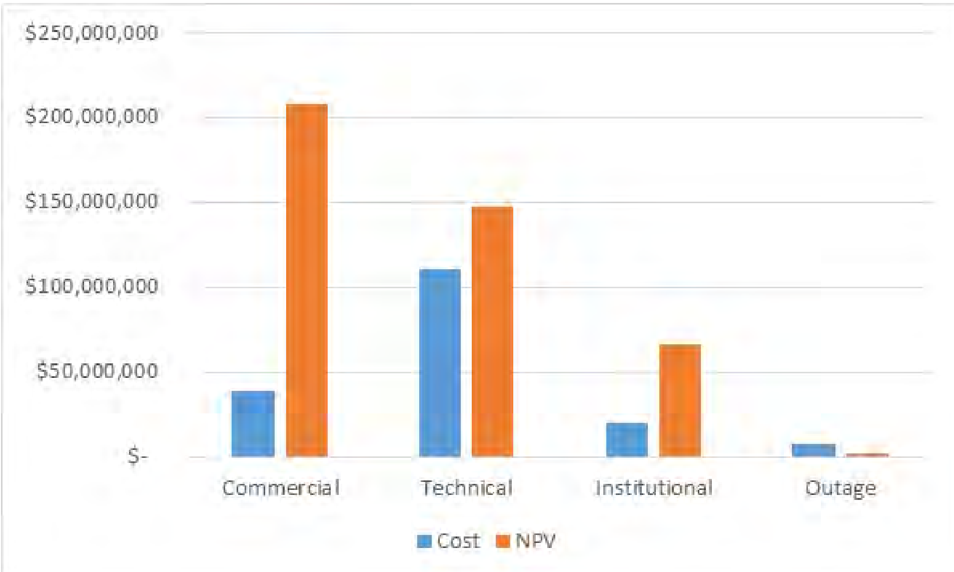
Sub-Activity Name	Activity	Foundational (Yes/No)	Cost	Duration (Month)	NPV
ECG-Engr-10: Install Bulk Supply Point (BSP) substation with feeders to existing primary substations in Accra	Technical Losses Reduction	N	$ 7,736,000	31	$ 20,469,000
ECG-Engr-11: Install Kotobabi/Nima primary substation with interconnecting sub-transmission links and MV offloading circuits	Technical Losses Reduction	N	$ 10,415,000	39	$ 20,090,000
ECG-Engr-12: Install Ogbodzo/ Madina primary substation with interconnecting sub-transmission links and MV offloading circuits	Technical Losses Reduction	N	$ 7,924,000	39	$ 21,880,000
ECG-Engr-13: Install Mataheko primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	Technical Losses Reduction	N	$ 10,415,000	39	$ 19,273,000
ECG-Engr-14: Install Teshie primary substation with interconnecting sub-transmission links and MV offloading circuits	Technical Losses Reduction	N	$ 10,415,000	39	$ 18,366,000
ECG-Engr-15: Install Airport Residential Area primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	Technical Losses Reduction	N	$ 10,415,000	39	$ 18,366,000
ECG-Service-04: Distribution System Master Plan	Institutional Support	Y	$ 819,000	28	$ 2,907,000
ECG-Service-05: Assistance to ECG training center in Tema	Institutional Support		$ 1,000,000	24	-
ECG-Engr-07: Reactive power compensation for primary substations	Technical Losses Reduction	N	$ 4,058,000	41	$ 2,600,000
		Total	$179,866,000		$423,513,000

The dollar values in Table 4-1 are summarized in Figure 4-1 by Activity. The commercial loss Sub-Activities provide the highest financial return. Technical loss reduction projects yield the next highest NPV, even though their capital costs are high. These two areas yield the highest return because savings in kWh due to loss reduction are valued at the full amount of the average tariff, without any discount. Since all costs, whether purchased power or distribution costs, are already incurred, savings due to loss reduction have a high value.

Institutional support investments and outage reduction efforts show lower NPV because they do not save energy that has already been paid for, but rather tend to improve service quality and thereby increase sales.

Additional energy sales from whatever source are valued at the difference between the average tariff and the average purchased power cost. However even though such projects have a lower NPV than loss reduction projects, ECG should invest in institutional improvements. Similarly, ECG should invest in outage reduction because their customer satisfaction, and hence willingness to pay, depends to a great degree upon the reliability of the electricity service. If consumers are forced to incur extra costs due to high System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI), they may be reluctant to pay ECG bills.

FIGURE 4-1
Summary of Sub-Activity Investment Costs and Net Present Value by Activity Grouping



4.2.2 ECG Estimates and Assumptions

Estimated cost, schedule, and assumptions for the SADs were provided by ECG. SAD cost detail is provided in Appendix D (Sub-Activity unit cost analysis, assumptions and information source). Appendix J provides pictures, illustrations and conceptual schematics of representative technologies that may be deployed as part of the SAD implementation. Cost information was reviewed for reasonableness by verifying costs with regional cost data and verifying general reasonableness against a comprehensive US-based construction and material costs database.

Some general observations about the estimates and assumptions indicate that:

- Unit costs of material as estimated by ECG were low as compared with the costs of similar material in the U.S. market. However, this did not result in lower overall facility cost because ECG engineers tend to over-design/specify its equipment (e.g. transformer and conductor sizes) thus driving up total capital costs. While overdesign would seem to improve reliability, the substandard material utilized in most ECG projects in fact is not sufficiently robust to accommodate system irregularities and thus fails prematurely. The result of these two competing forces is that the overall facility costs are about equivalent to what might result from an optimized design using higher quality equipment. NRECA does not recommend any changes in the cost estimates for the interventions at this point, although the process of design of the facilities should consider design optimization and more careful material specification.
- Based on verified costs, construction labor was estimated to be 30% 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 was assumed to be the same as typical international rates prevalent in the region.

- Project duration was estimated based upon the availability of a qualified technical assistance team providing support to ECG. Available subject matter expertise is particularly important for projects such as the Enterprise Resource Planning effort (ECG-Service-01) that involve requirements for expertise that ECG has not yet developed.
- Annual operating and maintenance (O&M) expense was taken to be 0.74% of investment cost for ECG based on ECG historical operating costs. This figure is low in comparison with industry averages of 2-2.5%, and it is uncertain exactly why. The majority of O&M costs are comprised of the salaries and benefits of staff engaged in operations and maintenance tasks. The cost of spare parts and consumable materials, such as fuel for vehicles, etc. is also included, but typically does not contribute as significantly as labor. ECG costs include labor, but the data resolution does not allow for distinguishing between administrative, commercial and system operations and maintenance labor costs. The ratio of consumers to ECG employees is not unreasonable, compared to other utilities, so it was decided to use ECG historical O&M costs.

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 (likelihood) 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. Accordingly risk ratings are based on experience and not on objectively derived values.

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 ECG 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 ECG has a quality assurance practice in place to verify work practices.

TABLE 4-2
Risk Register

Event	Type	Likelihood	Consequence	Overall Risk Score	Mitigation
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 ECG to follow or to timely implement recommendations from MIDA's technical assistance contractor and program manager	Institutional	Medium	High	Medium	Ensure adequate management information system is in place to monitor ECG compliance with of process of implementation of recommendations by MIDA technical assistance contractor and program manager; condition release of subsequent tranches 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&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 LCU 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 ECG'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 the 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 successfully deploy CIS software currently in procurement	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; ensure that ECG is vigorously pursuing deployment and debug of CIS with vendor or other third par consultant, as condition of disbursement; build software bridges between the CIS anc the new ERP systems.
Grid Company of Ghana (GRIDCo) fails to construct its portion of the bulk supply point	Financial	Medium	Medium	Medium	Ensure that funds are available to GRIDCo to build its portion of the BSP before ECG start the tendering process for the BSP
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
Land ownership / 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.

TABLE 4-2
Risk Register

Event	Type	Likelihood	Consequence	Overall Risk Score	Mitigation
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.
Utilities fail 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 ECG 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.
Private sector participant (PSP) operator may be introduced in ECG early in the implementation stages of the program, resulting in employee loss of focus and potential for change in direction of investment program	Institutional	Low	High	Medium	Consultations with PSP to ensure that employees engaged in investment program have certainty about their future. Tranche II project could be changed to the liking of the PSP operator as a compromise on the project in the investment program.
Sub-activity is in Tranche II of the compact and cannot be funded until conditions for release are met.	Institutional	Medium	High	Medium	Open and constant communication between MCC, MiDA and the GoG regarding the development of the PSP activity. To the extent possible, dependencies such as these should be avoided in design of the project, i.e. all Tranche II activities should be independent of Tranche I activities and justifiably related to conditions precedent for Tranche II.

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. Florida Power and Light's reform program of the 1970's successfully employed this approach. In the event that a PSP is selected during the course of the program, it would be logical to assure the members of the Implementation Team that they would have first choice of positions in the private operator's corporate structure. By the same token it will be essential that ECG agree to impose consequences, such as reassignment, for staff members that are important to program implementation but who oppose or do not engage effectively in it as required.

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 technologies (IT), 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 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 ECG performance improvement Sub-Activities, which is further described in Appendix E (ECG Sub-Activity Proposed Detailed Schedule). An abbreviated work plan Gantt chart, based upon Sub-Activities, is provided in Figure 4.3 at the end of this section. 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 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 Enterprise Resource Program will ensure that data is effectively managed and controlled;

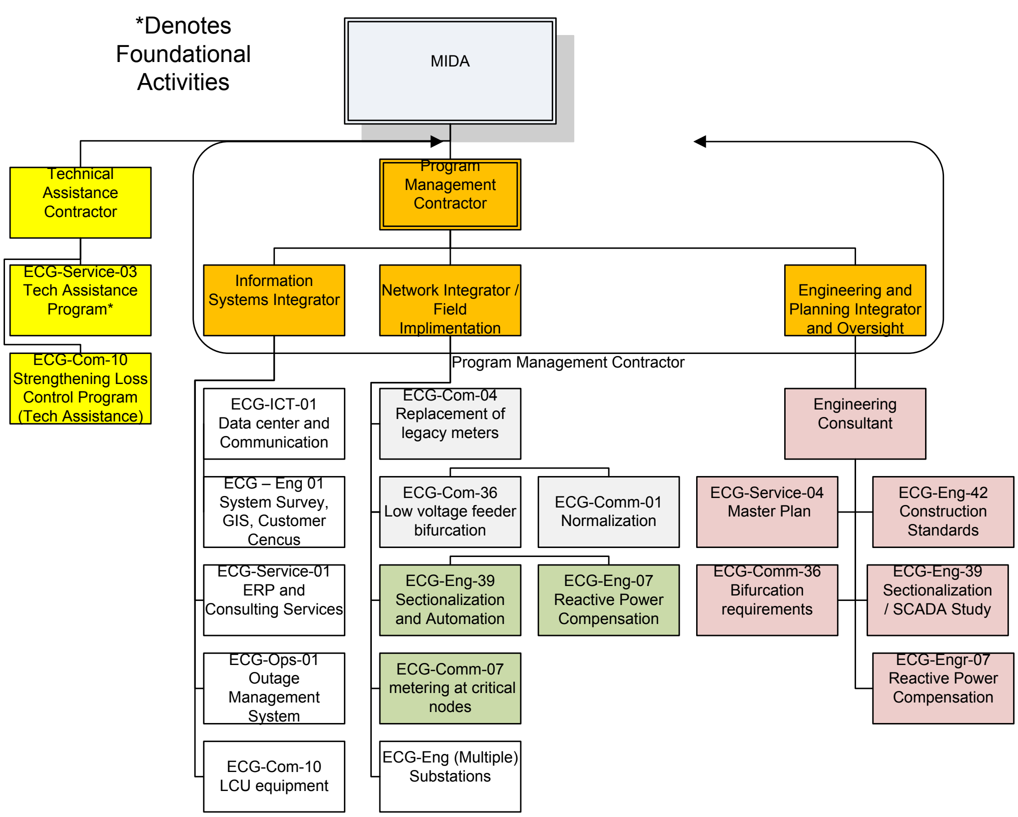
3) Data system and communication network is in place to deploy the ERP; 4) Updating design and construction standards, which are needed prior to network improvements; 5) Development of a distribution master plan to determine specific requirements and general locations for network improvements. We recommend that these specific activities start prior to entry into force of the compact. Once these activities are completed, service normalization, meters and most of the technical loss reduction activities can occur. It is also 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 achieving close coordination between the proposed compact program and any ongoing or planned projects that ECG may have in process outside the compact.

In addition, land acquisition and resettlement issues should be addressed early. The overall Resettlement Policy Framework is therefore defined at 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 and proposed substations are sited.

4.2.5 Procurement Plan

Figure 4-2 describes a proposed procurement approach. This graphic illustrates three key contractors that MiDA should consider engaging early in the process to support development of follow-on procurements. Specifically MiDA should bring on the Technical Assistance (TA) contractor and the Program Management (PM) contractor on as early as possible. 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 will have with MiDA (as their program manager) and the consideration they would be essentially evaluating their own performance if they were also the TA. Having separate contractors for these two functions will ensure independence for the PM as well as let the TA act as a true 'advisor' and not be seen as an organizational threat.

FIGURE 4-2
Procurement Structure



The form of contract used for the TA and the PM is typically 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 selections of the PM and TA fit 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.

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

- Better pricing may be obtained for a bulk purchase of materials for all or a major part of the Compact II projects due to the economies of scale.
- Better pricing may 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 local offices of a labor contractor.
- The project may have better control over quality of materials if the material vendors are answerable directly to the PM rather 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 bid as requests for quotations on detailed lists of materials in accordance with specifications determined in coordination with ECG. The form of contract will be a fixed price purchase order with delivery schedules structured to match the likely requirement for materials. Construction labor procurements will be requests for quotations 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%.

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 may 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 TA will be expected to work closely with ECG in identifying needs and implementing solutions. The PM would be responsible for developing the schedule, working with MiDA to prepare procurements and ensure coordination among vendors. They would track and manage program deliverables and work closely with MiDA to manage risks. As shown in Figure 4-2, there are three key areas of expertise that the PM needs to have to manage the integrated loss program. The first is expertise in distribution information systems and integration. Next, there should be expertise for network/field implementation. Finally, the PM should have engineering / planning skills to oversee the engineering aspects of the program.

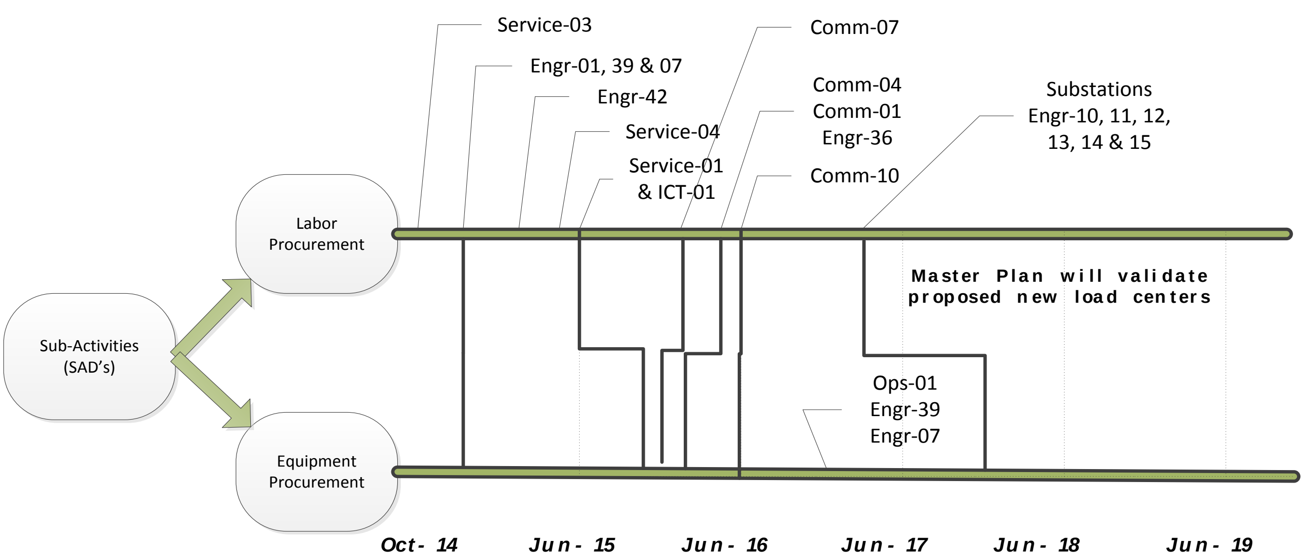
A third contract is assumed to be an engineering contract. Figure 4-2 illustrates one engineering contractor responsible for multiple activities with a primary focus on master planning and development of engineering standards. The PM should not have combined responsibility for carrying out engineering design. The PM oversees the engineering contractor, which requires independence between the two. The other vendor packages are shown in Figure 4-2 which may or may not be bundled. A few of those Sub-Activities are coded with similar colors and which could be bundled given their similar procurement and scope requirements. More details and suggestions regarding such bundling can be found in Appendix I. Appendix I also provides recommendations regarding the proposed procurement to limit the procurement requirements specifically through:

- Blanket purchase agreements for materials that could be updated through the compact providing flexibility and scalability for activities such as bifurcation and normalization.
- Fixed unit-rate contracts that combine bifurcation, meter installation, normalization, sectionalization, etc., with multiple local vendors reducing procurement requirements and allowing significant scalability for these types of activities.

Appendix I also provides recommendations regarding the type of procurement that should be considered for each of the different Sub-Activity procurements.

Figure 4-3 illustrates the process / flow in which the procurements are sequenced to match the requirements for each SAD. Similarly, Appendix I describes the procurement package prioritization.

FIGURE 4-3
Procurement Timeline



Within the procurement plan there are a number of specific distribution program studies required to allow for subsequent SADs (see Table 4-3). Study delivery dates are provided to ensure that they meet the overall schedule. The table also describes what needs to occur prior to study finalization as well as the Sub-Activities the studies impact.

TABLE 4-3
Distribution Program Studies

Study	Sub-Activity	Delivery Date	Pre-requirements and Impacts
GIS development and CIS consumer census	ECG-Eng-01	May 2016	The development of the GIS and the consumer census is a pre-requisite to all distribution planning studies and all performance improvement projects.
Distribution Master Plan	ECG-Service-04	January 2017	Requires GIS and CIS data to begin system modeling. This study impacts siting of proposed substations and focus areas for bifurcation
Sectionalizing Study	ECG-Engr-39	March 2017	This study follows GIS and Distribution Master Plan. This study impacts system outage reduction activities and supports the OMS implementation
Capacitor Placement Study	ECG-Engr-07	January 2017	This study is part of the distribution master plan. Impacts power compensation capacitor placement
Material and Construction Standards document	ECG-Eng-42	May 2015	This study impacts metering, line construction, service installations, substation development and line device/material standards

In Figure 4-4 a high level schedule illustrates the coordinated aspect of the multiple SADs implementation. Certain activities are necessary pre-conditions including the early development of Resettlement Action Plans (RAPs). Coordination is required between the development of the master plan and the RAPs as select SADs are likely to be implemented before the master plan is complete. It is anticipated ECG will continue to acquire land for some substations and bulk supply points as an on-going process and the RAPs will need to be prepared on a project by project basis. Figure 4-4 indicates the RAP preparation and the design for the BSPs and substations needs to be closely coordinated. Resettlement, if necessary, would occur during the procurement process and prior to final award.

4.3 Conclusions

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

- First, the 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 ECG builds its system with appropriate equipment that will both improve system performance and reliability.
- The risk assessment identified ECG 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 ECG 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 contractors – a Program Management contractor; a Technical Assistance contractor; and an Engineering firm. It is critical that these three organizations are brought on early to manage the multiple activities that will occur during the program.

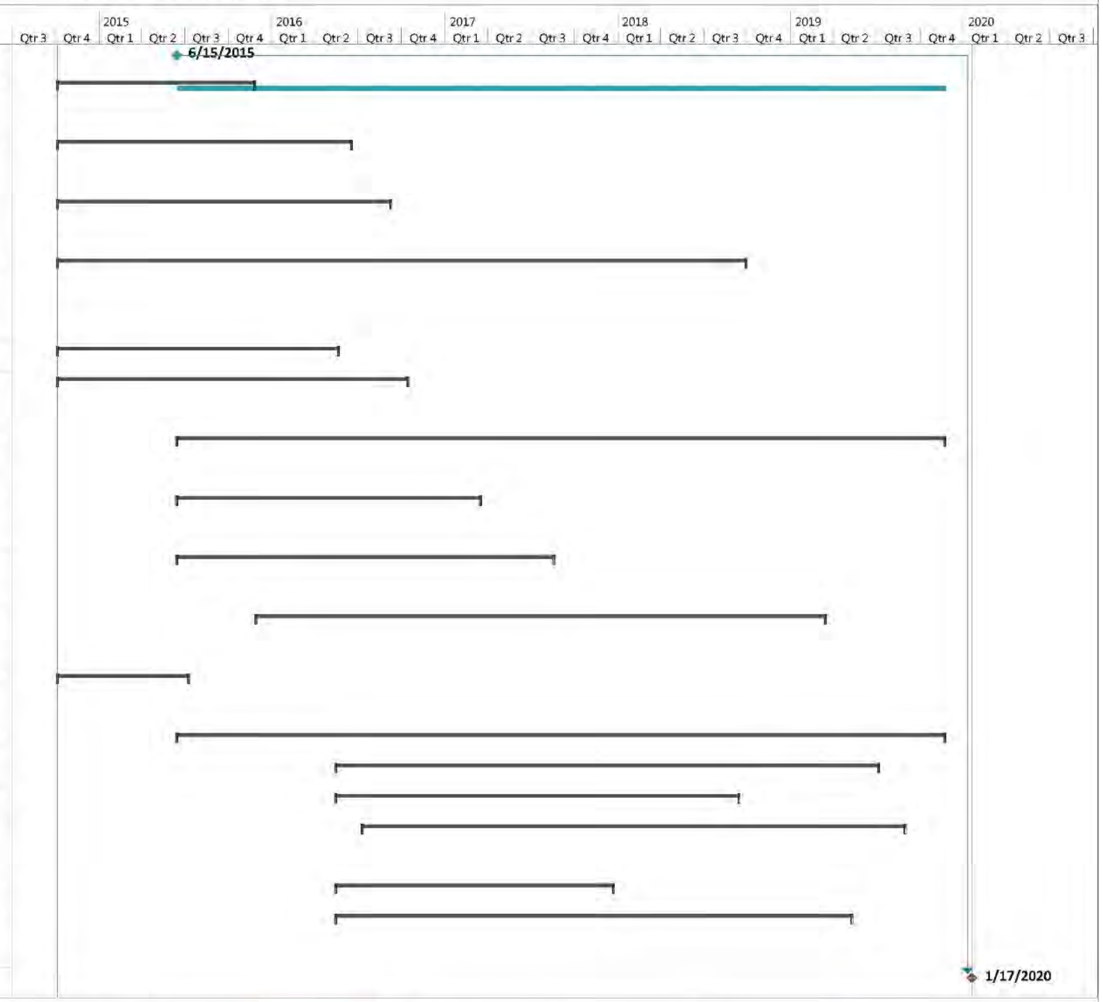
It is the conclusion of the CH2M HILL/NRECA team that the overall program can be successful but there are critical risk factors that could impede either its initial success or its sustainability. The likelihood of success would be greatly increased under the following conditions:

- Engagement of the senior management and the affected staff members of ECG in such a way that all are committed to achieving the goals of the project and that they perceive project 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.
- Early satisfaction of the conditions precedent for release of Tranche II funds to allow a reasonable period of time for implementation of those activities.

FIGURE 4-4
Level 1 Sub-Activity Implementation

ECG_Gant_Chart_2014-04-12_SK

ID	Task Mode	Task Name	Duration	Start	Finish
1		Compact 5 year time clock start	0 mons	Mon 6/15/1	Mon 6/15/15
2		**Resettlement Action Plans (Impacting Substations, Bifercation, BulkSupply Point)**	**15 mons**	Mon 10/6/14	Fri 11/27/15
5		**GIS based distribution management system, grid digitization and customer census**	**22.25 mons**	Mon 10/6/14	Fri 6/17/16
32		**Installation of ERP system and integration with existing enterprise applications**	**25.25 mons**	Mon 10/6/14	Fri 9/9/16
48		**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
53		**Data Center and Communication Network**	**21.25 mons**	Mon 10/6/1	Fri 5/20/16
80		**Distribution Master Plan (short & Long Term capital improvements)**	**26.5 mons**	Mon 10/6/14	Fri 10/14/16
85		**Service connection standards and normalization of customer connections**	**58 mons**	Mon 6/15/15	Fri 11/22/19
97		**Loss Control Units Strengthening (within Energy Loss Control Center)**	**23 mons**	Mon 6/15/15	Fri 3/17/17
110		**Installation of meters at critical distribution network nodes**	**28.5 mons**	Mon 6/15/15	Fri 8/18/17
123		**Replacement of legacy meters with prepayment meters**	**43 mons**	Mon 11/30/15	Fri 3/15/19
136		**Update distribution design and construction standards to reflect best practice**	**10 mons**	Mon 10/6/14	Fri 7/10/15
141		**LV network improvements (Bifurcation)**	**58 mons**	Mon 6/15/1	Fri 11/22/19
156		**Capacitor banks for reactive power compensation**	**41 mons**	Mon 5/16/1	Fri 7/5/19
171		**Install Bulk Supply Points with 33kV links**	**30.5 mons**	Mon 5/16/1	Fri 9/14/18
189		**Install primary substations with interconnecting 33kV links and 11kV offloading circuits**	**41 mons**	Mon 7/11/16	Fri 8/30/19
206		**Installation of Outage Management System**	**21 mons**	Mon 5/16/1	Fri 12/22/17
221		**Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion**	**39 mons**	Mon 5/16/16	Fri 5/10/19
234		Compact 5 year mark	0 mons	Fri 1/17/20	Fri 1/17/20



Project: Activity_Gant_Chart Date: Thu 5/22/14	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	

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SECTION 5

Environmental, Social, and Gender Assessment (Task 5)

5.1 Approach

A Framework Environmental and Social Impact Assessment (FESIA) was prepared for the ECG Sub-Activities. A total of 20 ECG Sub-Activities (projects) within four Activities have been identified as the top priority for funding under the MCC Ghana Compact II. These Sub-Activities include improvements to ongoing business practices, changes to customer metering, improvements to existing substation and distribution infrastructure, and the construction of new substations and distribution lines. 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, 2011) 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 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 ECG 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.

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 project's potential for impact. An evaluation of the likely level of environmental and social analysis to be required for each of the proposed Sub-Activities was conducted. The evaluation was based on the Ghana EPA's *Guidelines for Environmental Impact Assessment for the Energy Sector* and the MCC 2012 Environmental Guidelines project classification system.

As indicated in Table 5-1, 14 of the 20 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 six 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, 13 of the Sub-Activities are classified as Category C projects and are likely to have minimal or no adverse environmental impacts, with no EIA required. The seven 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 capable of effective mitigation using international best management practices. Those Sub-Activities involving construction of substations and transmission line may result in the following impacts:

- 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
- Worker health and safety risk associated with substation 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 from 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 ESMPs. ECG will develop an overall Environmental and Social Management System (ESMS) that provides the institutional arrangements that will manage and implement the Sub-Activity ESMPs.

Because most distribution line construction will take place in existing utility corridors adjacent to public roads, only minimal impacts to 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
Activity: Commercial Losses Reduction and Collection Efficiency Improvement				
ECG-Comm-01: Normalization of existing services to comply with improved service connection standard	A	C	No	Potential customer disconnections
ECG-Comm-04: Replacement of legacy meters with prepayment meters	A	C	No	Potential customer disconnections
ECG-Comm-07: Metering at critical nodes of the distribution system	A	C	No	None
ECG-Comm-10: Strengthening loss control program	A	C	No	None
Activity: Institutional Support				
ECG-Engr-01: Distribution system survey, GIS system development, and customer census	A	C	No	Potential customer disconnections
ECG-Ict-01: Data center and communication network	A	C	No	None
ECG-Service-01: Installation of ERP system and integration with existing enterprise applications	A	C	No	None
ECG-Service-03: Technical Assistance Program	A	C	No	None
ECG-Service-04: Distribution System Master Plan	A	C	No	None
Activity: Technical Losses Reduction				
ECG-Engr-07: Reactive power compensation for primary substations	A	C	No	None
ECG-Engr-10: Install Bulk Supply Point (BSP) substation with feeders to existing primary substations in Accra	B	B	Yes	Possible Resettlement
ECG-Engr-11: Install Kotobabi/Nima primary substation with interconnecting sub-transmission links and MV offloading circuits	B	B	Yes	Possible Resettlement
ECG-Engr-12: Install Ogbodzo/Madina primary substation with interconnecting sub-transmission links and MV offloading circuit**s**	B	B	Yes	Possible Resettlement
ECG-Engr-13: Install Mataheko primary substation with interconnecting sub-transmission links and MV offloading circuits	B	B	Yes	Possible Resettlement
ECG-Engr-14: Install Teshie primary substation with interconnecting sub-transmission links and MV offloading circuits	B	B	Yes	Possible Resettlement
ECG-Engr-15: Install Airport Residential Area primary substation with interconnecting sub-transmission links and MV offloading circuits	B	B	Yes	Possible Resettlement
ECG-Engr-36: Low voltage feeder bifurcation with MV upgrade	A	B	Yes	Possible Resettlement

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

Sub-Activities	Ghana EPA Category[a]	MCC Category[b]	Potential Resettlement	Potentially Important Impacts
ECG-Engr-42: Update distribution construction standards based on current low loss practices	A	C	No	None
Activity: Outages Reduction				
ECG-Engr-39: Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion	A	C	No	None
ECG-Ops-01: Outage management system	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.

5.3 Energy Losses Due to Electricity Theft

Recent studies indicate that a considerable number of ECG 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 ECG Loss Control Units, prepared by GECE (LCU, 2012) was conducted to assess losses from the ECG system due to the theft of electricity. The study sampled one percent (22,819) of the total number of ECG customers (2,281,879) and found 2,930 customers stealing electricity by various means. This number represents a theft rate of 12.8%. A wide range of customer types were found to be involved with pilfering of electricity. The LCU study showed that approximately 88% of the theft amount in 2011 was recovered by ECG, indicating that many of those with illegal connections were in fact capable of paying their electric bill but chose not to. 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 ECG 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 ECG. 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.

Theft of electricity can be accomplished by a number of means, these include:

- Tampering with the meters to slow or disrupt their functioning
- On-selling where multiple customers are connected to a single meter
- Meter by-bass where high use appliance and possible on-selling lines are connected prior to the installed meter thus taking power that is not being registered by the meter
- Not paying the electric bill
- Direct connection to distribution line without a meter of electric account.

The following Sub-Activities have the potential to result in customers with currently illegal connection losing their service:

- ECG-Comm-01: Normalization of existing services to comply with improved service connection standard
- ECG-Comm-04: Replacement of legacy meters with prepayment meters
- ECG-Engr-01: Distribution system survey, GIS system development, and customer census.

These Sub-Activities will involve ECG employees visiting customers, inspecting the existing electrical connections, modifying the connections, and installing prepaid meters. Through this process, some customers with illegal connections will be identified, and ECG'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. ECG has standard procedures for dealing with three types of illegal connections, details of which are contained in Appendix F:

1. Illegal connection with no previous service being provided
2. Illegal connection to existing metered service or connection to unmetered conductor by customer residing at this premise.

3. Meter tampering

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 ECG 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 could 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.
- ECG 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 by ECG, 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 ECG.

5.4 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.

5.5 Institutional Arrangements

The ECG Environmental Health and Safety (EHS) Unit is responsible for overseeing, developing and implementing EHS policies and procedures for the company. In addition to enforcing compliance with the requirements established by the Ghana EPA, the EHS Unit is also responsible for implementing the requirements of the IFC PSs and ECG internal standards for projects implemented under the MCC Ghana Compact II. The EHS Unit currently consists of two people and will require strengthening in order to undertake the management and monitoring of environmental and social risks resulting from Compact II Sub-Activities to the standard required by the IFC PSs.

ECG has an Environmental Management Plan that was revised in 2013; however, this plan does not address social issues. This plan will need to be updated to reflect the needs of the various MCC Compact II projects to be implemented and the ESMS requirements of the IFC PSs.

5.6 Conclusions

The objective of this 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 results of the Phase II Feasibility Study identified 20 Sub-Activities, 14 of which will only require the preparation of Form EA1 and not an EIA for the Ghana EPA. The remaining six 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 on the information provided in the PEA.

Similarly, 13 of the Sub-Activities classified by the MCC are likely to have minimal or no adverse environmental impacts, with no ESIA required. Seven of the Sub-Activities that require construction of substations or distribution lines will have the potential to result in some level of fit for purpose ESIA.

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.

The ECG EHS Unit will require strengthening in order to undertake the management and monitoring of environmental and social risks resulting from Compact II Sub-Activities to the standard required by the IFC PSs.

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, seven ECG 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 all ECG and NEDCo distribution Sub-Activities identified through the Phase I and II Sub-Activity screening, prioritization, and feasibility studies. 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.[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 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 seven Sub-Activities identified as potentially requiring involuntary resettlement. The total length of the proposed distribution lines is around 6,600 kilometers (km) almost all of which is related to the bifurcation SAD which will involve the addition of MV to more than 400 km of existing LV lines and the replacement of around 6,000 km of existing LV lines

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[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,

with aerial bundled cables (ABC) throughout Accra. The total length of the other components is around 120 km. All SADs apart from the bifurcation project include the construction of new sub-stations.

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

SAD ID	Name	Location	Type of Area	Sub-station	SAD Distribution Components (km)					
					Sub-transmission (33 kV)		MV (11 kV)		LV	Total Length
					UG	OH	UG	OH	OH	km
ECG-10	Bulk Supply Point	Pokuase	Peri-urban	1	3	15	0	0	0	18
EC-11	Nima Substation	Kotobabi/ Nima	Inner/ Dense/ part slum	1	10	0	12	12	0	34
ECG-12	Madina Substation	Ogbodzo/ Madina	Outer/ medium low density	1	0	15	12	12	0	39
ECG-13	Mataheko Substation	Mataheko	Low medium	1	10	0	12	12	0	34
ECG -14	Teshie Substation	Teshie	Peri-urban/ low density/ slum	1	10	0	12	12	0	34
ECG -15	Airport Residential Substation	Airport Residential Area	Low density/ high income/ commercial	1	10	0	12	12	0	34
ECG-36	Line Bifurcation	Throughout Accra						436	5,967	6,403
		Sub-total - ECG		**6**	**43**	**30**	**60**	**496**	**5,967**	**6,596**

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

In line with current ECG 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—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; 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.
- The presence of existing overhead lines along many roads will reduce the need for the creation of new outside existing ROWs, further reducing 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 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 ECG 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, ECG, 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 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. The portfolio of activity interventions can be evaluated as a whole on utility financial performance.

Task 3 of the Scope of Services requires financial analysis of each intervention based upon the implementation cost of each investment and the predicted benefits. The Sub-Activity Descriptions provide the calculated NPV, EIRR (calculated from the economic analysis), and investment assumptions for each Sub-Activity and are provided in Appendix C. For this section (Task 7), the impact of all of the interventions on the overall financial performance of ECG revenues and expenses is addressed.

7.1.1.1 Sources of Data

The primary source of data for model inputs was the financial data presented in the AF Mercados study entitled, "Ghana Power Distribution PSP: Due Diligence Report," [3] Volumes III & IV 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; as well as financial analysis. 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, CH2M HILL presented commercial data requests to the utility including purchased power, sales, energy losses, collections, and number of consumers by category. Where data from the Mercados report conflicted with utility source data, the data from the utility was given a higher priority. This consideration primarily applies to energy loss and collection rate information where significant variances were noted between the data provided by the utility commercial systems and the data reported in the Mercados report. In all cases, the CH2M HILL team reviewed the Mercados data against information and data obtained directly from the utility. For purposes of consistency with other projections performed for MCC, financial data reported by the utility for calendar year 2012 has been employed in the financial model.

7.1.1.2 Structure of the Financial Model

The financial model was developed by using a combination of historic 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 each utility with sales and cost projections obtained from the Mercados report. The Mercados data is comprehensive on the level of the utility, but is not disaggregated 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, 2012 sales data provided by the utility were used to create the ratio of total sales to sales for each region; these ratios were then employed

[3] "Ghana Power Distribution PSP Due Diligence Report Volume III: ECG," AF Mercados, February 24, 2014.

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

to allocate projected sales by region for future years based upon the Mercados growth projections for each utility. The same methodology was employed to allocate consumer growth by service area based on ratios developed from 2012 utility data. 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 considered an acceptable approximation because modeling electric utilities most often averages growth across the entire market. In addition, depreciation allowances, operating costs etc. 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 area using a similar methodology. The utility records wholesale power cost by service region; 2012 cost data provided by the utility was integrated into the model to provide the basis for future cost projections. The 2012 cost data was 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 differences are not material. Furthermore, the allocation of assets, operating and other costs by service area would require considerable effort coupled with numerous assumptions on how to disaggregate certain cost categories. For the purposes of this feasibility study, analysis of the impact of the projects on financial performance can be performed while allocating operating costs at a global level without compromising the materiality of the results.

7.1.2 Results

The financial model integrates growth in sales, revenues, costs, and implementation of Sub-Activities to yield resulting profit/loss for ECG based upon the revenue and cost structure embedded in the historic performance of the utility. The behavior of ECG 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. A control panel has been designed to allow the user to incrementally change these values for the Accra region of ECG, and to evaluate the impact of these changes on ECG as a whole. While the Accra region serves less than approximately 15% of ECG consumers, the region is responsible for more than 36% of losses system wide.

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

Two additional changes to ECG are modeled that help to understand the potential for healthy financial performance. First, 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. Secondly, the AF Mercados[5] CAPEX projections include a projection of the combined investments made by the World Bank, the African Development Bank, the Ghanaian Government and other investors of $240 million per year to accommodate load growth expansion as well as system improvement.

Analysis of impacts of the loss reduction/performance improvement portfolio was accomplished by varying the energy losses and collection rates as projected by the implementation schedule for all Sub-Activities included in the MCC investment portfolio. Sensitivity analyses were performed to evaluate how the performance of the portfolio of interventions impacts financial performance of each utility. 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

[5] Ghana Power Distribution PSP: Due Diligence Report, Volume III, ECG. AF Mercados EMI, February 2014.

improvements (i.e., reduction of losses and improvements in collection rates) are 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 pool of enterprise-wide utility cost and revenue streams.

7.1.2.1 Baseline

A baseline was established to allow for understanding the effects of implementation of SADs or other interventions. Table 7-1 shows the power purchased and sales data for all nine ECG regions for calendar year 2012. The purchase data for Accra East and West is identical because the three BSPs serve feeders that cross regional boundaries, so there is no good way to disaggregate the purchase data until CIS and GIS are implemented. The sales data is built up from district accounts.

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

Region	Purchases (GWh)	Sales (GWh)
Accra East	1,540	1,109
Accra West	1,540	1,268
Tema	1,520	1,022
Ashanti East	677	562
Ashanti West	677	392
Western	1,087	927
Central	302	305
Eastern	351	259
Volta	250	201
Total	7,941	5,800

Source: ECG commercial data
GWh = gigawatt hours

The base model presents a twenty year financial horizon employing existing loss levels and collection rates, using historic tariffs for 2012-2014. Table 7-2 presents financial results for ECG for the base case, that is, before any loss reduction/performance improvement projects are implemented. Operating revenues increase 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 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 tariff for wholesale power for 2014 and all subsequent years, was obtained from the PURC Ruling effective January 1, 2014, and PURC Ruling planned for April 1, 2014, but expected to be implemented May 1, 2014. The wholesale tariff includes a bulk generation charge as well as a transmission service charge. The wholesale power tariff as of May 2014 is 0.264483 GHS/kWh or about $0.09/kWh at an exchange rate of 0.34529 prevailing in May 2014. Both the retail tariff and the wholesale purchase tariff are kept constant between May 2014 and 2032 (no inflation).

The demand for purchased power grows at a compound annual growth rate as shown in the AF Mercados financial model projections. For the modeling period 2013-2032, while the growth rate varies year to year, the average annual growth rate is 4.12%.

Annual operating costs reflect historic ECG records. O&M costs grow as a function of the ECG asset base relative to the current value for O&M. Distribution expenses grow as a function of the growth 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 growth 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.[6]

As shown in Table 7-2, the results of the financial model shows a pattern of improving financial performance with the impact of the tariff changes taking place followed by a reversal financial performance. Furthermore ECG shows a net profit in 2014 that is more than offset by the significant collection losses. With the average tariff held constant and operating costs continuing to increase, there is a negative effect on profitability. Figure 7-1 illustrates the trend in revenue, net profit / loss and net profit / loss after collection losses over the entire 20 year horizon.

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

	2012	2013	2014	2015	2016	2017
Energy Sales (MWh)	5,695,399	5,825,714	6,053,851	6,416,328	6,772,314	7,115,269
Average tariff (GHS/kWh),	0.24	0.26	0.43	0.43	0.43	0.43
Revenue from Energy Sales	1,349,653	1,487,686	2,576,779	2,731,065	2,882,588	3,028,564
Operating Revenue	1,435,358	1,583,445	2,677,495	2,836,726	2,993,382	3,142,179
Cost of Wholesale Power - Revised	993,651	1,042,915	2,078,187	2,297,209	2,424,850	2,547,843
Gross Margins	441,707	540,531	599,308	539,517	568,533	594,336
Operating Costs						
Operations and Maintenance	83,771	89,711	93,944	99,884	105,824	111,764
Distribution Expenses	56,233	62,830	66,082	69,327	72,695	74,545
Administration Expenses	163,417	182,588	192,039	201,469	211,256	216,633
Other Operating Income/Expenses	6,907	7,717	8,117	8,515	8,929	9,156
Total	296,515	327,412	343,948	362,164	380,845	393,786
Depreciation	219,424	222,355	226,826	235,321	249,315	263,310
Financing Costs	16,185	29,228	30,607	32,543	34,478	36,413
Operating Profit/Loss	(90,417)	(38,465)	(2,074)	(90,511)	(96,106)	(99,174)
Non-Operating Income/Expenses	2,158	2,356	3,813	4,025	4,233	4,431
Net Profit/Loss	(88,258)	(36,109)	1,739	(86,486)	(91,873)	(94,742)
Collection Losses - Revised	(263,495)	(290,443)	(503,068)	(533,190)	(562,736)	(591,195)
Net Profit/Loss after Collection Losses - Revised	(351,753)	(326,552)	(501,329)	(619,676)	(654,608)	(685,937)

Source: CH2M HILL ECG financial model

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

The biggest issue facing ECG is low collection rates. Collection losses are 19.5% of revenue from sales of energy in 2012, and this percentage is assumed constant over the forecast period in the base case. The model shows positive margins in 2014 before collection rates are taken into consideration and a significant loss if collection rates do not improve.

The Mercados report for ECG states that in 2012, approximately 21% of the receivables balance was due to ministries, departments and agencies (MDA) accounts taken as a percentage of the sum of receivables from private clients and those from MDA accounts. The report also shows a large receivables balance from street lighting shortfall recovery. It is clear that improving collection rate overall is of primary importance. The process for recovery of receivables has recently been modified and the Ministry of Finance is not in a payment role as has been the case. Rather, some MDAs will now employ prepayment meters while all others will be directly responsible for payment of electric service to ECG, and have been instructed to include electric consumption in their annual budgets.

7.1.2.2 Financial Impact of Sub-Activity Investments

The financial model has been designed to allow losses and collection rates to be varied for the Accra region only, while holding losses and collection rates at the 2012 levels for future years for the rest of the ECG regions. Table 7-3 provides information on losses including ATC&C, technical, commercial and collection categories. Based upon the implementation schedule of the Sub-Activity investments, the loss reduction and collection efficiency values have been projected (see Table 7-3).

TABLE 7-3
Loss and Collection Values for Accra and Greater ECG Employed in Financial Model

	Base	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Accra							
Technical Losses	8.3%	8.3%	8.3%	7.5%	6.7%	5.8%	5.0%
Commercial Losses	25.3%	25.3%	25.3%	23.8%	22.3%	21.3%	21.1%
Collection Efficiency	82.3%	82.3%	82.3%	85.5%	88.7%	91.8%	95.0%
Collection Losses	17.7%	17.7%	17.7%	14.5%	11.4%	8.2%	5.0%
ATC&C Loss	45.4%	45.4%	45.4%	41.3%	37.0%	33.1%	29.7%
Outside Accra							
Technical Losses	10.0%	10.0%	10.0%	10.0%	9.9%	9.8%	9.7%
Commercial Losses	11.9%	11.9%	11.9%	11.9%	11.7%	11.4%	11.2%
Collection Efficiency	79.6%	79.6%	79.6%	79.6%	80.1%	80.6%	81.1%
Collection Losses	20.4%	20.4%	20.4%	20.4%	19.9%	19.4%	18.9%
ATC&C Loss	37.8%	37.8%	37.8%	37.8%	37.2%	36.5%	35.8%

Sources: ECG commercial data; CH2MHILL projections.

Table 7-3 projects a net technical loss reduction of 3.3% from year 3 to year 6 given that it will take two years for the sub-activity interventions to be completed and the technical loss reduction benefits to be realized. The primary contributing sub-activity to technical loss reduction will be the feeder bifurcation intervention that will be responsible for 2.7% loss reduction from improved performance in the low voltage feeders as verified through the load flow analyses of loss reduction options. Reactive power compensation, five new primary substations and the new bulk supply point, service normalization and technical standards all contribute to the remaining 0.6% loss reduction projection for ECG.

Table 7-3 also indicates a 4.2% reduction in commercial losses for ECG. Commercial loss reduction cannot be measured as directly as technical losses because commercial losses represent gaps in process effectiveness. For this reason, the basis of commercial reduction was to evaluate the revenue recovery improvement potential for each intervention, and then to derate the improvement for the purpose of presenting a more conservative loss reduction projection. The single largest contributor to commercial loss reduction is the normalization of existing services – ensuring that all ECG consumers are properly recorded in the customer data base, have accurate meters with authorized service installations. The expected loss reduction from this intervention is projected at 1.2% loss reduction. The low voltage feeder bifurcation project will contribute a commercial loss reduction of .8% by installing insulated low voltage conductor that is less vulnerable to energy theft and also removing all illegal connection during the installation process. Other significant contributors to commercial loss reduction include strengthening the ECG loss control unit (LCU) team; performing a consumer census in conjunction with a geographic information system, and tying these to the customer information data base (providing improved ability to identify anomalies in consumption through the CIS); and installation of advanced metering infrastructure (AMI) meters on substation feeders and distribution transformers.

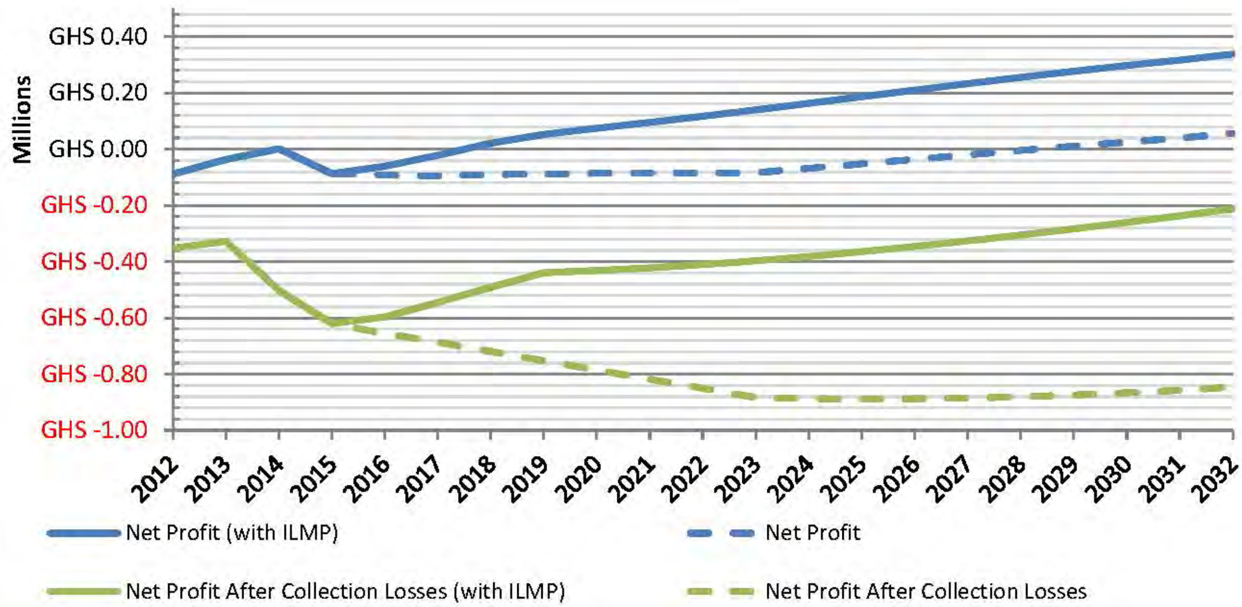
Table 7-3 also shows a significant improvement in collection efficiency. In similar fashion to commercial loss reduction estimates, collection efficiency improvements are estimated based upon an evaluation of increased revenue recovery potential for each intervention, and then to derate the improvement for the purpose of presenting a more conservative loss reduction projection. The principal revenue improvement intervention affecting collection rate is associated with replacement of legacy post-payment meters with prepaid technology. This accounts for over half of the projected improvement. Other significant contributors include normalization of service installations; moving meters from inside consumer premises is needed for disconnection and purposes in non-payment situations; installation of the ECG ERP system to provide accurate and up-to-date information on delinquent consumers and anomalies in consumption; and, strengthening the LCU to disconnect delinquent accounts on a timely basis and to reconnect them when fees and past due accounts have been paid.

Using the information in Table 7-3, the model is used to calculate the profit and loss results for ECG from 2012 through 2032 with the assumed ILMP improvements. The results of this analysis are shown in Figure 7-1 compared with the results for the base case.

The ILMP projects reduce collection loss to 8.2% in the Accra area by year five, but this has only a limited impact on ECG as a whole. Overall collection loss, taking into account both Accra and the area outside Accra is reduced from 19.5% of sales revenue in 2012 to 15.7 % in 2017.

The results shown in Figure 7-1 for the case of implementation of the ILMP show dramatic improvement over the baseline model results in terms of net profit/loss after collection losses. Net profit improves due to commercial loss reduction and collection efficiency improvements. However the model also shows investment in the ILMP Sub-Activities is insufficient to achieve positive margins for ECG independent of tariff adjustments.

FIGURE 7-1
ECG Baseline Financial Projection and with Incorporation of Integrated Loss Management Program



Investment and implementation of the ILMP also results in reductions of the cost of wholesale power (i.e., purchases of wholesale power are reduced). The wholesale power cost is reduced due to technical loss reduction. Table 7-4 summarizes the net effects from 2012 to 2017.

TABLE 7-4
Integrated Loss Management Program Effects on Cost of Wholesale Power and Net Profit (GHS 000)

Change in	2012	2013	2014	2015	2016	2017
Wholesale power	-	-	-	-	(10,028)	(30,361)
Net Profit	-	-	-	-	58,401	141,072

With the financial model and the incorporation of the ILMP investment, operating revenues remain unchanged from the baseline. Because costs have been reduced and ECG is still not profitable, a complementary strategy is to increase revenue. To increase operating revenues, an increase in tariff is one tactic. If the tariff is increased by the percentage of net loss over the operating revenue for 2015, ECG should begin to achieve profits from that point forward. Table 7-5 illustrates that with a real 13.3% tariff increase in 2015 (and no increase in the wholesale power rate), ECG achieves zero net profit in that year, and begins to earn margins thereafter – without any further performance improvements. Note that this tariff increase is based on the May 2014 purchasing power of the Ghanaian Cedi. Any increase in cost of operations due to inflation of the Cedi would require an additional tariff increase. Thus, if inflation between May 2014 and the effective date of the tariff increase were 6%, the total tariff increase in actual Cedis (as opposed to real Cedis) would be 19.3%.

TABLE 7-5
ECG Net Profit after One-time 2015 Tariff Increase of 13.3% (GHS 000)

Change in	2014	2015	2016	2017	2018	2019
Operating revenue	2,850,813	3,239,389	3,430,274	3,615,460	3,799,507	4,035,255
Net Profit (000)	0	0	80,220	167,506	278,363	299,577
Net profit (%)	0%	0%	2.61%	5.19%	8.10%	8.27%

It is also useful to perform sensitivity analyses to understand the impacts associated with more conservative benefit realization from the ILMP investment. As illustrated in Table 7-6, the loss components are reduced to reflect lower rates of loss reduction. This case assumed that the ILMP investment program results in a 30% lower improvement of technical losses (2.3% reduction in technical loss as compared to 3.3% reduction); 25% lower reduction in commercial losses (3% reduction as opposed to 4% reduction; and 39% lower improvement in collection rate (8% improvement as compared to an 13% improvement) as compared with the values for year six of the project as presented in Table 7-3. With these lower values of performance improvement, the financial model shows that a tariff increase of 15.6% would be required to achieve financial break even in 2016 as compared to 13.3% shown earlier. Table 7-6 shows the result of the tariff increase taken together with the reduced performance improvements as listed above.

TABLE 7-6
ECG Comparative Net Profit after 2015 Tariff Increase of 13.3% and 15.6% (GHS 000)

	Baseline			13.3% Tariff Increase			15.6% Tariff Increase (with conservative benefit realizations)		
Change in	**Operating revenue**	**Net Profit (000)**	**Net profit (%)**	**Operating revenue**	**Net Profit (000)**	**Net profit (%)**	**Operating revenue**	**Net Profit (000)**	**Net profit (%)**
2014	2,677,495	1,739	0.06%	2,850,813	0	0%	2,850,813	0	0%
2015	2,836,726	(86,486)	-3.05%	3,239,389	0	0%	3,306,458	0	0%
2016	2,993,382	(91,873)	-3.07%	3,430,274	80,220	2.61%	3,501,016	64,980	2.11%
2017	3,142,179	(94,742)	-3.02%	3,615,460	167,506	5.19%	3,689,733	126,531	3.92%
2018	3,342,691	(89,474)	-2.68%	3,799,507	278,363	8.10%	3,878,572	213,545	6.21%
2019	3,521,258	(87,861)	-2.5%	4,035,255	299,577	8.27%	4,118,567	231,278	6.39%

As with the analysis presented in Table 7-5, the tariff increase of 15.6% cited above is a real tariff increase, that is, net of inflation. Both of these analyses overlook any consumers' reaction to a tariff increase of this magnitude and whether the projected revenue increase will be forthcoming. Utility staff will need to be vigilant to minimize increases in theft of power.

Experience has shown that significant real tariff increases can result in temporary reductions in consumption as consumers adapt to a higher real cost of power. Such reductions in consumption tend to be 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. 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% 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 to real tariff increases can be considered robust.

7.1.3 Conclusions – Financial Modeling

- Over the 20-year forecast horizon and with the ILMP, ECG net profit after collection losses is projected to have an NPV of ~$750 million.
- ILMP investments reduce the cost of wholesale power purchases.
- However, ILMP investments are insufficient on their own to achieve positive annual net cash flow.
- A change in the ECG tariff that are equivalent to a real increase of approximately 15% is projected to result in positive margins – but only if tariffs are adjusted annually to keep pace with inflation and increases in wholesale power cost.

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 interventions 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 interventions in terms of the opportunity costs of the resources involved in the electricity supply sector only.[7] Primary benefits and costs are calculated using this opportunity cost approach. Secondary benefits are imputed to the extent that certain kinds of valuations (e.g., new service, restoration of lost load) represent activities that occur outside the electricity supply industry. The model uses present value methods to put all of the proposed investments on an equivalent temporal footing. The economic model has been 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[8]
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 that are used to modify the operation of the model. One set of parameters includes overarching economic assumptions such as discount rates, foreign exchange rates, tariffs and is shown in Table 7-7. A second set of modifications (Table 7-8) permits the user to construct scenarios from the parametric values. The information describing the parameter values is presented in Appendix H.

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

[8] The word "access" has dual meanings for the utility sector in Ghana. In this report "access" refers to provision of utility services to a consumer and in this context refers to certain SADs. The Access Project is a GoG initiative funded by the GoG, the World Bank and other donors designed to expand access to electric service in urban, peri-urban and rural areas of Ghana.

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

Parameter	Value
Discount Rate	11.1%[9]
Bulk Generation (Gx) Charge	$0.0839/kWh
FOREX rate (Ghana Cedi:USD)	2.4
Transmission (Tx) losses	5%
Retail tariff	0.427 GH₵ / kWh[10]
Electricity average annual demand growth, 2013-2032	4.12%[11]
Standby Power Cost (USD/kWh)	0.39

Scenarios are created by combining a number of key attributes of each Sub-Activity (e.g., cost, performance, valuation of electricity). Financial analysis of the proposed Sub-Activity investments uses 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 values the benefits differently. New service is valued according to a consumers' willingness to pay for electricity. Technical loss reduction is valued at the resources saved by the improved performance of the system's technical components. Outage reduction is expressed in terms of value of lost load (VOLL), which is not the same as the cost of generation. Finally, the improvement in commercial performance is measured by the return that ECG 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 (e.g., fuel, transmission losses) and is 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 is 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.

[9] ECG informed CH2M HILL that 11.1% is the nominal discount rate they are required to use for all financial analyses as directed by the Ministry of Finance. ECG provided an internal study entitled, "Feasibility Study of Operating Tema as Mesh presented in December, 2013" that uses this same discount rate to evaluate construction project feasibility.

[10] The retail tariff value reflects full cost recovery tariff/valuation of electrical energy at distribution for a particular scenario. 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

[11] This figure is based on Mercados demand forecasts for electricity in the ECG service area. The 4.12% 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

TABLE 7-8
Scenario Parameters

Variable	Illustrative Scenario #	Scenario Pricing and Valuation Description
Bulk Generation Charge (BGC)	2	"1" is current BGC, "2" is efficient economic BGC, "3" is shadow price of additional generation, "4" is worst case
Distribution Service Charge (DSC)	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
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

7.2.1.1 Sensitivity Analyses

Scenarios are also grouped into probability "buckets" to enable sensitivity analyses as presented in Table 7-9. The scenarios are reflective of a combination of parameters that are likely to be encountered in the implementation of Sub-Activities.

TABLE 7-9
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 7-10 provides the combination of parameters and values for each of the sensitivity scenarios.

TABLE 7-10
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
Value of Lost Load	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 determine 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 SADs that do not feature new connections ("access projects") as the main benefit are considered. Under that condition neither the costs nor the other benefits – technical, non-technical, and outage reduction – of the six access projects are considered. In the second instance all of the projects are included.

The case for including the six access projects is that these investments, though enabling up to 18,000 new customers each, will also enable future normal growth in demand and customer density. [12] The alternative is likely to be that these investments will become critical within 3-5 years with higher technical losses the likely result of *not* making such investments.

Topline results for the five scenarios are summarized in table 7-11. Detailed results for each of the proposed investments are shown in Appendix H.

TABLE 7-11
Scenarios and Key Results - EIRR and NPV With and Without Access Projects

		P90	P50	P10	Best	Worst
With Access Projects	EIRR %	21.58%	25.24%	35.06%	70.64%	< 0
	NPV (US$)	$150,717,996	$203,638,143	$349,153,911	$1,305,040,190	-$339,090,461

		P90	P50	P10	Best	Worst
Without Access Projects	EIRR %	17.85%	21.79%	30.21%	40.99%	9.25%
	NPV (US$)	$62,127,688	$98,960,357	$174,060,273	$278,057,672	-$21,304,189

EIRR – economic internal rate of return

Under most likely conditions the proposed collection of projects is economically feasible. The rate of return for the P_{90} Scenario, at almost 22%, is comfortably above the discount rate of 11.1% and the MCC threshold of 10%. Even without the six infrastructure projects that will allow an additional 108,000 customers, the packages are still economically feasible. As demonstrated in Figure 7-2, technical loss reduction provides the greatest share of annual benefits, at almost 50%.

[12] The "Access projects are the six that feature new substations and bulk supply points that permit the connection of substantial numbers of new customers. These are:

ECG-Engr-10: Install Bulk Supply Point (BSP) substation with feeders to existing primary substations in Accra
ECG-Engr-11: Install Kotobabi/Nima primary substation with interconnecting sub-transmission links and medium voltage offloading circuits
ECG-Engr-12: Install Ogbodzo/Madina primary substation with interconnecting sub-transmission links and medium voltage offloading circuits
ECG-Engr-13: Install Mataheko primary substation with interconnecting sub-transmission links and medium voltage offloading circuits
ECG-Engr-14: Install Teshie primary substation with interconnecting sub-transmission links and medium voltage offloading circuits
ECG-Engr-15: Install Airport Residential Area primary substation with interconnecting sub-transmission links and medium voltage offloading circuits

FIGURE 7-2
P50 Benefits by Category (Without Access Case)

With the additional customers (and costs) the rates of return are 4-5% percentage points higher than the without access cases for three of the scenarios and much greater for the two extreme cases, Best and Worst. Access provides almost half the benefits when those projects are included. Outage reduction is the smallest of the benefit categories with or without Access projects included.

The biggest difference between the *with* and *without* access cases is the NPV, which is much greater in all four of the positive NPV cases when the Access projects are included. The exception is the Worst Case, where consumers value electricity at less than its cost of supply, and eliminating the access projects reduces the economic loss of supplying electricity at an opportunity cost that is greater than the willingness to pay of new customers. In fact, the conditions leading this scenario to become infeasible, discussed below, are highly improbable as long as consumers value new electricity service at a level that is above the cost of supply and that cost of supply is not unduly elevated due to failures in the generation expansion program (the “Value of New Service” and “Marginal Cost of Generation”, respectively).

When access projects are included, the greatest proportion of the economic value comes from the addition of new customers, 48% in the P_{90} Scenario.[13] When access projects are cut, then the Technical Loss Reduction projects generally account for 38-50% of annual benefits, except for the Best scenario where Outage reductions account for 41% of annual benefits due to the high VOLL and low cost of generation.

7.2.2.1 Attributes of Scenarios Used

Key attributes of each scenario are shown in Table 7-12. 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% 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 and VOLL. The team economist devised groupings based on the predominant type of benefit to assess the concentration in the five categories of benefits. It was noted that a relatively small number of projects contribute a large fraction of the net benefits.

TABLE 7-12
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 (DSC)	Current DSC	Current DSC	DSC in IFC Report	Full incorporation of losses *with* performance improvement	Full incorporation *without* performance improvement

[13] In the other scenarios the proportion of benefits attributable to access is 43%, 46%, and 76% for the P_{50}, P_{10}, and Best Scenarios, respectively.

TABLE 7-12
Key Attributes of the Five Scenarios

	Scenario Parameter Values				
Parameter	**P_{90}**	**P_{50}**	**P_{10}**	**Best**	**Worst**
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 generator cost for 35%, retail tariff for others	Standby generator cost 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

In some cases financial prices are used as a stand-in for the value of electricity and as a test of whether an investment is feasible using actual prices rather than imputed values.

In the P_{90} scenario, as in the other 3 with feasible EIRR values, only 2 of the 21 proposed investments showed a rate of return less than the discount rate of 11.1%.[14] About 75% of the total net benefits came from 7 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 as shown in Table 7-13.

TABLE 7-13
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%

[14] For the Worst Scenario only 9 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.

7.2.2.2 Key Parameters

Of the 11 parameters shown in Table 7-14, the most important are those that affect the value of electricity supplied, saved or consumed. For example, if the value of electricity to new users is below the cost of supply, as can happen in some locations, then the more successful ECG is with its access projects the lower the rate of return.

For the without access case the EIRR of 17.9% will fall below the discount rate if just the marginal cost of generation and the VOLL are changed to plausible, if only somewhat improbable, values. Changes in those two parameters drop the EIRR by more than 7 percentage points. Only 8 of the 14 projects will be feasible with these prices.

For the access case, changing just 3 prices – the VOLL, cost of additional generation to service the demand as outages are reduced, and the value of electricity for new customers - is sufficient to reduce the EIRR for the P_{50} Scenario from 25.2% to 9.4%, an economically infeasible number. A high marginal generation cost also affects the feasibility of some technical loss reduction programs positively as the energy saved is more valuable.

The effects of these prices are greater than the effects of changes in the effectiveness parameters. For example, leaving prices as they were intended for the P_{50} Scenario (without access), and reducing the effectiveness of each project category from 100% to 75% lowers the EIRR by 2.5 percentage points, to 15.1%. To make the entire program infeasible implementation of the investments at half the planned effectiveness will lower the EIRR below the discount rate (true also for the access case).

Costs remain important to returns, a 30% cost overrun, combined with indifferent implementation (75% effectiveness) will lower the P_{50} EIRR to 11.7%, just barely above the discount rate of 11.1%. In other words, as long as the cost of generation remains reasonable and customers place appropriate valuations on the benefits, even mediocre execution will leave the returns and present worth of the investments in a feasible range, though just barely.

7.2.3 Conclusions – Economic Modeling

- ILMP with access case has a higher EIRR than without access.
- In almost all scenarios, EIRR for ILMP both with access and without access is higher than the MCC investment threshold of 10%.

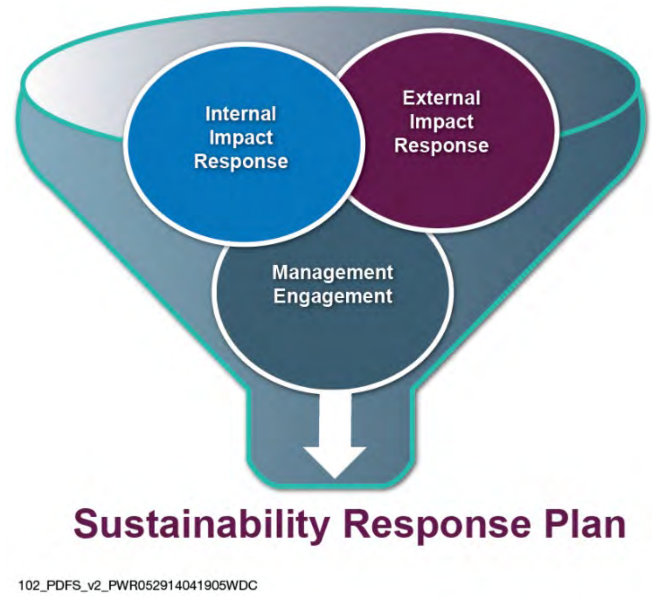
Therefore, investment in foundational and non-foundational ILMP projects is warranted based upon the analytic results.

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, the board of director's and management's 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 ECG are aligned in internal, external and governance/management. Each category is examined below and then followed by recommendations that support ECG sustainability.

8.2.1 ECG Internal Processes and Staffing Requirements

Foundational projects provide the tools and expertise to respond to key information gaps within ECG. ECG will need trained staff and formal processes to ensure that these systems are effectively deployed. These topics 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 ECG 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 ECG, which has an impact on client perceptions.

8.2.2.1 Clearance of MDA Arrears

ECG has significant arrears from government clients. Government accounts are called MDA accounts and represent a significant percentage of ECG'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 responsible for paying ECG directly for power bills. Some MDAs were converted to prepayment metering, but these are likely smaller consumers given the load limitations for prepayment meters.

Acknowledging that the former system of clearing MDA accounts did not work well, the new, more direct system of creating a primary relationship between the MDAs and the two utilities was developed, but unfortunately this system is apparently not working well either. Significant payment issues still exist with MDA accounts. The issue of timely MDA payment will likely exist until a clear instruction from the highest political level is issued to change the culture of non-payment in the Government of Ghana. Regular and timely MDA payments is critical to ECG and would have a significant impact on its financial sustainability.

8.2.2.2 Electricity Tariffs

Ghana electricity tariffs have reached a point wherein the structure may be the cause of economic harm rather than supporting economic growth. Tariffs reflect the cost of service to most consumers and there are large transfers of cash within consumer categories, from one category to another, and from one region of the country to another. The characteristics of such electricity tariffs lead 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, ECG 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. It can be expected that the financial downgrade will lead to difficulty in financing new independent power producers, 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 subject to two different forms of calculation. On the cost side there is an accounting of the cost elements in bulk generation charge (BGC), transmission service charge (TSC), and distribution service charge (DSC). This accounting is additive, so a customer connected to the HV 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 transfer 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) [15]

[15] 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.

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 to 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 the 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 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.

The first step Ghana should take before making any rate adjustments is to design and implement a willingness-to-pay analysis of electricity for 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. Based on such a study, 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.
- 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.
- 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.
- 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.
- Reform the lifeline tariff so that it is applied only to customers who need assistance (means test). If that is not possible, at least it needs to be changed so that it only applies 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, the 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 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 ECG revenues.

8.2.2.3 Improvements in the ECG Customer Perception – Customer Care

The term "customer care" captures the overall relationship between the electric service provider (ECG) 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 ECG as the primary culprit and blame poor performance on ECG.
- 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 there 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, ECG has corporate priorities that may include profitability, safety, or reliability. If customers perceive that ECG's priorities are in conflict with customers' priorities, then a misalignment between what is important to customers and utilities may result 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 ECG's response to weather-related events or news coverage of increasing electric rates. In some instances, ECG 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.

Presently, the status of ECG'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. There is a general perception that customers are not satisfied with the level of customer care they currently receive and there is likely significant room for improvement.

Improvements in ECG 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" in the ECG Accra region 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 ECG'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 provide some examples as to why an unwillingness to pay for electricity exists.

To respond to these issues, ECG should take steps to improve its overall customer service, which starts with a focus on service by the directors and senior management. The ECG board could consider engaging an external consultant to 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, ECG 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

ECG 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:

- ECG 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.
- The ECG tariff structure includes 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 attitude of policy makers toward whether ECG 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:

- Policy makers will need to expressly commit to ensuring that ECG 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.
- Politically identified cross subsidies, such as lifeline tariffs, should be considered as commitments of the government, payable to ECG at the cost of service.
- Board participation should be based upon demonstrated competence and expertise rather than purely political considerations, 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 ECG. 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 ECG'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 challenge for 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).

ECG 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 ECG that the utility has maintained the political focus of expanding access rather 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 chief executive officer, particularly 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. Candidate committees include: the audit committee, the compensation committee, and the nominating committees. 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 ECG general manager to focus on implementing a program that ensures effective utility operations with minimal political interference.

Given the deteriorating financial performance of ECG, the most compelling issue facing the board of directors is that of ensuring financial viability. Above all, this board should provide executive management strategy, goals, and performance measures that systematically strengthen the utility's financial returns, reduces losses, and improve quality of service.

To improve shareholder (government), board and executive management team governance, 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 its effort in improving these metrics. Additionally, MCC/MiDA could provide the board with training on recommended board practices. Of special concern, MCC/MiDA can help to ensure that that loss metrics and system improvement evaluation is a major part of every board meeting. Such practices will 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 not achieve the level of success that is possible and will not be effective. 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 a 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 ECG 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 ECG develop integrated loss reduction management units. These units should include members from Engineering, Operations, Commercial 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 team 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 ECG 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 ECG employees on all new software platforms, planning and engineering procedures and other changes in operational policies and procedures to include training on integrated resource planning.	Internal	Administrative
Create job descriptions and include possible staff skills training in the system rollout of activities.	Internal	Division Management
Develop a quality assurance system that involves periodic assessments of ECG procedures and processes as they are 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 of MDA arrears, establish procedures to incent MDA to avoid non-payments	External	GoG: Ministry of Finance
Align improved tariffs to cost of service	External	PURC
Create Board of Directors Integrated Loss Management Memorandum of Support	Management	MiDA and Utility Chairman of the Board
Develop 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 ECG 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 assessing proposed evaluation indicators and identifying potential gaps in existing systems and processes used by ECG 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 ECG 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 SAIDI and SAIFI is not only needed for internal purposes, but is also provided to PURC for regulatory purposes.

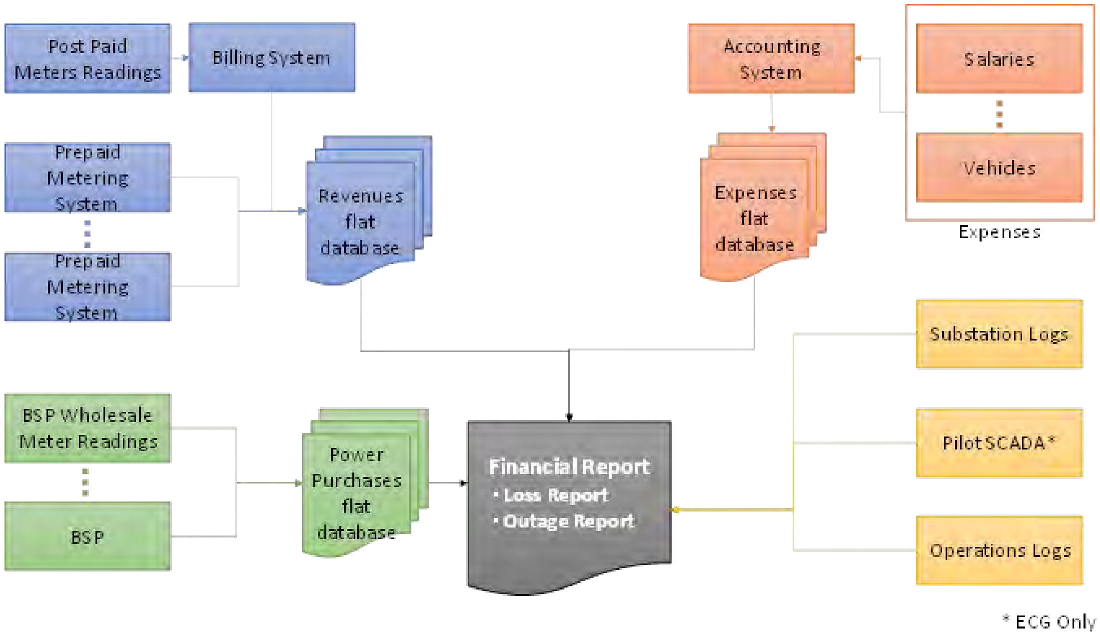
9.2.1 Existing Data Collection and Reporting Gaps

ECG 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 ECG lacks the capability to disaggregate technical and non-technical losses. The general process ECG follows for data collection is illustrated in Figure 9-1.

At the regional level, existing data is problematic given that customer data is geographic rather than tied to the network boundaries. For example, purchased power is recorded at BSPs, but then BSPs often serve feeders that cross regional service boundaries. In contrast, sales are recorded along regional geographic limits. This has caused significant confusion and erroneous reporting for a number of key performance indices, particularly ATC&C calculations at the regional level.

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. Although ECG has developed a meter-reading system that locates consumers on the basis of their meter reading route, it has not 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 with the technology ECG is using at the present.

FIGURE 9-1
ECG Data Collection Process



In addition to postpaid metering systems, ECG has invested significantly in prepayment metering systems, installing more than 700,000 prepaid meters over the last 5 years. Prepayment meters have the advantage of improving cash flow (the company receives payment before energy use). 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 complex tariffs, which are structured for energy usage within a fixed 30-day period. Tracking energy consumption is further complicated by the fact that ECG has seven 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 inspect meter locations on a regular basis. Inspection allows ECG to identify energy theft through by-passing and tampering with meter installations.

To overcome these difficulties a two-way prepaid metering standard should be adopted and employed in concert with a meter data management system to facilitate correlation of monthly consumer metering location consumption to distribution transformer and feeder automatic meter reading (AMR) values. In the interim, all pre-paid 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 problematic. ECG has a corporate call center, but the outage data do not have the resolution that one would normally expect to see in a well-designed outage database. Outage statistics are recorded by combining data from the ECG SCADA and the regional management system into which customer complaints and maintenance records are entered. The ECG SCADA is currently limited in coverage to Accra and Tema regions for 33 and 11 kV feeders. It is being slowly expanded to other ECG operational regions.

9.2.2 Steps to Improve Data Collection and Data Quality

Modern distribution utilities employ a 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. In the case of ECG, the utility does not have an up-to-date system maps nor does it 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 the planning department has not developed a discipline of system-wide modeling, investment planning cannot systematically identify how and where to optimize investments in performance improvements. Table 9-1 summarizes the Sub-Activities with monitoring improvements that have been proposed for ECG.

TABLE 9-1
Proposed Sub-Activities with Monitoring Improvements

Sub-Activity	Technical	Commercial	Operations	Financial
ECG-Comm-07: Metering at critical nodes of the distribution system	X	X		
ECG-Comm-10: Strengthening loss control program		X		
ECG-Engr-01: Distribution system survey, GIS system development, and customer census	X	X		
ECG-Engr-39: Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion			X	
ECG-Ops-01: Outage management system			X	
ECG-Service-01: Installation of ERP system and integration with existing enterprise applications				X
ECG-Service-03: Technical Assistance Program	X	X	X	X

The GIS Sub-Activity will geographically reference ECG's consumers, tying them to distribution transformers via low voltage circuits, and the transformers tied to MV feeders. The GIS database will also allow distribution system assets attributes including substations, MV feeders, transformers and low voltage feeders to be recorded in an asset database. 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 ECG has replaced more than 700,000 meters, but still needs to replace several hundred thousand more meters, and does not have a route of scheduled field testing or inspection of active meter locations, which would reveal defective meters.

In addition to the proposed Sub-Activities, ECG should update the management of its data quality and integration systems. Although information 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 data, and there is a team specifically engaged in aggregating and developing the required reports.

Loss data monitoring and reporting is facilitated by 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 even feeder level as needed. Such a report provides key performance indicators and a useful source of data for analysis of utility operations 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 at least 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 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 combines 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.

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.

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 geographic 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 = 100 – Cash Recovery Index (CRI). CRI = (100- SL) * CR SL=System Losses in percent CR=Collection Rate in percent	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’ [a]
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 data will identify poorly managed areas.

[a] From discussions with ECG Director of Engineering, ECG only records outages in two categories and only started the third level last month. The SAIFI, SAIDI and CAIDI values for prior year’s annual reports only recorded ECG outages and not that from the supplier or due to load shedding.

9.2.3 ECG Monitoring and Evaluation Framework

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

- Key assumptions related to performance benchmarks.
- Proposed Compact II indicators. This section presents the indicators that will be used to track progress during the compact implementation period. Recommended changes and/or additions are noted in RED for comparison with MCC's proposed indicators. A second table describes indicator collection gaps and consideration for certain indicators.

9.2.3.1 Data Assumptions and Considerations

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 ECG to monitor performance on a regional level. Given the geographic focus on Accra, the data collection and reporting framework will be piloted in Accra. For the MCC investments, data will be collected for Accra East and West regions to evaluate technical and non-technical losses, and benefits will be evaluated at the feeder level in synch with the performance improvement investments. This approach will enable ECG 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 ECG 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.

We also assume that that the customer information system financed by the World Bank, which is currently being implemented, will be implemented in coordination with the customer census and GIS to ensure that the data linkages are intimated integrated with one another. We also assume that ECG accounting system will be refined to allow much improved tracking of operational costs. This task will need to be integrated in the technical assistance program designed to ensure the MCC investments result in significant performance improvement.

9.2.3.2 Interim Improvements

Table 9-3 presents performance improvement targets for Compact II for ECG. The table presents targets over a 6-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 ECG for Accra 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 management information system (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 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 from the Burma Camp substation and applied to the Accra East and West region. The collection efficiency reduction matches the target from the PURC and is obtainable if ECG practices the policy of not allowing MDAs in the collection efficiency rate.

9.2.3.3 ECG Financial and Operational Turnaround 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.

TABLE 9-3
ECG Financial and Operational Turnaround Project Indicators (Accra Regions)
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.

Result Statement	Indicator	Definition	Unit	Baseline	Year 5 Target	Data Source	Rationale & 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 (before EIF)	TBD	~~Customer satisfaction module in Enterprise Survey~~ ECG Customer Service	To measure customer perceptions of ECG service, and to provide feedback to utility and thus enabling customers to influence their performance. There is no evidence that ECG has ever conducted such a survey and a baseline is required.
	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 complain resolution time.	Level	TBD (before EIF)	TBD	Service Center Field Survey; Customer Information System (telephone timeframe/service reports, complaint resolution and connection response time)	To measure ECG's improvement in responding to customer needs – this should have a direct impact on overall satisfaction. Baseline is required.
	Customer and Employee Safety	Safety lost time accidents/1,000,000 hrs worked. (serious injuries)	Hours	Unknown	10	ECG Operations	Currently ECG only tracks lost days off so the numbers appear low.. There is no real base for lost-time.
	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	410,000 (2013)	TBD	ECG CIS	To measure growth in grid connections and household access to electricity. An individual customer is equivalent to a household or firm. 2,211,195 (2012) is customers for all ECG. It is difficult to establish customer growth because it is not directly tied to improvements, but is largely based upon non-program-related factors.
Consumption of electricity increased	Electricity consumption	Total GWh of electricity consumed by all customers (disaggregated by customer type)	GWh	6,079 (2012)	TBD	~~ECG SCADA/dispatch centers (new forms need to be developed)~~ECG CIS	Load shedding, WAGP, Jubilee delays and DSM can mask what is happening here. MCC economic model shows: 200 hours per customer. This presently translates to 260 GWh of electricity not delivered through the network for ECG. It is difficult to establish consumption growth because it is not directly tied to improvements, but is largely based upon non-program-related factors.
Reinvestment and maintenance in capital expenditure	Capital expenditure [b]	Total value of new equipment installed in the distribution network through projects funds and/or private sector partners	US$	181.85M (2012)	TBD	ECG Financial Statements	Proxy measure of sustainability of operational investments in ECG. Accra substations that appeared to have high rates of outages in reliability reports are also among the oldest areas of Accra. If ECG resources for re-investment are limited – for routine maintenance and equipment replacement – and spread thinly, then areas with older assets could

TABLE 9-3
ECG Financial and Operational Turnaround Project Indicators (Accra Regions)
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.

Result Statement	Indicator	Definition	Unit	Baseline	Year 5 Target	Data Source	Rationale & Measurement Details
							display higher rates of system failure. The impacts of investments in a utility such as ECG are linked to critical equipment replacement (compact-mediated hardware inputs) and higher levels of financial resources applied to system maintenance and re-investment (compact-mediated institutional, 'software' inputs), which shall result in a different spatial profile of outages over time, as estimated in the ERR. Capital expenditure is typically tied to annual budget (based upon the tariff allows to spend).
	Ratio of actual maintenance expenditures to planned maintenance budget[c]	Actual maintenance expenditures divided by Planned maintenance budget	Number	TBD	TBD	ECG Financial Statements	Currently ECG does not have a planned maintenance budget and does not have an effective budgeting process and could be included in management improvement activities.
	Ratio of actual maintenance expenditures to dollar value of total distribution assets	Actual maintenance expenditures divided by total value of distribution assets	Number	0.74% (2012)	TBD	ECG Financial Statements	Proxy measure of sustainability of operational investments in ECG. O&M costs are largely dependent upon the location and climate – rates are typically somewhere around 3% for a US utility.
Enhanced investment capacity	Asset turnover	Net sales divided by total assets	Ratio	0.33 (2012)	TBD	ECG Financial Statements	Measure of the financial security of ECG.
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	ECG Financial Statements	Measures the cost of producing 1kWh of electricity, and GoG / ECG attempts to reduce total operating costs.
Outcomes							
Utility Financial Health improved	Operating profit (loss)	Operating revenue minus operating expenses	$US	-50.27M (2012)	TBD	ECG Financial Statements	Measures the capital structure and health of the company. Assumptions based on an operating margin of +5%. This is based upon a tariff set at 15% operating margin and generally shows positive financial management.
	Operating Margin	Operating Income / Net Sales	Percentage	(7.5%) (2012)	5%	ECG Financial Statements	

TABLE 9-3
ECG Financial and Operational Turnaround Project Indicators (Accra Regions)
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.

Result Statement	Indicator	Definition	Unit	Baseline	Year 5 Target	Data Source	Rationale & Measurement Details
	~~Net profit~~	~~Net income divided by net sales~~	~~Number~~	~~0.095 (2012)~~	~~TBD~~	~~ECG~~	
	Quick ratio	Current assets minus stock divided by current liabilities	Number	0.76 (2012)	TBD	ECG Financial Statements	
	Debt to equity ratio	Long-term liabilities divided by shareholders equity.	Number	0.099 (2012)	TBD	ECG Financial Statements	
Outage response time improved	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.	Number	248, 190, 206 (2012)	135[a] (Accra Metro Area)	ECG ~~(Metro, Urban, Rural)~~Operations	This index as stated / reported to PURC only records ECG outages and does not include supplier outages or load shedding requirements 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 outage reporting and response process and service normalization.
Unplanned outages and faults reduced	SAIFI	Number of customer interruptions divided by total customers in system at the substation level	Number	69, ~~88, 124~~ (2012)	38	ECG Operations	To measure number of outages and frequency. This index as stated / reported to PURC only records ECG outages and does not include supplier outages or load shedding requirements. 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 and service normalization.
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)	ECG Finance	See reform project indicators. Ensures power producers are paid on time (45 days is likely just below contract requirements) and improves ECG credit-rating.
	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)	ECG Finance	

TABLE 9-3
ECG Financial and Operational Turnaround Project Indicators (Accra Regions)
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.

Result Statement	Indicator	Definition	Unit	Baseline	Year 5 Target	Data Source	Rationale & Measurement Details
Gender employment targets met	Percentage of female employees	Number of female employees divided by number of employees time 100	Percentage	20 (2013)	TBD	ECG Human Resources	
Commercial losses reduced	Commercial losses	System losses minus technical losses.	Percentage	~~12.51~~ Accra 25.3% Outside Accra 11.9% (2012)	Accra 21.3% Outside Accra 11.4%	ECG MIS	Represents megawatts 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). The number shown are based upon ATC&C calculations developed during Phase I with ECG data. Proposed improvements based upon interventions proposed for Accra region
Billing & Collections improved	Billing and collection ratio	Revenue collected divided by total value of electricity billed.	Percentage	~~89.16~~ Accra 82.3% Outside Accra 79.6% (2012)	Accra 91.8% Outside Accra 80.6%	ECG MIS	Reasonable levels of collection efficiency.
	Average collection period (accounts receivable)	Receivables divided by credit sales times 360 days	Days	345 (2012)	90	ECG MIS	This is the PURC's stated target. 90 days is a reasonable number of days and significant improvement over the current collection period.
Distribution 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	Accra 33.6% Outside Accra 21.9%	Accra 27.1% Outside Accra 21.2%	ECG MIS	To be calculated 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	Accra 8.3% Outside Accra 10%~~10.97~~ (2012)	Accra 5.8% Outside Accra 9.8%	ECG MIS	To be updated during loss characterization study planned for Compact-in-force. ATC&C calculation is based upon the evaluation completed during phase I and based upon actual ECG data.
Distribution Revenue	Aggregate Technical,	~~Total electricity purchased by distributors minus total electricity sold (or billed) as a percentage of total electricity purchased~~ 1-(1-	Percentage	Accra 45.4% Outside	Accra 33.1%	ECG MIS	ATC&C calculation is based upon the evaluation completed during phase I and based upon actual ECG data.

TABLE 9-3
ECG Financial and Operational Turnaround Project Indicators (Accra Regions)
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.

Result Statement	Indicator	Definition	Unit	Baseline	Year 5 Target	Data Source	Rationale & Measurement Details
Recovery Enhanced	Commercial and Collection Loss (ATC&C)	total energy losses)*billing and collection ratio		Accra 37.8% ~~23.48~~ (2012)	Outside Accra 36.5%		

[a] The value given as a baseline and target reduction will only review outages past the Bulk Supply Point on ECG system. The Outage Management System will record supplier outages as SAIFI, SAIDI and CAIDI indices.

[b] All capital expenditure is money from GoG or donors.

[c] 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. Review IFC model for OpEx.

MWh – megawatt hours

TABLE 9-4
ECG Financial and Operational Turnaround Project Indicators (Data Considerations and Gaps)

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	Yearly	This will be highly sensitive to cost changes. May want to consider additional indicators regarding service and quality (i.e. outages and response)	This is not a current practice with the utility. Will require a baseline study. Such a study needs to consider timing as results are sensitive to pricing factors etc.
	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 complain resolution time.	Yearly	Walk-in assessments are completed by field surveys.	It is unknown if ECGs telephone system tracks response times – most systems will include this metric. Currently the ECG 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 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	ECG 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. The Technical Assistance Program respond to this issue.
	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	ECG does not disaggregate by gender. To develop such data, the information would need to be collected 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	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 be based upon an investment plan developed through system model and long-range plan.	This will require ECG to develop more regular financial statements because such statements are normally considered only once per year. Also there is general concern about the accuracy of ECG's cost accounting. More detail into these practices should be considered.
	Ratio of actual maintenance expenditures to planned maintenance budget[b]	Actual maintenance expenditures divided by Planned maintenance budget	Monthly		The ECG cost accounting lacks granularity and is not broken down by work unit at this time impacting a true picture of accounting values. In particular, current maintenance expenditures seem 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		Lack of cost accounting detail/specificity may impact this value

TABLE 9-4
ECG Financial and Operational Turnaround Project Indicators (Data Considerations and Gaps)

Result Statement	Indicator	Definition	Frequency	Data Collection Considerations	Measurement Gaps
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	Monthly		
	Operating Margin	Operating Income / 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		
Outage response time improved	SAIDI	Sum of durations of all customer interruptions divided by Total customers in system at the substation level	Monthly		Currently, number of affected customers is an estimate. The GIS system, tied to the CIS, will ensure more accurate readings.
Unplanned outages and faults reduced	SAIFI	Number of customer interruptions divided by total customers in system at the substation level	Monthly		Currently, number of affected customers is an estimate. The GIS system, tied to the CIS, will ensure more accurate readings.
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	Quarterly		ECG does not track its payables at this level. This would require changes in organizational accounting practices.
	Average payment period to GRIDCo	360 times total value of accounts payable to GRIDCO divided by annual cost of power purchased from GRIDCO	Quarterly		ECG does not track its payables at this level. This would require changes in organizational accounting practices.
Gender employment targets met	Percentage of female employees	Number of female employees divided by number of employees time 100	Quarterly		
Commercial losses reduced	Commercial losses	System losses minus technical losses.	Quarterly		Currently this cannot be accurately established. Upon finalization of foundational sub-activities this will be available.
	Billing and collection ratio	Revenue collected divided by total electricity billed.	Quarterly		

TABLE 9-4
ECG Financial and Operational Turnaround Project Indicators (Data Considerations and Gaps)

Result Statement	Indicator	Definition	Frequency	Data Collection Considerations	Measurement Gaps
Billing & Collections improved	Average collection period (accounts receivable)	Receivables divided by credit sales times 360 days	Quarterly		
Distribution technical losses reduced	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	Monthly		Currently this value is estimated on a sample basis. Upon finalization of foundational sub-activities this will be available on a more complete basis.
	Distribution system losses (ATC&C)	~~Total electricity purchased by distributors minus total electricity sold (or billed) as a percentage of total electricity purchased~~ 1-~~-~~(1-energy losses)*collection efficiency)	Monthly		

[a] All capital expenditure is money from GoG or donors.

[b] 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. Review IFC model for OpEx.

9.3 Conclusions

A number of actions are required for ECG 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 ECG 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 ECG 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, MV 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 MV feeders.
5. Install AMR metering on all MV feeders and distribution transformers.
6. Integrate all metering systems 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. 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.
9. Refine and implement a financial and statistical report that will be completed on a monthly basis. In conjunction with the monthly financial and statistical report, prepare and present specific performance indices as an annex to such a report.
10. Distribute the financial and statistical report to all board members, senior management staff, and key managers within ECG.

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 5 months of working with ECG. 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 ECG losses and provide a relative basis for comparison with other distribution utilities. The ATC&C metric was subsequently used 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

Decision-makers within Ghana's power sector have not fully embraced the idea of creating commercially-oriented 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 ECG is governed, changes that would provide the necessary incentives for making more effective investment and operational decisions that would reduce losses. ECG focuses considerable resources on politically important investments, such as access expansion, and is therefore unable to invest in essential performance improvements that would result in significant cost savings and revenue collection improvements.

High annual growth in demand, both energy and peak load, is exacerbating the challenges for ECG. Growth in sales has averaged over 6 percent annually since 2001. High ATC&C losses place ECG in a negative annual income position with poor cash flow. Yet the GoG's national policy for universal electricity access, coupled with a rising economy and tariffs that do not fully recover costs, is straining ECG's resources to meet demand while focusing on reducing losses.

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

Planning department lacks focus and resources. To a certain extent, the distribution planning department is operating without a roadmap and is consumed with responding to urgent demands rather than addressing the long-term needs of the organization. The department lacks basic and essential 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.

Knowledge of customers is limited. ECG 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, especially one as large as ECG. In the case of ECG, the basic building blocks of customer behaviors and needs are not well understood because ECG has not conducted focus group or consumer surveys to gather the data and insight needed to better understand customer desires and needs.

ECG staff effectiveness is limited. Institutional impediments within the ECG organization need to be addressed to improve effectiveness. Although an in-depth institutional assessment was not part of the scope of services for this project, interactions with ECG engineering and customer service directorates showed no evidence of efforts by ECG senior management to promote information sharing or team building. Certainly there are cultural considerations to address, but there appears to be little incentive for employees to develop and champion new ideas to improve ECG performance. To align employee motivation with corporate goals, clearly communicated goals, objectives, and rewards should be developed to drive employee behavior.

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. ECG has the capability but has not developed a format in which performance data can be presented and used by the ECG board of directors and senior management for decision making, particularly strategic investment decisions.

10.3 Conclusions

ATC&C has to be reduced. ECG 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, ECG will continue to experience significant financial losses. Two areas, collection and commercial losses, are of particular concern. The GoG arrears to ECG 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 ECG’s financial position. ECG has started implementing prepaid meters for non-critical government customers to try to mitigate this problem.

An ILMP needs to be implemented. ECG addresses ATC&C losses in a disjointed manner. An ILMP will integrate the key functions of engineering, operations, commercial, and administration into 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 needs to be controlled. High growth in demand is challenging even for well-managed and financially healthy organizations. ECG 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 ECG board of directors cannot make informed decisions or prioritize investments to those that will yield highest performance improvements. A reporting framework, similar to the U.S. Department of Agriculture Rural Utilities Service (RUS) Form 7 report, [16] provides a concise and accepted reporting format for electric utilities.

[16] The USDA RUS requires all RUS borrowers to submit comprehensive monthly reports that present a snapshot sales, losses, financial results, plant in service, and detailed costs and revenues in a simple and easy

Modeling indicates positive returns to the Ghanaian economy. The financial health and stability of ECG requires reduction of ATC&C losses to improve revenue collection and cash flow. The project's financial modeling has demonstrated that implementation of the multiple Sub-Activities results in improved cash flow. The NPV for the ILMP is positive. Economic modeling demonstrates that the proposed Sub-Activities have an IERR of 29.3 percent by improving fuel management and reducing outages.

Planning. ECG 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 a GIS and load flow modeling software. Short-, medium- and long-term expansion plans provide a roadmap for capital investments that address load requirements for ECG's distribution network. Over the past years, ECG 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 ECG has purchased and installed more than 700,000 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.

Institutional culture should be strengthened. ECG needs to make a sweeping change in its institutional culture. Senior management needs to engage in a process to define immediate and long-term goals, and to align staff with these goals so that long-term performance improvements are achieved. The ECG staff is experienced and talented but lacks the proper incentives to focus its abilities on improving ECG performance. For initiatives to succeed, such as the ILMP, ECG 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. Seven of the Sub-Activities have the potential for environmental social, and resettlement impacts; these involve the construction of substations and various distribution line construction and modifications. There is inherent flexibility in the location and design of proposed substations and distribution lines that will enable potential environmental and social impacts to be minimized. However, there is a potential for a need to resettle numerous informal businesses that locate within the utility corridors along busy roads. Although the GoG policy is not to 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. Therefore, it will be important for ECG 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. To incubate an effective loss management program, the program needs to be integrated between several directorates in ECG.

Towards this end, it is recommended that ECG focus on a loss reduction program in a specific geographic area to integrate customer service, engineering, operations, and administration activities. The program should contain performance improvement metrics that will be measured regularly and on a comprehensive basis. A team should be created that has the mandate to integrate key functions from various directorates that will directly support MCC investment objectives. The ILMP will provide the granularity to help focus decision-making, and the Technical Assistance Program (ECG-Service-03) will be able to support ECG 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. ECG leadership, and perhaps the technical advisors who support the MCC investment, will need to identify and

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to use format. The report presents not only key performance data, but also key performance indices. This form has been used by RUS for more than 50 years and has enabled close scrutiny of all RUS borrowers.

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 ECG 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 ECG customers.

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

Internal liaison. The ECG 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, ECG 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 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 ECG will need to develop procedures for identifying and dealing with employees who continue to pursue such activities through legal action.

Customer knowledge. ECG 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 ECG 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 ECG’s customers and their behaviors.

SECTION 11

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Appendix A
Consolidated Sub-Activity List and Results

Sub-Activity Name	Activity	Cost	Start Year	Duration (months)	Precedents	NPV	ERR
ECG-Comm-01: Normalization of existing services to comply with improved service connection standard	Commercial Losses Reduction and Collection Efficiency Improvement	$ 12,614,000	1	52	ECG-Engr-01	$ 71,692,000	26%
ECG-Comm-04: Replacement of legacy meters with prepayment meters	Commercial Losses Reduction and Collection Efficiency Improvement	$ 18,779,000	1	39	ECG-Engr-01	$ 112,281,000	30%
ECG-Comm-07: Metering at critical nodes of the distribution system	Commercial Losses Reduction and Collection Efficiency Improvement	$ 7,063,000	1	39	ECG-Engr-01	$ 6,913,000	5%
ECG-Comm-10: Strengthening loss control program	Commercial Losses Reduction and Collection Efficiency Improvement	$ 1,065,000	1	23	ECG-Engr-01	$ 16,910,000	96%
ECG-Engr-01: Distribution system survey, GIS system development, and customer census	Institutional Support	$ 2,481,000	0	22	None	$ 23,514,000	65%
ECG-Engr-07: Reactive power compensation for primary substations	Technical Losses Reduction	$ 4,058,000	2	41	None	$ 2,599,000	37%
ECG-Engr-10: Install Bulk Supply Point (BSP) substation with feeders to existing primary substations in Accra	Technical Losses Reduction	$ 7,736,000	2	31	ECG-Service-04	$ 20,468,000	37%
ECG-Engr-11: Install Kotobabi/Nima primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	Technical Losses Reduction	$ 10,415,000	2	39	ECG-Service-04	$ 20,089,000	35%
ECG-Engr-12: Install Ogbodzo/Madina primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	Technical Losses Reduction	$ 7,924,000	2	39	ECG-Service-04	$ 21,879,000	53%
ECG-Engr-13: Install Mataheko primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	Technical Losses Reduction	$ 10,415,000	2	39	ECG-Service-04	$ 19,273,000	40%
ECG-Engr-14: Install Teshie primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	Technical Losses Reduction	$ 10,415,000	2	39	ECG-Service-04	$ 18,366,000	40%
ECG-Engr-15: Install Airport Residential Area primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	Technical Losses Reduction	$ 10,415,000	2	39	ECG-Service-04	$ 18,366,000	41%
ECG-Engr-36: Low voltage (LV) feeder bifurcation with medium voltage (MV) upgrade	Technical Losses Reduction	$ 49,389,000	1	58	ECG-Engr-01	$ 25,440,000	32%
ECG-Engr-39: Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion	Outages Reduction	$ 6,392,000	2	39	ECG-Engr-01	$ 1,012,000	7%
ECG-Engr-42: Update distribution construction standards based on current low loss practices	Technical Losses Reduction	$ 256,000	0	10	ECG-Engr-01	$ 777,000	31%
ECG-Ops-01: Outage management system	Outages Reduction	$ 2,132,000	2	21	ECG-Engr-01	$ 679,000	n/a
ECG-Ict-01: Data center and communication network	Institutional Support	$ 1,760,000	0	22	None	$ 12,790,000	7%
ECG-Service-01: Installation of ERP system and integration with existing enterprise applications	Institutional Support	$ 4,838,000	1	26	ECG-Ict-01	$ 24,709,000	53%
ECG-Service-03: Technical Assistance Program	Institutional Support	$ 9,900,000	0	54	None	$ 2,837,000	-1%
ECG-Service-04: Distribution System Master Plan	Institutional Support	$ 819,000	0	28	ECG-Engr-01	$ 2,906,000	99%
ECG-Service-05: Assistance to the ECG training center in Tema	Institutional Support	$ 1,000,000	3	26	None	n/a	0%
Total		$ 179,866,000					

Appendix B
Loss Study Results

TABLE-2

Feeder Name	From GIS Field Survey: Total No. of Transformers	Total Connected kVA	Recorded Feeder Peak Amp for 2013	Estimated Peak Amp	Calc. Peak kW	Trafo Average Loading	Remarks	Analysis Result: Load (kW)	HT Length (km)	HT Loss (kW)	LT Length (km)	LT Loss (kW)	Transf Total Loss (kW)	Trans NL Loss (kW)	Trans Load Loss (kW)	Load at Source (kW)	% Demand Loss
Accra Cewtral BSP								**27399**	**8.5**	**538.37**			**257.6**	**30**	**227.6**		
Transformer T-031			**870**									Estimated				Estimated	
Feeder L03	11	5630	120	160	2743	49%		2620	8.35	28.65		151.6	35.69	12.43	23.26	2836	7.6%
Feeder L04	33	17520	240	290	4973	28%		4549	13.14	259.38		274.8	55.87	30.78	25.09	5139	11.5%
Feeder L05	31	11095	300	300	5144	46%		4538	15.81	129.79		268.4	83.86	25.14	58.72	5020	9.6%
Feeder L06	5	2500	140	100	1715	69%		1647	2.5	11		94.8	20.07	6	14.07	1773	7.1%
Feeder L09	1	500	250	20	343	69%		329	3.3	1.2		19.0	5.41	1.2	4.21	355	7.2%
Transformer		***Sub-total:***	**1050**	**870**													
Transformer T-032			**840**														
Feeder L10	24	13955	270	350	6001	43%		5575	8.41	222.06		331.5	71.96	28.56	43.4	6201	10.1%
Feeder L11	13	9030	230	230	3944	44%		3755	4.46	58.63		218.0	45	16.04	28.96	4077	7.9%
Feeder L12	11	6700	280	170	2915	44%		2749	6.21	65.48		161.1	36.91	13.3	23.61	3012	8.7%
Feeder L13	8	4115	280	100	1715	42%		1637	6.6	18.65		94.8	22.35	9.32	13.03	1773	7.7%
		Sub-total:	**1060**	**850**													
						HT Total		**27399**	**68.78**	**794.84**		**1,614.0**	**377.12**	**142.77**	**234.35**	**30185**	**9.2%**
												Measured				**Measured**	
Feeder L05	31	11095	300	**300**	**5144**	**46%**		**4538**	**15.81**	**129.79**	**60**	**268.42**	**83.86**	**25.14**	**58.72**	**5020**	**9.6%**
												0.053469374			482.07		
Feeder L05 (After Bifurcation)	62	14995	300	300	5144	34%		4538	20.2	113.85	60	49.56	76.91	30.36	46.55	**4778**	**5.0%**

Loss Calculaiton: Load Factor %	Loss Load Factor %	Line Loss %	Transformer Loss %	LT Loss %
50.0%	32.5%	1.16%	0.7%	
50.0%	32.5%	0.7%	1.4%	3.5%
50.0%	32.5%	3.3%	1.5%	3.5%
50.0%	32.5%	1.7%	1.8%	3.5%
50.0%	32.5%	0.4%	1.2%	3.5%
50.0%	32.5%	0.2%	1.4%	3.5%
50.0%	32.5%	2.3%	1.4%	3.5%
50.0%	32.5%	0.9%	1.2%	3.5%
50.0%	32.5%	1.4%	1.4%	3.5%
50.0%	32.5%	0.7%	1.5%	3.5%
50.0%	32.5%	**1.7%**	1.5%	3.5%
50.0%	32.5%	1.7%	1.8%	3.5%
50.0%	32.5%	**1.5%**	1.9%	0.7%

Appendix C
Sub-Activity Descriptions

Identification

Sub-Activity Name	Normalization of existing services to comply with improved service connection standard
Activity	Commercial Losses Reduction and Collection Efficiency Improvement
Region(s)	Accra
Foundational	Yes
Sub-Activity Dependency	ECG-Engr-01: Distribution system survey, GIS system development, and customer census
Project Source	GEC loss Study

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. Electricity services and meter installations in the ECG service territory are often non-compliant with published ECG installation standards. Contractors hired to install new services do not follow ECG construction standards and have not been subject to routine inspection to ensure that the services meet these standards. This leads to service installations that are vulnerable to tampering, which is the leading cause of the commercial losses (according to the GEC loss study, ~75% of new services are connected in a non-standard format).

Implementation. ECG needs to update its service connection standards with a tamper- resistant, safe, and economic design for each customer category. A consultant will be hired to collect field information regarding the different structure types that require electric services ("structures" refer to construction units for the service – the meter base, mast, weather-head, all of this is a single structure).

Then, in consultation with ECG, the consultant will update the existing standards with either a new or revised design. During the customer census (Sub-Activity Engr-01) locations will be identified that are in violation of these new standards. A team of trained linemen (either ECG employees or hired contractors) will then repair and upgrade non-conforming services, which will initially target inaccessible or tampered meters. Subsequently, the ECG utility inspector and LCU personnel will be trained to enforce the new standards. Based on the GEC loss study field measurement work conducted in 2011, we assume that 18 percent of all the connected services in Accra fall into this category requiring upgrades.

Metrics

Investment	$	12,614,000	**Financial Rate of Return (IRR)**	70%
Net Present Value (NPV)	$	71,692,000	**Economic Rate of Return (ERR)**	25.8%
Yearly Operations and Maintenace	$	94,000		

ECG-Comm-01: Normalization of existing services to comply with improved service connection standard

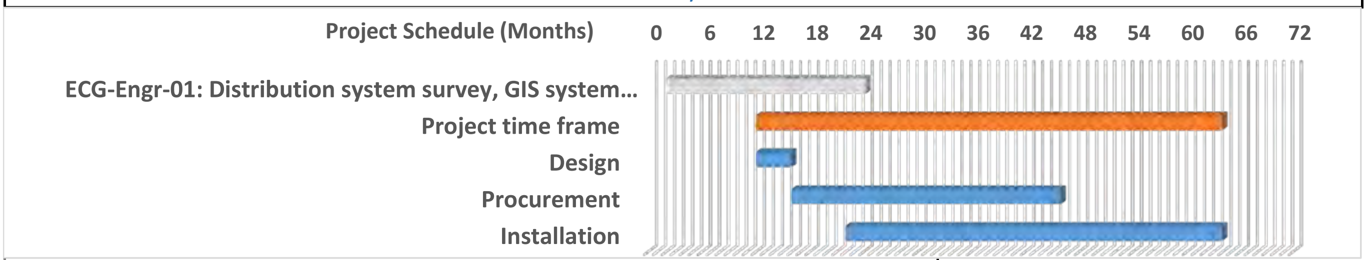
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Service connection upgrades	*Services*	99,300	$ 2,384,000	$ 7,647,000	$ 10,031,000
Service Standard	*Study*	1	$ 61,000	$ -	$ 61,000
Service Standard Books	*Books*	70,000	$ -	$ 210,000	$ 210,000
Training ECG inspector	*work days*	15	$ 19,000	$ -	$ 19,000
Contingency on labor	*Percentage*	10	$ 247,000	$ -	$ 247,000
Contingency on material	*Percentage*	5	$ -	$ 393,000	$ 393,000
PMC, Design & Supervision	*Percentage*	15	$ 370,000	$ 1,179,000	$ 1,549,000
Env/Social Mitigation	*Percentage*	1	$ 25,000	$ 79,000	$ 104,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 3,106,000	$ 9,508,000	$ 12,614,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.5%	508,000	$ 49,000
Commercial loss	29.5%	36,334,000	$ 5,933,000
Collection efficiency	16.0%	37,676,000	$ 6,152,000
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration of new systems and work methods into existing business practices	Institutional	Ensure that the technical advisors are engaged in the implementation and integration of the new system into the work procedures. The technical advisor shall also be responsible for reporting 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. Develop strong qualifications statement and ensure
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
Customers lose electrical service as a result of sub-activity	Social	MCC/MiDA to develop a means test and mitigation approach with utility
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

Identification

Sub-Activity Name	Replacement of legacy meters with prepayment meters
Activity	Commercial Losses Reduction and Collection Efficiency Improvement
Region(s)	Accra
Foundational	No
Sub-Activity Dependency	ECG-Engr-01: Distribution system survey, GIS system development, and customer census
Project Source	GEC loss Study

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 government programs (SHP and GEDAP) were designed to increase access to electric service have used various types of post-paid meter technology. As a result, there are a large number of legacy post-paid meters within ECG's service territory. Over the past few years, ECG has been installing prepaid meters to improve collection efficiency. However, these pre-payment systems have been obtained from a variety of vendors, which has created some integration difficulties and timely closing of monthly financial documents. The World Bank-funded Indra CIS application is designed to integrate the multiple pre-paid billing systems, and ECG has a goal of having all NSLT customers on pre-paid meters in the near future. However, this approach is not economically feasible based upon current tariffs, for low-consumption customers. This Sub-Activity will be used to install pre-paid meters for NSLT customers who are not on the life-line tariff and do not exceed a 100 kW service size. The customer census (Sub-Activity Engr-01) will identify the candidate NSLT customers

Implementation. The GIS data collection and customer census (Sub-Activity Engr-01) will be the first step in a review of the existing meter installations in ECG service territory. A consultant will be hired to conduct an evaluation of pre-paid systems to identify the system / technology vendor most compatible with the Indra CIS application. A contractor will then be hired to install specified pre-paid meters as prioritized by the customer census and historical usage data for those ECG consumers not included in the service normalization Sub-Activity (Comm-01).

Metrics

Investment	$	18,779,000	**Financial Rate of Return (IRR)**	90%
Net Present Value (NPV)	$	112,281,000	**Economic Rate of Return (ERR)**	29.9%
Yearly Operations and Maintenace	$	150,000		

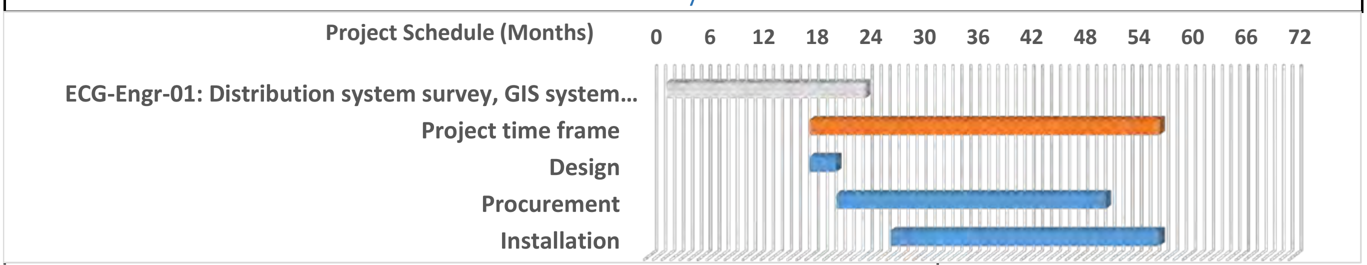
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Prepayment meters procurement and installation	*Services*	88,500	$ 3,532,000	$ 11,771,000	$ 15,303,000
Prepayment vending software deployment and integration	*Software*	1	$ 28,000	$ 10,000	$ 38,000
Prepayment technology analysis study	*work days*	22	$ 28,000	$ -	$ 28,000
Contingency on labor	*Percentage*	10	$ 359,000	$ -	$ 359,000
Contingency on material	*Percentage*	5	$ -	$ 590,000	$ 590,000
PMC, Design & Supervision	*Percentage*	15	$ 539,000	$ 1,768,000	$ 2,307,000
Env/Social Mitigation	*Percentage*	1	$ 36,000	$ 118,000	$ 154,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 4,522,000	$ 14,257,000	$ 18,779,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	2.0%	2,463,000	$ 402,000
Collection efficiency	62.0%	145,996,000	$ 23,841,000
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. Develop strong qualifications statement and ensure
Access to consumer premises	Technical	Ensure that all required documentation to access premises are
CIS software financed deployed successfully	Technical	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	MCC/MiDA to develop a means test and mitigation approach with utility

Identification

Sub-Activity Name	Metering at critical nodes of the distribution system
Activity	Commercial Losses Reduction and Collection Efficiency Improvement
Region(s)	Accra
Foundational	Yes
Sub-Activity Dependency	ECG-Engr-01: Distribution system survey, GIS system development, and customer census
Project Source	GEC loss Study

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 at critical nodes in the distribution system will allow ECG 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 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 ECG to identify losses that occur between node points, and high loss variations between these points will help ECG to select the geographic areas on which to focus resources.

Implementation. Installation of automated meter reading meters at special load tariff service locations and on selected non-special load tariff service locations in the ECG Target Regions as well as installation of metering at critical nodes of the distribution system in the ECG Target Regions. This will provide ECG the ability to identify and monitor where technical and commercial losses are occurring. Under this sub-activity, meters with communication capability will be purchased and installed by ECG staff at all the critical nodes so that information can be relayed to the newly installed Indra CIS system.

The Indra CIS system has a module capable of accounting for all the energy recorded by the critical meters and then computing the losses in the each system segment. These losses can then be compared to the anticipated technical loss and the calculated commercial losses. This information is used by the LCU to target the area of the system with the highest commercial energy losses.

Metrics

Investment	$	7,063,000	**Financial Rate of Return (IRR)**	24%
Net Present Value (NPV)	$	6,913,000	**Economic Rate of Return (ERR)**	4.7%
Yearly Operations and Maintenace	$	53,000		

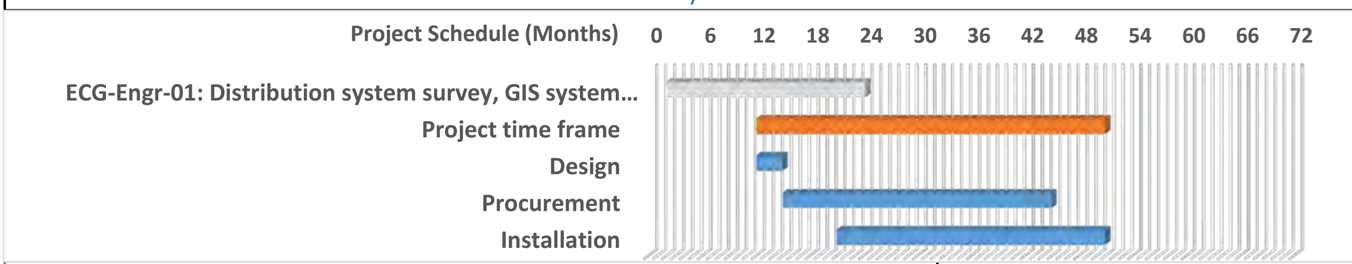
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
BSP outgower feeders meters	*Meters*	13	$ 3,000	$ 8,000	$ 11,000
Primary substation feeders metering instruments	*3Ph Metering instruments*	83	$ 254,000	$ 847,000	$ 1,101,000
Primary substation feeders meter	*Meters*	166	$ -	$ 100,000	$ 100,000
Meters for SLT	*Meters*	498	$ 90,000	$ 299,000	$ 389,000
Distribution transformer meters and metering instruments	*DT Meter Assembly*	2,419	$ 799,000	$ 3,387,000	$ 4,186,000
Contingency on labor	*Percentage*	10	$ 115,000	$ -	$ 115,000
Contingency on material	*Percentage*	5	$ -	$ 233,000	$ 233,000
PMC, Design & Supervision	*Percentage*	15	$ 172,000	$ 697,000	$ 869,000
Env/Social Mitigation	*Percentage*	1	$ 12,000	$ 47,000	$ 59,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 1,445,000	$ 5,618,000	$ 7,063,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	10.0%	12,317,000	$ 2,011,000
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. Develop strong qualifications statement and ensure
Access to consumer premises	Technical	Ensure that all required documentation to access premises are
CIS software financed deployed successfully	Technical	Ensure that the technical advisors come aboard as early as possible and include a contingency ICT budget for the implementation of the CIS
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	Strengthening loss control program
Activity	Commercial Losses Reduction and Collection Efficiency Improvement
Region(s)	Accra
Foundational	Yes
Sub-Activity Dependency	ECG-Comm-07: Metering at critical nodes of the distribution system
Project Source	GEC loss Study

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 key to reducing commercial loss is to strengthen the existing ECG-Loss Control Unit (LCU) in Accra. According to the GEC loss study report, the LCU detected only about 2% of commercial losses. The report also notes that the LCU identified fewer cases in 2011 than in 2010, when in fact the number of loss cases identified should have increased. Metering at critical nodes of the distribution system sub-activity (Comm-07) will provide the LCUs with a tool to hone in on the specific areas with the highest commercial losses. However, metering alone is not enough to reduce the commercial losses. The LCU needs additional staff, training, and equipment to identify and respond to losses. ECG intends to increase the number of LCU teams from 4 to 10 (currently LCU teams consist of 4 personnel).

Implementation. This sub-activity has three parts: 1) Strengthen the ECG loss control team by hiring additional qualified engineering staff to support loss control activities in each of the district offices of Accra East and Accra West, 2) Provide equipment, including small trucks and load loggers, and 3) Implement a training program and provide technical assistance via a loss control/commercial specialist. A loss control expert will be hired as part of an ECG technical assistant team. The loss control expert will conduct on-the-job training at the district offices for a 1-year period. During that year, the ECG employees will learn how to use data from the Indra CIS, AMR systems, SCADA, and critical node points to evaluate energy use and losses. Employees will also learn how to systematically target the commercial loss sources in the field and complete the required service upgrades to prevent future recurrence of the losses. In addition to the field work, the loss control department will perform energy balances for high loss substations towards the goal of evaluating how to overcome endemic commercial losses that persist even after significant investment in loss control interventions.

Metrics

Investment	$	1,065,000	**Financial Rate of Return (IRR)**	213%
Net Present Value (NPV)	$	16,910,000	**Economic Rate of Return (ERR)**	95.5%
Yearly Operations and Maintenace	$	728,000		

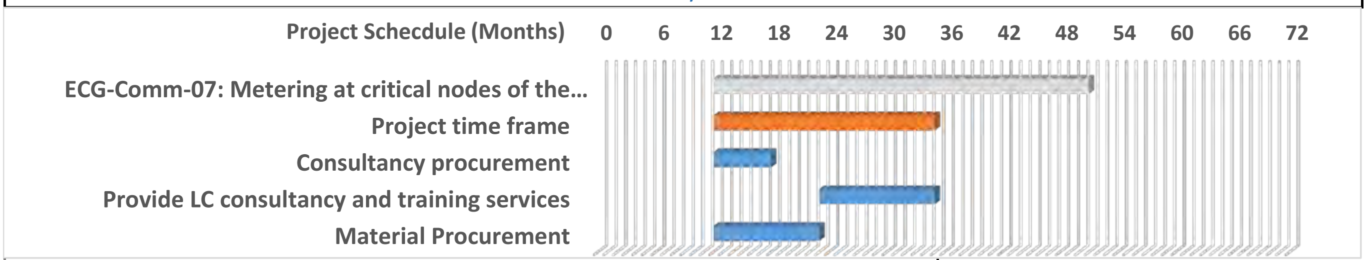
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Vehicles	*Vehicule*	12	$ -	$ 360,000	$ 360,000
Tools and testing equipment	*Set*	12	$ -	$ 120,000	$ 120,000
Loss control office refu	*Office*	2	$ 3,000	$ 60,000	$ 63,000
Expert technical assistance	*Work Days*	264	$ 330,000	$ -	$ 330,000
Contingency on labor	*Percentage*	10	$ 34,000	$ -	$ 34,000
Contingency on material	*Percentage*	5	$ -	$ 27,000	$ 27,000
PMC, Design & Supervision	*Percentage*	15	$ 50,000	$ 81,000	$ 131,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 417,000	$ 648,000	$ 1,065,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	15.0%	18,475,000	$ 3,017,000
Collection efficiency	3.0%	7,064,000	$ 1,154,000
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. Develop strong qualifications statement and ensure
Access to consumer premises	Technical	Ensure that all required documentation to access premises are
CIS software financed deployed successfully	Technical	Ensure that the technical advisors come aboard as early as possible and include a contingency ICT budget for the implementation of the CIS
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	Distribution system survey, GIS system development, and customer census
Activity	Institutional Support
Region(s)	Accra
Foundational	Yes
Sub-Activity Dependency	None
Project Source	GEC loss 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. A properly maintained Geographic Information System (GIS) is one of the operational foundations of a modern utility database. The GIS provides a medium to store a large amount of data on the utility system and allows for integration of multiple business applications. GIS data can be used in conjunction with an engineering model to calculate technical losses or with CIS data to calculate and visualize commercial losses. Other uses of GIS data will support creation of an Outage Management System, a vehicle tracking system, asset management, workforce management and many other uses. ECG does not have an up-to-date system map with a geographically referenced asset database. This intervention will establish an ECG GIS and provide a foundation for all subsequent loss and outage reduction efforts.

Implementation. This sub-activity will include a geographic survey of the region and integration of the survey data into a GIS (hardware and software) that is procured and managed within the Engineering Directorate. A contractor will be hired to perform the geographic survey. The survey will include the location and attributes of all electrical plant assets from the bulk supply points to the low voltage network (for example, substations, lines, poles, public streetlights, transformers, sectionalizing equipment, capacitor banks, and any other line equipment or asset).

In a parallel activity, the contractor will undertake a consumer census during which all active and inactive connections will be identified by a unique location identifier. The consumer and meter information will be recorded, verified, and uploaded into the meter management module of the Indra CIS and linked to the GIS database.

The contractor will also train the ECG staff to update the GIS asset data base, SCADA, CIS, and meter control module on a routine basis. The procedures to ensure control and accuracy of these modules will be drafted, tested, and deployed by the consultant hired to develop the GIS and asset control system. Training will also be provided to the ECG planning engineers in Accra on how to transfer the information to an engineering analysis software and allow ECG to calculate technical losses and conduct other engineering studies of its system.

Metrics

Investment	$ 2,481,000	**Financial Rate of Return (IRR)**	77%
Net Present Value (NPV)	$ 23,514,000	**Economic Rate of Return (ERR)**	64.5%
Yearly Operations and Maintenace	$ 103,000		

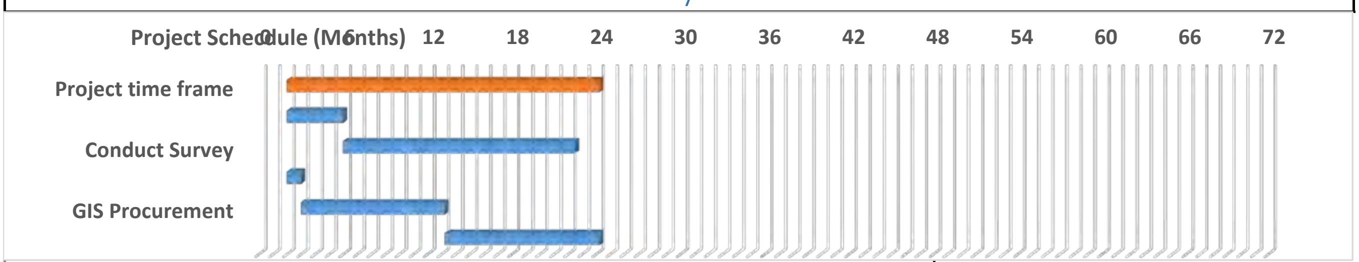
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
GIS Software and Hardware	*Users*	5	$ 3,000	$ 81,000	$ 84,000
GIS Integration with other systems	*Work Days*	88	$ 110,000	$ -	$ 110,000
GIS training	*Work Days*	110	$ 138,000	$ -	$ 138,000
MV Lines survey and digitisation	*km*	2,311	$ 162,000	$ -	$ 162,000
LV Lines survey and digitisation	*km*	5,967	$ 418,000	$ -	$ 418,000
Customer census	*Customers*	705,173	$ 1,058,000	$ -	$ 1,058,000
Contingency on labor	*Percentage*	10	$ 189,000	$ -	$ 189,000
Contingency on material	*Percentage*	5	$ -	$ 5,000	$ 5,000
PMC, Design & Supervision	*Percentage*	15	$ 284,000	$ 13,000	$ 297,000
Env/Social Mitigation	*Percentage*	1	$ 19,000	$ 1,000	$ 20,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 2,381,000	$ 100,000	$ 2,481,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	15.0%	18,475,000	$ 3,017,000
Collection efficiency	3.0%	7,064,000	$ 1,154,000
Outages	3.0%		$ 54,000

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration of new systems and work methods into existing business practices	Institutional	Ensure that the technical advisors are engaged in the implementation and integration of the new system into the work procedures. The technical advisor shall also be responsible for reporting any deviation
Access to consumer premises	Technical	Ensure that all required documentation to access premises are
Accuracy of distribution network digitization	Technical	Ensure that the technical advisor is engaged in the GIS implementation and quality control
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
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	Reactive power compensation for primary substations
Activity	Technical Losses Reduction
Region(s)	Accra
Foundational	No
Sub-Activity Dependency	None
Project Source	GEC loss Study

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 GIS field work (Sub-Activity Engr-01) and the engineering analysis has been completed, capacitor bank locations will be recommended. It is anticipated the capacitor banks will be located within a substation lot or placed along the 11 kV network.

Metrics

Investment	$ 4,058,000	**Financial Rate of Return (IRR)**	20%
Net Present Value (NPV)	$ 2,599,000	**Economic Rate of Return (ERR)**	36.8%
Yearly Operations and Maintenance	$ 31,000		

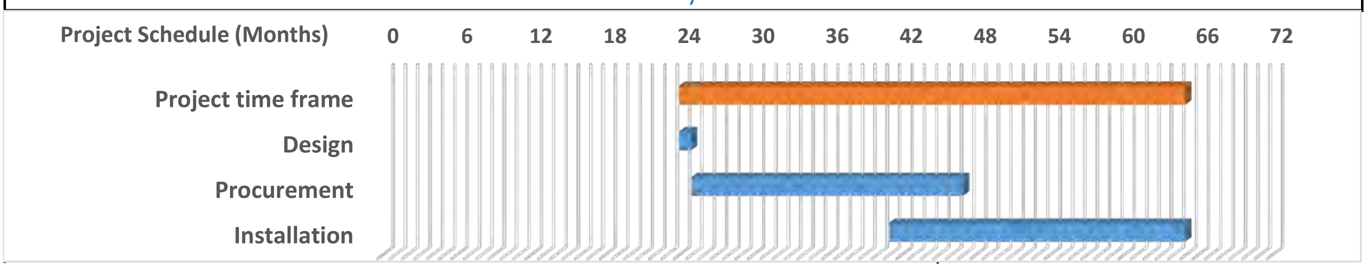
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Fix and switched capacitor banks	*600 kVAR Cap. Bank*	167	$ 268,000	$ 3,073,000	$ 3,341,000
Contingency on labor	*Percentage*	10	$ 27,000	$ -	$ 27,000
Contingency on material	*Percentage*	5	$ -	$ 154,000	$ 154,000
PMC, Design & Supervision	*Percentage*	15	$ 41,000	$ 461,000	$ 502,000
Env/Social Mitigation	*Percentage*	1	$ 3,000	$ 31,000	$ 34,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 339,000	$ 3,719,000	$ 4,058,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	10.0%	10,161,000	$ 982,000
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	Install Bulk Supply Point (BSP) substation with feeders to existing primary substations in Accra
Activity	Technical Losses Reduction
Region(s)	Accra
Foundational	No
Sub-Activity Dependency	ECG-Service-04: 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. The three Bulk Supply Points (BSPs) currently serving the greater Accra region will become overloaded based on the current demand forecast. To avoid rolling blackouts a new BSP will be required. BSPs are the power injection point into the ECG distribution network from the GRIDCo transmission and generation system. They are made up of two sections: (1) the GRIDCo section, which includes the transformer and the incoming transmission lines and (2) the ECG section, which includes the sub-transmission and distribution outgoing feeders and switching equipment. Meters are installed between the two sections to account for all of ECG’s power purchase.

Implementation. ECG will coordinate with GRIDCo for the procurement and installation of the new BSP. A contractor will be hired to procure and build a substation that conforms to ECG’s standard substation design. This will include the construction of the ECG section of the BSP that will serve the north-central portion of Accra’s sub-transmission and distribution network. Nsawam, Mampong, Aburi, Ofankor Kwabenya, and Adenta substations will become connected to the new BSP as part of this project. The construction will include a control house and switching yard that are fenced within the perimeter of the substation. In addition, lines will be built from the BSP to the various substations mentioned above to offload the other BSP currently feeding those loads. This sub-activity does not include the cost that will be incurred by GRIDCo to build its side of the substation.

Metrics

Investment	$ 7,736,000	**Financial Rate of Return (IRR)**	38%
Net Present Value (NPV)	$ 20,468,000	**Economic Rate of Return (ERR)**	36.8%
Yearly Operations and Maintenace	$ 58,000	**Yearly revenue from new cust.**	$ 4,380,000

ECG-Engr-10: Install Bulk Supply Point (BSP) substation with feeders to existing primary substations in Accra

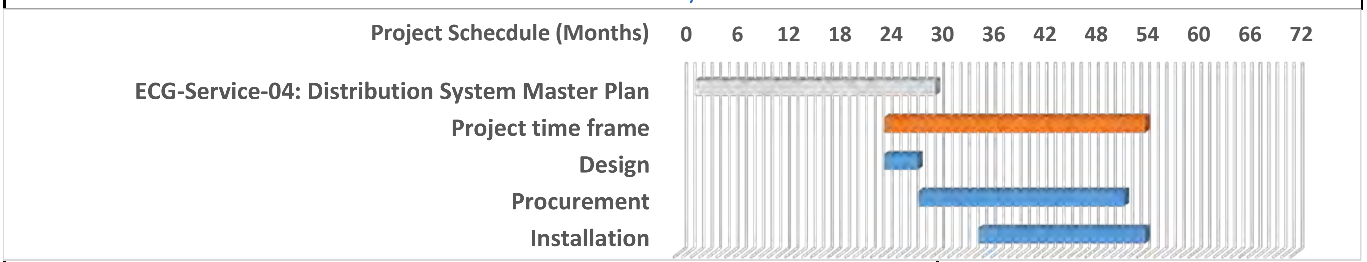
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
BSP outdoor	*Substation*	1	$ 647,000	$ 2,154,000	$ 2,801,000
Sub-Transmission UG Lines	*km*	3.0	$ 279,000	$ 930,000	$ 1,209,000
Sub-Transmission OH Lines	*km*	15.0	$ 478,000	$ 1,593,000	$ 2,071,000
Contingency on labor	*Percentage*	10	$ 141,000	$ -	$ 141,000
Contingency on material	*Percentage*	5	$ -	$ 234,000	$ 234,000
PMC, Design & Supervision	*Percentage*	15	$ 211,000	$ 702,000	$ 913,000
Env/Social Mitigation	*Percentage*	1	$ 15,000	$ 47,000	$ 62,000
Resettlement	*Percentage*	5	$ 71,000	$ 234,000	$ 305,000
		Total	$ 1,842,000	$ 5,894,000	$ 7,736,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	2.0%	2,032,000	$ 196,000
Commercial loss	0.0%	-	$ -
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
GRIDCo building its portion of the bulk supply point	Financial	Ensure that funds are available to GRIDCo to build its portion of the BSP before ECG start the tendering process for the BSP
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
Sub-activity is in Tranche II of the compact and cannot be funded until	Institutional	Open and constant communication between MCC, MiDA and the GoG regarding the development of the PSP activity.
PSP operator may have own views about the investment program	Institutional	Tranche II project could be changed to the liking of the PSP operator as a compromise on the project in the investment program.
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement can not be avoided.

Identification

Sub-Activity Name	Install Kotobabi/Nima primary substation with interconnecting sub-transmission links and medium voltage offloading circuits
Activity	Technical Losses Reduction
Region(s)	Accra
Foundational	No
Sub-Activity Dependency	ECG-Service-04: 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. The primary substations currently serving the greater Accra region will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the newly installed BSP, a primary substation will be installed at Kotobabi/Nima. Before the energy injected by the BSP can be used by most loads (consumers) in Accra, voltage has to be transformed to bring it to a level that can be consumed by standard electric equipment. The voltage transformation occurs at the primary substation, where the voltage is stepped down to 11 kV levels. The new substation will also help reduce technical losses and avoid extended outages caused by failures or maximum capacity reached at geographically adjacent substations.

Implementation. A contractor will be hired to procure and build a substation that conforms to ECG's standard substation design. This will include the construction of a new 33/11 kV 2x20/26 MVA substation to meet the forecasted load. The typical primary substation in the Accra region has two matched transformers, a switch yard, capacitor banks, and a control house within the fenced perimeter of the substation. It also includes lines for the incoming sub-transmission feeders and outgoing feeders that extend for distances ranging from 500 m to multiple km to a point where they connect with existing ECG substitutions or lines.

Metrics

Investment	$ 10,415,000	**Financial Rate of Return (IRR)**	32%
Net Present Value (NPV)	$ 20,089,000	**Economic Rate of Return (ERR)**	34.9%
Yearly Operations and Maintenace	$ 78,000	**Yearly revenue from new cust.**	$ 4,867,000

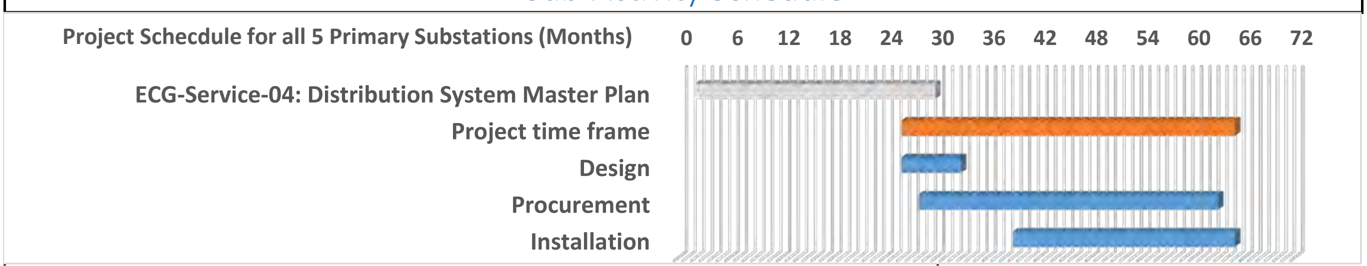
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Primary Substation	*Substation*	1	$ 647,000	$ 2,154,000	$ 2,801,000
Medium Voltage Lines UG	*km*	12	$ 261,000	$ 868,000	$ 1,129,000
Medium Voltage Lines OH	*km*	12	$ 53,000	$ 176,000	$ 229,000
Sub-Transmission Lines UG	*km*	10	$ 930,000	$ 3,100,000	$ 4,030,000
Sub-Transmission Lines OH	*km*	-	$ -	$ -	$ -
Contingency on labor	*Percentage*	10	$ 190,000	$ -	$ 190,000
Contingency on material	*Percentage*	5	$ -	$ 315,000	$ 315,000
PMC, Design & Supervision	*Percentage*	15	$ 284,000	$ 945,000	$ 1,229,000
Env/Social Mitigation	*Percentage*	1	$ 19,000	$ 63,000	$ 82,000
Resettlement	*Percentage*	5	$ 95,000	$ 315,000	$ 410,000
		Total	$ 2,479,000	$ 7,936,000	$ 10,415,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	1.0%	1,016,000	$ 98,000
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
Sub-activity is in Tranche II of the compact and cannot be funded until	Institutional	Open and constant communication between MCC, MiDA and the GoG regarding the development of the PSP activity.
PSP operator may have own views about the investment program	Institutional	Tranche II project could be changed to the liking of the PSP operator as a compromise on the project in the investment program.
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement can not be avoided.

Identification

Sub-Activity Name	Install Ogbodzo/Madina primary substation with interconnecting sub-transmission links and medium voltage offloading circuits
Activity	Technical Losses Reduction
Region(s)	Accra
Foundational	No
Sub-Activity Dependency	ECG-Service-04: 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. The primary substations currently serving the greater Accra region will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the newly installed BSP, a primary substation will be installed at Ogbodzo/Madina. Before the energy injected by the BSP can be used by most loads (consumers) in Accra, voltage has to be transformed to bring it to a level that can be consumed by standard electric equipment. The voltage transformation occurs at the primary substation, where the voltage is stepped down to 11 kV levels. The new substation will also help reduce technical losses and avoid extended outages caused by failures or maximum capacity reached at geographically adjacent substations.

Implementation. A contractor will be hired to procure and build a substation that conform to ECG’s standard substation design. This will include the construction of a new 33/11 kV 2x20/26 MVA substation to meet the forecasted load. The typical primary substation in the Accra region has two matched transformers, a switch yard, capacitor banks, and a control house within the fenced perimeter of the substation. It also includes lines for the incoming sub-transmission feeders and outgoing feeders that extend for distances ranging from 500 m to multiple km to a point where they connect with existing ECG substitutions or lines.

Metrics

Investment	$ 7,924,000	**Financial Rate of Return (IRR)**	40%
Net Present Value (NPV)	$ 21,879,000	**Economic Rate of Return (ERR)**	53%
Yearly Operations and Maintenace	$ 59,000	**Yearly revenue from new cust.**	$ 4,867,000

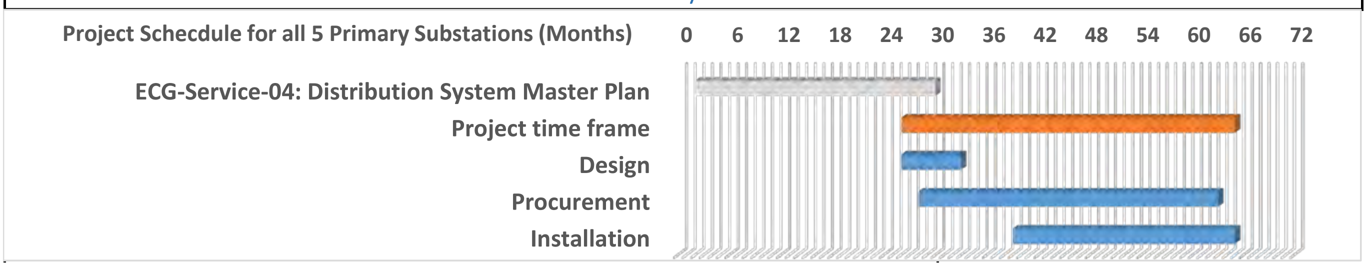
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Primary Substation	*Substation*	1	$ 647,000	$ 2,154,000	$ 2,801,000
Medium Voltage Lines UG	*km*	12	$ 261,000	$ 868,000	$ 1,129,000
Medium Voltage Lines OH	*km*	12	$ 53,000	$ 176,000	$ 229,000
Sub-Transmission Lines UG	*km*	-	$ -	$ -	$ -
Sub-Transmission Lines OH	*km*	15	$ 478,000	$ 1,593,000	$ 2,071,000
Contingency on labor	*Percentage*	10	$ 144,000	$ -	$ 144,000
Contingency on material	*Percentage*	5	$ -	$ 240,000	$ 240,000
PMC, Design & Supervision	*Percentage*	15	$ 216,000	$ 719,000	$ 935,000
Env/Social Mitigation	*Percentage*	1	$ 15,000	$ 48,000	$ 63,000
Resettlement	*Percentage*	5	$ 72,000	$ 240,000	$ 312,000
		Total	$ 1,886,000	$ 6,038,000	$ 7,924,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	1.0%	1,016,000	$ 98,000
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
Sub-activity is in Tranche II of the compact and cannot be funded until	Institutional	Open and constant communication between MCC, MiDA and the GoG regarding the development of the PSP activity.
PSP operator may have own views about the investment program	Institutional	Tranche II project could be changed to the liking of the PSP operator as a compromise on the project in the investment program.
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement can not be avoided.

Identification

Sub-Activity Name	Install Mataheko primary substation with interconnecting sub-transmission links and medium voltage offloading circuits
Activity	Technical Losses Reduction
Region(s)	Accra
Foundational	No
Sub-Activity Dependency	ECG-Service-04: 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. The primary substations currently serving the greater Accra region will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the newly installed BSP, a primary substation will be installed at Mataheko. Before the energy injected by the BSP can be used by most loads (consumers) in Accra, voltage has to be transformed to bring it to a level that can be consumed by standard electric equipment. The voltage transformation occurs at the primary substation, where the voltage is stepped down to 11 kV levels. The new substation will also help reduce technical losses and avoid extended outages caused by failures or maximum capacity reached at geographically adjacent substations.

Implementation. A contractor will be hired to procure and build a substation that conform to ECG's standard substation design. This will include the construction of a new 33/11 kV 2x20/26 MVA substation to meet forecasted load. The typical primary substation in the Accra region has two matched transformers, a switch yard, capacitor banks and a control house within the fenced perimeter of the substation. It also includes lines for the incoming sub-transmission feeders and outgoing feeders that extend for distances ranging from 500 m to multiple km to a point where they connect with existing ECG substitutions or lines.

Metrics

Investment	$ 10,415,000	**Financial Rate of Return (IRR)**	32%
Net Present Value (NPV)	$ 19,273,000	**Economic Rate of Return (ERR)**	40.2%
Yearly Operations and Maintenace	$ 78,000	**Yearly revenue from new cust.**	$ 4,867,000

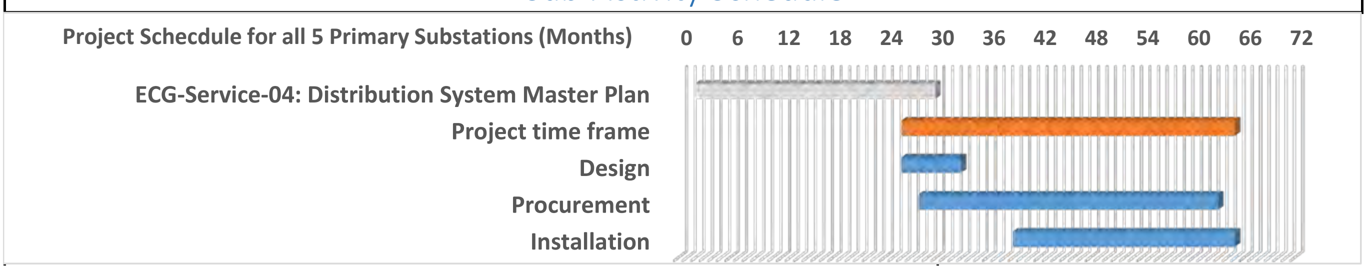
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Primary Substation	*Substation*	1	$ 647,000	$ 2,154,000	$ 2,801,000
Medium Voltage Lines UG	*km*	12	$ 261,000	$ 868,000	$ 1,129,000
Medium Voltage Lines OH	*km*	12	$ 53,000	$ 176,000	$ 229,000
Sub-Transmission Lines UG	*km*	10	$ 930,000	$ 3,100,000	$ 4,030,000
Sub-Transmission Lines OH	*km*	-	$ -	$ -	$ -
Contingency on labor	*Percentage*	10	$ 190,000	$ -	$ 190,000
Contingency on material	*Percentage*	5	$ -	$ 315,000	$ 315,000
PMC, Design & Supervision	*Percentage*	15	$ 284,000	$ 945,000	$ 1,229,000
Env/Social Mitigation	*Percentage*	1	$ 19,000	$ 63,000	$ 82,000
Resettlement	*Percentage*	5	$ 95,000	$ 315,000	$ 410,000
		Total	$ 2,479,000	$ 7,936,000	$ 10,415,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	1.0%	1,016,000	$ 98,000
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
Sub-activity is in Tranche II of the compact and cannot be funded until	Institutional	Open and constant communication between MCC, MiDA and the GoG regarding the development of the PSP activity.
PSP operator may have own views about the investment program	Institutional	Tranche II project could be changed to the liking of the PSP operator as a compromise on the project in the investment program.
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement can not be avoided.

Identification

Sub-Activity Name	Install Teshie primary substation with interconnecting sub-transmission links and medium voltage offloading circuits
Activity	Technical Losses Reduction
Region(s)	Accra
Foundational	No
Sub-Activity Dependency	ECG-Service-04: 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. The primary substations currently serving the greater Accra region will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the newly installed BSP, primary substations will be installed at Teshie. Before the energy injected by the BSP can be used by most loads (consumers) in Accra, voltage has to be transformed to bring it to a level that can be consumed by standard electric equipment. The voltage transformation occurs at the primary substation, where the voltage is stepped down to 11 kV levels. The new substation will also help reduce technical losses and avoid extended outages caused by failures or maximum capacity reached at geographically adjacent substations.

Implementation. A contractor will be hired to procure and build a substation that conform to ECG's standard substation design. This will include the construction of a new 33/11 kV 2x20/26 MVA substation to meet forecasted load. The typical primary substation in the Accra region has two matched transformers, a switch yard, capacitor banks, and a control house within the fenced perimeter of the substation. It also includes lines for the incoming sub-transmission feeders and outgoing feeders that extend for distances ranging from 500 m to multiple km to a point where they connect with existing ECG substitutions or lines.

Metrics

Investment	$ 10,415,000	**Financial Rate of Return (IRR)**	32%
Net Present Value (NPV)	$ 18,366,000	**Economic Rate of Return (ERR)**	40.0%
Yearly Operations and Maintenace	$ 78,000	**Yearly revenue from new cust.**	$ 4,867,000

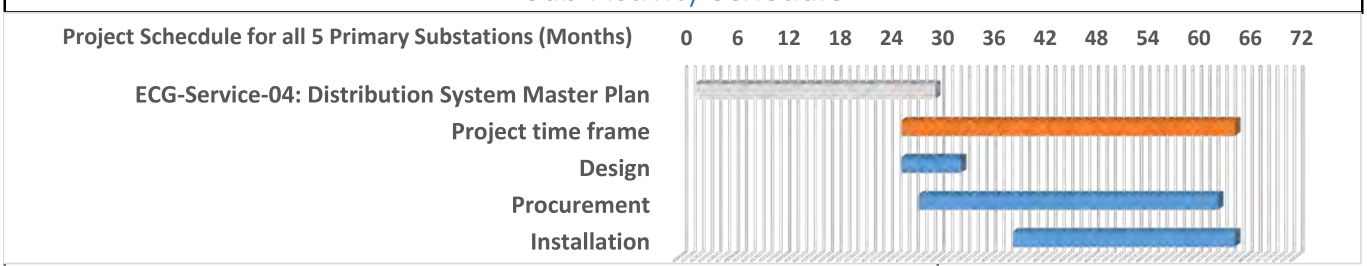
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Primary Substation	*Substation*	1	$ 647,000	$ 2,154,000	$ 2,801,000
Medium Voltage Lines UG	*km*	12	$ 261,000	$ 868,000	$ 1,129,000
Medium Voltage Lines OH	*km*	12	$ 53,000	$ 176,000	$ 229,000
Sub-Transmission Lines UG	*km*	10	$ 930,000	$ 3,100,000	$ 4,030,000
Sub-Transmission Lines OH	*km*	-	$ -	$ -	$ -
Contingency on labor	*Percentage*	10	$ 190,000	$ -	$ 190,000
Contingency on material	*Percentage*	5	$ -	$ 315,000	$ 315,000
PMC, Design & Supervision	*Percentage*	15	$ 284,000	$ 945,000	$ 1,229,000
Env/Social Mitigation	*Percentage*	1	$ 19,000	$ 63,000	$ 82,000
Resettlement	*Percentage*	5	$ 95,000	$ 315,000	$ 410,000
		Total	$ 2,479,000	$ 7,936,000	$ 10,415,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	1.0%	1,016,000	$ 98,000
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
Sub-activity is in Tranche II of the compact and cannot be funded until	Institutional	Open and constant communication between MCC, MiDA and the GoG regarding the development of the PSP activity.
PSP operator may have own views about the investment program	Institutional	Tranche II project could be changed to the liking of the PSP operator as a compromise on the project in the investment program.
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement can not be avoided.

Identification

Sub-Activity Name	Install Airport Residential Area primary substation with interconnecting sub-transmission links and medium voltage offloading circuits
Activity	Technical Losses Reduction
Region(s)	Accra
Foundational	No
Sub-Activity Dependency	ECG-Service-04: 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. The primary substations currently serving the greater Accra region will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the newly installed BSP, a primary substation will be installed at the Airport Residential Area. Before the energy injected by the BSP can be used by most loads (consumers) in Accra, voltage has to be transformed to bring it to a level that can be consumed by standard electric equipment. The voltage transformation occurs at the primary substation, where the voltage is stepped down to 11 kV levels. The new substation will also help reduce technical losses and avoid extended outages caused by failures or maximum capacity reached at geographically adjacent substations.

Implementation. A contractor will be hired to procure and build a substation that conform to ECG's standard substation design. This will include the construction of a new 33/11 kV 2x20/26 MVA substation to meet forecasted load. The typical primary substation in the Accra region has two matched transformers, a switch yard, capacitor banks and a control house within the fenced perimeter of the substation. It also includes lines for the incoming sub-transmission feeders and outgoing feeders that extend for distances ranging from 500 m to multiple km to a point where they connect with existing ECG substitutions or lines.

Metrics

Investment	$ 10,415,000	**Financial Rate of Return (IRR)**	32%
Net Present Value (NPV)	$ 18,366,000	**Economic Rate of Return (ERR)**	41.3%
Yearly Operations and Maintenace	$ 78,000	**Yearly revenue from new cust.**	$ 4,867,000

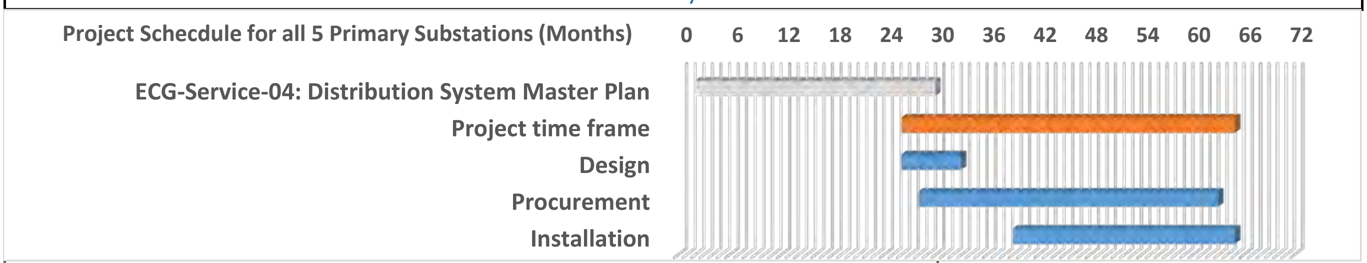
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Primary Substation	*Substation*	1	$ 647,000	$ 2,154,000	$ 2,801,000
Medium Voltage Lines UG	*km*	12	$ 261,000	$ 868,000	$ 1,129,000
Medium Voltage Lines OH	*km*	12	$ 53,000	$ 176,000	$ 229,000
Sub-Transmission Lines UG	*km*	10	$ 930,000	$ 3,100,000	$ 4,030,000
Sub-Transmission Lines OH	*km*	-	$ -	$ -	$ -
Contingency on labor	*Percentage*	10	$ 190,000	$ -	$ 190,000
Contingency on material	*Percentage*	5	$ -	$ 315,000	$ 315,000
PMC, Design & Supervision	*Percentage*	15	$ 284,000	$ 945,000	$ 1,229,000
Env/Social Mitigation	*Percentage*	1	$ 19,000	$ 63,000	$ 82,000
Resettlement	*Percentage*	5	$ 95,000	$ 315,000	$ 410,000
		Total	$ 2,479,000	$ 7,936,000	$ 10,415,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	1.0%	1,016,000	$ 98,000
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
Sub-activity is in Tranche II of the compact and cannot be funded until	Institutional	Open and constant communication between MCC, MiDA and the GoG regarding the development of the PSP activity.
PSP operator may have own views about the investment program	Institutional	Tranche II project could be changed to the liking of the PSP operator as a compromise on the project in the investment program.
Resettlement	Social	Minimize need for resettlement through facility siting and design, ensure appropriate compensation is paid in a timely manner when resettlement can not be avoided.

Identification

Sub-Activity Name	Low voltage (LV) feeder bifurcation with medium voltage (MV) upgrade
Activity	Technical Losses Reduction
Region(s)	Accra
Foundational	No
Sub-Activity Dependency	ECG-Engr-01: Distribution system survey, GIS system development, and customer census
Project Source	GEC loss Study

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. 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 Accra has been reported to be between 1:3 and 1:5 (GEC 2012). LV lengths will be customized for ECG from the sub activity (Engr-42) to improve service quality and reliability while lowering technical losses.

When LV lines are long (such as in Accra) 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 network drops below allowable standards for quality of service to the customer. The purpose of this project is to reduce the length of the 440 volt (LV) circuits (segmenting a large circuits into multiple smaller ones) to ensure that the 440 volt trunk lines do not exceed a length that affects the quality of service to the customer and a technical loss target from the KPIs.

Implementation. ECG will design the line bifurcation upgrades based on new distribution design standards prepared under Sub-Activity Engr-42. A contractor will be hired to construct and improve the power system based on these new standards. The scope of work includes extending the 11 kV overhead (MV) lines, replacing the poles currently carrying LV lines with taller poles, and installing additional transformers. It is assumed that 25 percent of the LV lines will be replaced with MV lines and LV installed under the MV lines. The final length of the line will be determined after the GIS sub-activity (Engr-01) and associated engineering analysis is completed and a detailed design is completed for each LV network.

Metrics

Investment	$ 49,389,000	**Financial Rate of Return (IRR)**	18%
Net Present Value (NPV)	$ 25,440,000	**Economic Rate of Return (ERR)**	32.0%
Yearly Operations and Maintenace	$ 367,000	**Yearly revenue from new cust.**	$ -

ECG-Engr-36: Low voltage (LV) feeder bifurcation with medium voltage (MV) upgrade

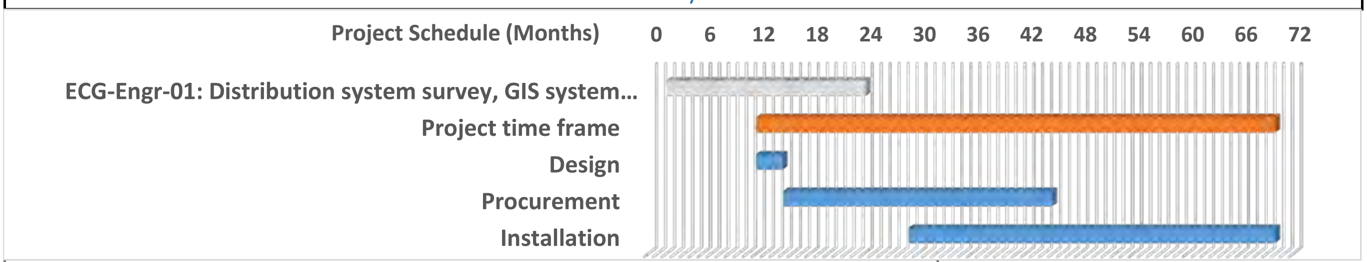
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Medium Voltage Lines	*km*	436	$ 1,007,000	$ 3,356,000	$ 4,363,000
Low Voltage Lines	*km*	5,967	$ 368,000	$ 1,226,000	$ 1,594,000
Transformers structures	*Transformers*	3,005	$ 6,935,000	$ 23,116,000	$ 30,051,000
Contingency on labor	*Percentage*	10	$ 831,000	$ -	$ 831,000
Contingency on material	*Percentage*	5	$ -	$ 1,385,000	$ 1,385,000
PMC, Design & Supervision	*Percentage*	15	$ 1,247,000	$ 4,155,000	$ 5,402,000
Env/Social Mitigation	*Percentage*	1	$ 84,000	$ 277,000	$ 361,000
Resettlement	*Percentage*	15	$ 1,247,000	$ 4,155,000	$ 5,402,000
		Total	$ 11,719,000	$ 37,670,000	$ 49,389,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	82.0%	83,322,000	$ 8,051,000
Commercial loss	20.0%	24,633,000	$ 4,023,000
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 into existing business practices	Institutional	Ensure that the technical advisors are engaged in the implementation and integration of the new system into the work procedures. The technical advisor shall also be responsible for reporting 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 can not be avoided.

Identification

Sub-Activity Name	Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion
Activity	Outages Reduction
Region(s)	Accra
Foundational	Yes
Sub-Activity Dependency	ECG-Engr-01: Distribution system survey, GIS system development, and customer census
Project Source	GEC loss Study

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 severly reduce the amount of unrealized or lost revenue.

Sub-Activity Description

Intervention. System outages are affecting larger areas and more and more consumers. ECG's current protection standards are basic and use only a breaker at the substation and fuses at the transformer. When a fault occurs, all of the customers on the feeder are out of power. One or two sectionalizers along the feeder can reduce the number of affected customers to a smaller number. Furthermore a sectionalizer will help crews find the trouble spot more quickly and subsequently reduce outage time. Historically, ECG has employed limited sectionalizing on its MV lines; rather, the ECG approach has been to install costly switching stations to split 33 kV sub-transmission lines into 33 kV distribution lines.
ECG has recently piloted automation on its lines and has successfully demonstrated adoption of sectionalizing devices on certain lines. A properly sectionalized distribution network will ensure that outages at the end of the lines and on a side tap do not trip the breaker at the substation and take out the entire line, thereby 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 the Accra network. The study results will be used to locate reclosers, switches, and other sectionalizing devices in the 11 kV network.
A contractor will be hired to implement the recommendations of the sectionalizing study in accordance with ECG specifications and standards. We assume that each feeder will require one recloser and four sectionalizers. All reclosers and sectionalizers will then be interconnected to the existing SCADA system for monitoring and remote operation. In addition, inline fuses will be installed as indicated by the study.

Metrics

Investment	$ 6,392,000	**Financial Rate of Return (IRR)**	14%
Net Present Value (NPV)	$ 1,012,000	**Economic Rate of Return (ERR)**	7.3%

Yearly Operations and Maintenace	$ 48,000	**Yearly revenue from new cust.**	$ -

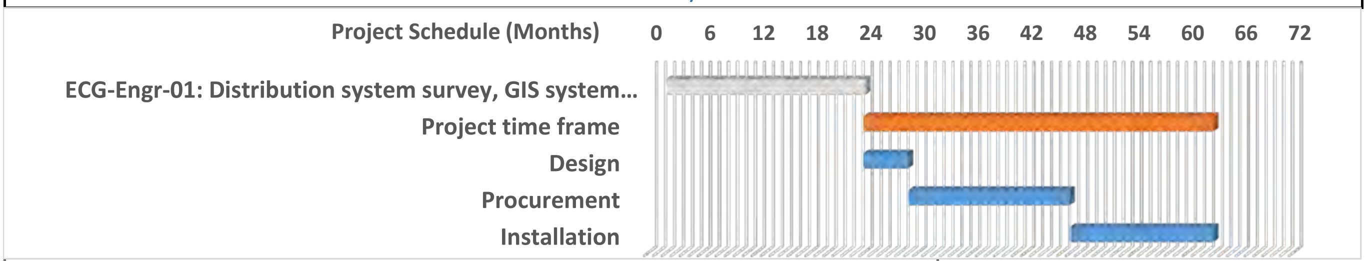
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Accra Sectionalizing study	*Work Days*	33	$ 42,000	$ -	$ 42,000
Feeder sectionalizing and automation	*Feeders*	83	$ 1,158,000	$ 3,860,000	$ 5,018,000
SCADA integration	*Work Days*	132	$ 165,000	$ -	$ 165,000
Contingency on labor	*Percentage*	10	$ 137,000	$ -	$ 137,000
Contingency on material	*Percentage*	5	$ -	$ 193,000	$ 193,000
PMC, Design & Supervision	*Percentage*	15	$ 205,000	$ 579,000	$ 784,000
Env/Social Mitigation	*Percentage*	1	$ 14,000	$ 39,000	$ 53,000
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 1,721,000	$ 4,671,000	$ 6,392,000

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	59.0%		$ 1,065,000

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration of new systems and work methods into existing business practices	Institutional	Ensure that the technical advisors are engaged in the implementation and integration of the new system into the work procedures. The technical advisor shall also be responsible for reporting any deviation from the updated work procedures
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 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	Update distribution construction standards based on current low loss practices
Activity	Technical Losses Reduction
Region(s)	Accra
Foundational	Yes
Sub-Activity Dependency	ECG-Engr-01: Distribution system survey, GIS system development, and customer census
Project Source	GEC loss Study

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. ECG currently has an engineering and construction standard that dates from 1998. Some of the standard specifications need to be updated (for example, move from open wire LV to multiplex LV cable, to reduce illegal connections).

Implementation. Under this sub-activity, a contractor will be hired to conduct a complete review of the engineering and construction standards used by ECG and to draft updated standards to ensure compliance with international best practice for low loss and economical designs.
The contractor will conduct training for project engineers, designers and planners at ECG on the updated material. Enforcement is anticipated to be the responsibility of ECG management. During construction the Project Engineers will ensure that standards are adhered to.

Metrics

Investment	$ 256,000	**Financial Rate of Return (IRR)**	45%
Net Present Value (NPV)	$ 777,000	**Economic Rate of Return (ERR)**	31.0%
Yearly Operations and Maintenace	$ 2,000	**Yearly revenue from new cust.**	$ -

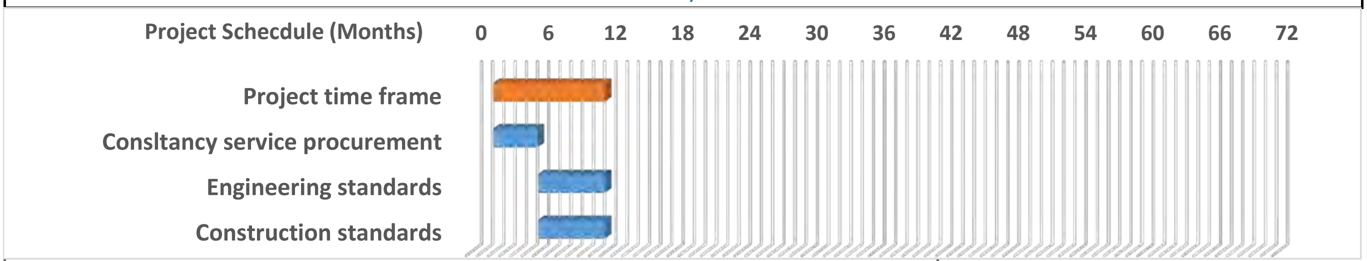
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Engineering standards	*Work Days*	363	$ 102,000	$ -	$ 102,000
Construction standards	*Work Days*	363	$ 102,000	$ -	$ 102,000
Contingency on labor	*Percentage*	10	$ 21,000	$ -	$ 21,000
Contingency on material	*Percentage*	5	$ -	$ -	$ -
PMC, Design & Supervision	*Percentage*	15	$ 31,000	$ -	$ 31,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 256,000	$ -	$ 256,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.5%	508,000	$ 49,000
Commercial loss	0.5%	616,000	$ 101,000
Collection efficiency	0.0%	-	$ -
Outages	0.0%		$ -

Sub-Activity Schedule



Risk Assessment & Mitigation Strategy

Description	Type	Mitigation
Integration of new systems and work methods into existing business practices	Institutional	Ensure that the technical advisors are engaged in the implementation and integration of the new system into the work procedures. The technical advisor shall also be responsible for reporting any deviation
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. Develop strong qualifications statement and ensure

Identification

Sub-Activity Name	Outage management system
Activity	Outages Reduction
Region(s)	Accra
Foundational	Yes
Sub-Activity Dependency	ECG-Engr-01: Distribution system survey, GIS system development, and customer census
Project Source	GEC loss Study

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 severly reduce the amount of unrealized or lost revenue.

Sub-Activity Description

Intervention. ECG needs a computer-based outage management system (OMS), which is a foundational requirement for a modern utility. Currently, the ECG customer call center receives trouble calls, which are recorded into an Excel database and are not tied to the existing CIS nor to the SCADA system. The call center subsequently dispatches repair crews to the affected area for investigations and possible repairs as needed.

An OMS is used to monitor and to quickly and effectively respond to outages without relying on consumer reporting. The predictive capabilities of the OMS allow for preliminary identification of the location of the outage and is based on the system configuration from the GIS data (Engr-01) and the Indra CIS. The call center assists the dispatched repair crews on the proper course of action in the field. One feature of the OMS that is of particular value is the linkage to the GIS database allows for prioritization efforts, for instance if there is a hospital that is affected by the outage then the repair crews know in advance where to focus their efforts. The OMS is also an effective tool for estimating the size of the repair crew to dispatch, conserving resources for the utility. Once the repair crew restores service, the OMS platform is used for recording the duration of the outage, the cause, and the remedy. Implementation of an OMS will also vastly improve ECG's capacity to evaluate SAIDI and SAIFI metrics due to significant improvements in the quality of outage data that will be directly recorded and interconnected with the GIS and CIS.

Implementation. Under this sub-activity, a contractor will be hired to procure and install an OMS in Accra. This system will be integrated with the call center, GIS, Indra CIS, and SCADA. The OMS will be able to identify outage locations and causes, thereby reducing outage frequencies and durations. Also under this activity, an improved call center software module will be procured and the call center staff will be trained in its use. ECG linemen will be trained on outage restoration practices using bucket trucks acquired as part of this sub-activity and equipment.

Metrics

Investment	$ 2,132,000	**Financial Rate of Return (IRR)**	16%
Net Present Value (NPV)	$ 679,000	**Economic Rate of Return (ERR)**	n/a

Yearly Operations and Maintenace	$ 41,000	**Yearly revenue from new cust.**	$ -

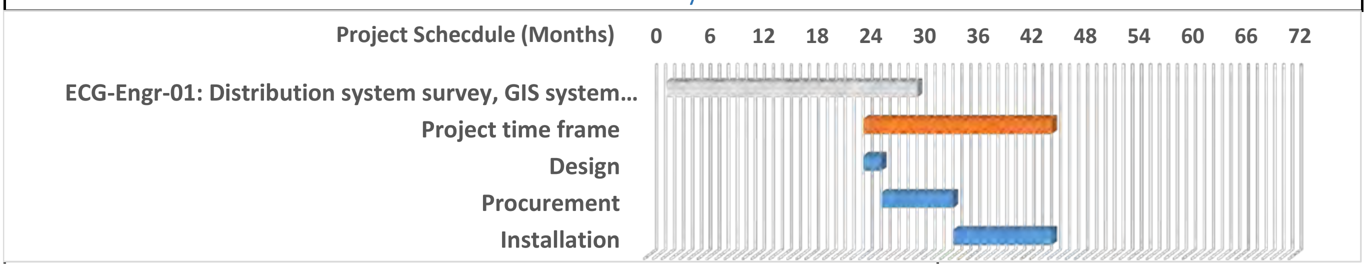
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
OMS Software and Hardware	*Users*	8	$ 22,000	$ 180,000	$ 202,000
OMS Training	*Workd Days*	22	$ 28,000	$ -	$ 28,000
OMS, GIS, CMS, SCADA integration	*Work Days*	132	$ 165,000	$ -	$ 165,000
Troublement trucks and tools	*Equipped trucks*	9	$ -	$ 1,170,000	$ 1,170,000
Lineman training	*Word Days*	132	$ 165,000	$ -	$ 165,000
Call Center Training	*Word Days*	22	$ 28,000	$ -	$ 28,000
Contingency on labor	*Percentage*	10	$ 41,000	$ -	$ 41,000
Contingency on material	*Percentage*	5	$ -	$ 68,000	$ 68,000
PMC, Design & Supervision	*Percentage*	15	$ 62,000	$ 203,000	$ 265,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 511,000	$ 1,621,000	$ 2,132,000

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	25.0%		$ 451,000

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 into existing business practices	Institutional	Ensure that the technical advisors are engaged in the implementation and integration of the new system into the work procedures. The technical advisor shall also be responsible for reporting any deviation
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. Develop strong qualifications statement and ensure

Identification

Sub-Activity Name	Data center and communication network
Activity	Institutional Support
Region(s)	Accra
Foundational	Yes
Sub-Activity Dependency	None
Project Source	GEC loss 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. ECG plans to install many systems that require enhanced data center services, including a decentralized 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 difficult to maintain. ECG expects to have access to fiber optic lines from a third party who is installing the lines on ECG poles and to use them to connect offices on the WAN.

Implementation. A contractor will be hired to create a detailed design based on the ECG ICT department technology roadmap and the WIPRO report. Another contractor will be hired to refurbish existing space to house an improved and expanded data center for Accra regions. The data center will feature climate control, access control, backup power, and fire suppression, and will be built to accommodate future growth and expansion of the ICT system. Initially, a limited number of servers will be installed. The space will prepared to accommodate additional servers envisioned by the ECG ICT team for various systems to be installed or migrated later. This sub-activity will connect the existing network to the data center and will upgrade the LAN in all the ECG offices in Accra. The currently used WAN connections will also be evaluated during detailed design. For high-priority nodes (regional offices), a redundant connection will be installed if one does not exist.

Metrics

Investment	$ 1,760,000	**Financial Rate of Return (IRR)**		96%
Net Present Value (NPV)	$ 12,790,000	**Economic Rate of Return (ERR)**		7.3%
Yearly Operations and Maintenace	$ 14,000	**Yearly revenue from new cust.**	$	-

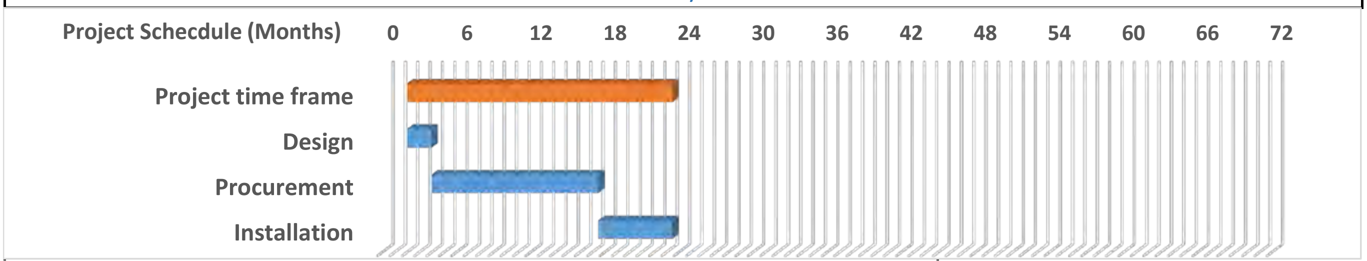
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Data Center	Data Center	1	$ 105,000	$ 700,000	$ 805,000
LAN and WLAN	Systems	5	$ 150,000	$ 500,000	$ 650,000
Contingency on labor	*Percentage*	10	$ 26,000	$ -	$ 26,000
Contingency on material	*Percentage*	5	$ -	$ 60,000	$ 60,000
PMC, Design & Supervision	*Percentage*	15	$ 39,000	$ 180,000	$ 219,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 320,000	$ 1,440,000	$ 1,760,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	3.0%	3,695,000	$ 603,000
Collection efficiency	3.0%	7,064,000	$ 1,154,000
Outages	10.0%		$ 181,000

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. Develop strong qualifications statement and ensure

Identification

Sub-Activity Name	Installation of ERP system and integration with existing enterprise applications
Activity	Institutional Support
Region(s)	Accra
Foundational	Yes
Sub-Activity Dependency	ECG-Ict-01: Data center and communication network
Project Source	GEC loss 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.
ECG currently uses individual applications with disconnected regional databases in many of its business applications. The current ECG practice leads to inefficiencies and poor data availability and quality, which can result in compromised decision making. WIPRO conducted an analysis of the ECG enterprise and created a roadmap to deploy an ERP for ECG.

Implementation. A contactor will be hired to finalize the ERP specification. Another contractor will be hired to procure and install the ERP system to integrate and/or replace selected standalone business software applications, including general ledger, customer information database, billing, human resources, payroll, and others. The ERP will need to be able to integrate with the new Indra CIS the GIS, OMS, and other applications.

Metrics

Investment	$	4,838,000	**Financial Rate of Return (IRR)**	66%
Net Present Value (NPV)	$	24,709,000	**Economic Rate of Return (ERR)**	53.1%
Yearly Operations and Maintenace	$	136,000	**Yearly revenue from new cust.**	$ -

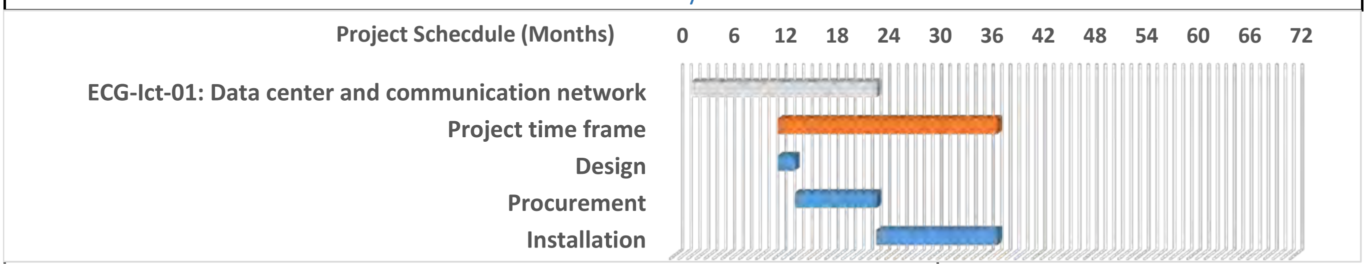
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
ERP System	*System*	1	$ -	$ 3,000,000	$ 3,000,000
ERP System integration	*Workd 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	3.0%	3,695,000	$ 603,000
Collection efficiency	10.0%	23,548,000	$ 3,845,000
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 into existing business practices	Institutional	Ensure that the technical advisors are engaged in the implementation and integration of the new system into the work procedures. The technical advisor shall also be responsible for reporting any deviation
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. Develop strong qualifications statement and ensure

Identification

Sub-Activity Name	Technical Assistance Program
Activity	Institutional Support
Region(s)	Accra
Foundational	Yes
Sub-Activity Dependency	None
Project Source	GEC loss 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. ECG 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 establish linkages between the ECG departments needed to coordinate projects and to establish the policies, practices, and procedures required to reduce technical losses, commercial losses, and outages, and improve collections and quality of service.

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:

1. Senior advisor for program direction and monitoring. Provide support to ECG senior management with coordination between engineering, commercial management, 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 ECG management and donor agencies, and will supervise the data verification process for loss reduction, revenue enhancement, and overall performance improvement.
2. Engineer technical advisor for planning and GIS implementation. This function includes training to develop and maintain geographically specific system maps with power line, transformer, and device characteristics. Once these maps and data sets are developed, the ECG team will require training to evaluate technical losses, sectionalizing characteristics and strategies, and performance improvement analyses. The training will be more effective if a planning engineer is embedded with ECG throughout implementation. It is anticipated the technical advisor will mentor multiple staff members through the various processes rather than providing incremental support through each of the different implementation requirements.
3. Commercial technical advisor to the LCU. The LCU within ECG needs to expand its scope of activities to reduce non-technical losses more effectively. It is anticipated the LCU will work with engineering planning personnel to evaluate technical losses and to systematically monitor total energy losses together with modeled technical losses as a means of identifying where non-technical losses are high. The team will require 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 a commercial specialist with practical experience in non-technical loss reduction programs, and with experience of metering systems, CIS systems, and energy/loss reporting and monitoring programs.
4. Operations technical advisor. This advisor will begin by evaluating ECG 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 sectionalization devices and improved linemen work practices.

Metrics

Investment	$ 9,900,000	**Financial Rate of Return (IRR)**	15%
Net Present Value (NPV)	$ 2,837,000	**Economic Rate of Return (ERR)**	-0.8%
Yearly Operations and Maintenace	$ -	**Yearly revenue from new cust.**	$ -

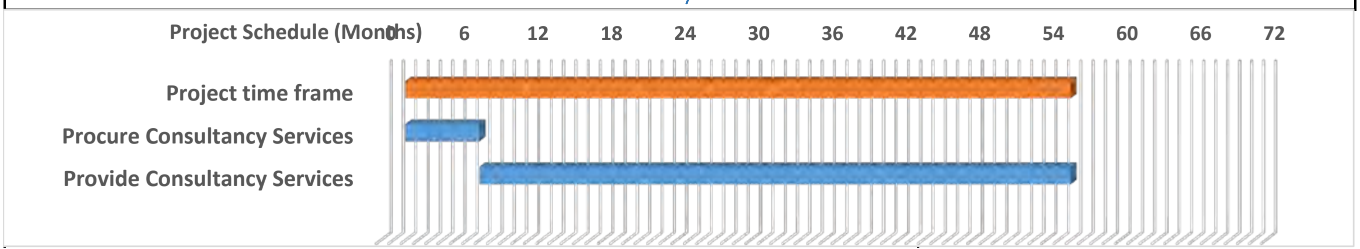
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Senior advisor for program direction and monitoring	*Worked Days*	1,056	$ 1,980,000	$ -	$ 1,980,000
Engineer technical advisor for planning and GIS implementation.	*Worked Days*	1,056	$ 1,980,000	$ -	$ 1,980,000
Commercial technical advisor to the LCU	*Worked Days*	1,056	$ 1,980,000	$ -	$ 1,980,000
Operations technical advisor	*Worked Days*	1,056	$ 1,980,000	$ -	$ 1,980,000
Contingency on labor	*Percentage*	25	$ 1,980,000	$ -	$ 1,980,000
Contingency on material	*Percentage*	5	$ -	$ -	$ -
PMC, Design & Supervision	*Percentage*	-	$ -	$ -	$ -
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 9,900,000	$ -	$ 9,900,000

Contribution to Key Performance Indicators Improvement

Indicator	Relative %	kWh / Yr	USD / Yr
Technical loss	0.0%	-	$ -
Commercial loss	2.0%	2,463,000	$ 402,000
Collection efficiency	3.0%	7,064,000	$ 1,154,000
Outages	3.0%		$ 54,000

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. Develop strong qualifications statement and ensure that procurement

Identification

Sub-Activity Name	Distribution System Master Plan
Activity	Institutional Support
Region(s)	Accra
Foundational	No
Sub-Activity Dependency	ECG-Engr-01: Distribution system survey, GIS system development, and customer census
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. The ECG distribution system master plan needs to be updated. The last plan was completed in 2008 and was based on 2007 data. Certain sub-activities need to be completed before a new master plan can be created, including population of the GIS data base and updating the load forecast (correlated to actual loads). An updated master plan will allow increased operational efficiency at ECG. The objective of the Master Plan is to evaluate the existing systems and contribute to the development of the short and long-term Capital Improvement Plan (CIP) for infrastructure capacity and facilities. The CIP, based on the Master Plans' 5-year, 10-year and "build-out" scenarios, is then implemented on an annual basis as part of the overall capital plan for ECG services.

Implementation. A contractor will be hired to update the master plan. The plan will include a roadmap for the 5-year horizon to meet 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	$ 819,000	**Financial Rate of Return (IRR)**	59%
Net Present Value (NPV)	$ 2,906,000	**Economic Rate of Return (ERR)**	98.6%
Yearly Operations and Maintenace	$ -	**Yearly revenue from new cust.**	$ 486,000

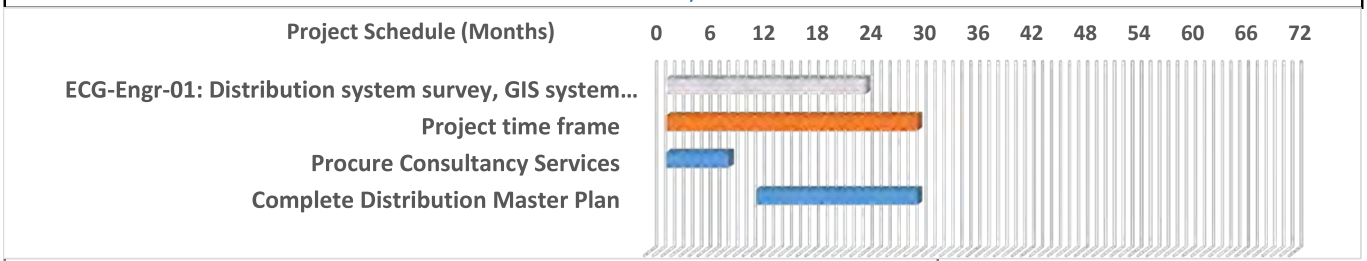
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Distribution Master Plan	*Work Days*	1,584	$ 654,000	$ -	$ 654,000
Contingency on labor	*Percentage*	10	$ 66,000	$ -	$ 66,000
Contingency on material	*Percentage*	5	$ -	$ -	$ -
PMC, Design & Supervision	*Percentage*	15	$ 99,000	$ -	$ 99,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 819,000	$ -	$ 819,000

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
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. Develop strong qualifications statement and ensure
Integration of new systems and work methods into existing business practices	Institutional	Ensure that the technical advisors are engaged in the implementation and integration of the new system into the work procedures. The technical advisor shall also be responsible for reporting any deviation

Identification

Sub-Activity Name	Assistance to the ECG training center in Tema
Activity	Institutional Support
Region(s)	Accra
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. ECG has a training center in Tema that requires support to be able to deliver services to the company

Implementation. Assistance to the ECG training center in Tema in the form of provision of training tools and development/updating of course curricula

Metrics

Investment	$ 1,000,000	**Financial Rate of Return (IRR)**	0%
Net Present Value (NPV)	$ (1,000,000)	**Economic Rate of Return (ERR)**	
Yearly Operations and Maintenace	$ -	**Yearly revenue from new cust.**	$ -

ECG-Service-05: Assistance to the ECG training center in Tema

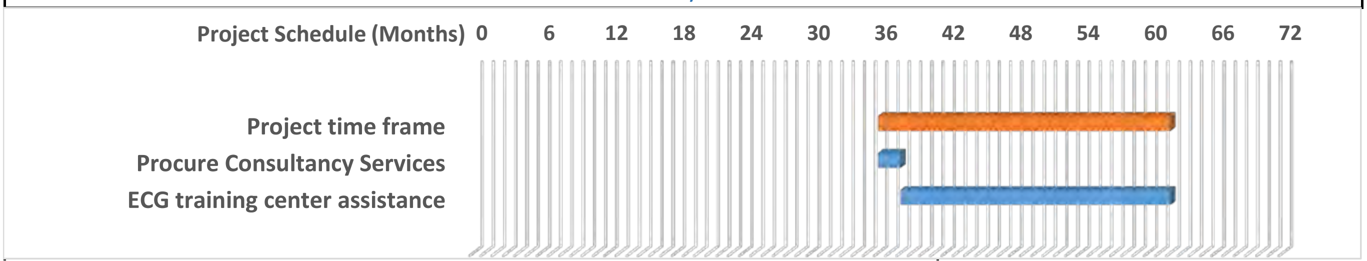
Cost Detail

Cost Elements	Unit	Qt.	Labor	Material	Total
Training Center Support	*N/A*	1	$ 405,000	$ 410,000	$ 815,000
Contingency on labor	*Percentage*	10	$ 41,000	$ -	$ 41,000
Contingency on material	*Percentage*	5	$ -	$ 21,000	$ 21,000
PMC, Design & Supervision	*Percentage*	15	$ 61,000	$ 62,000	$ 123,000
Env/Social Mitigation	*Percentage*	-	$ -	$ -	$ -
Resettlement	*Percentage*	-	$ -	$ -	$ -
		Total	$ 507,000	$ 493,000	$ 1,000,000

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

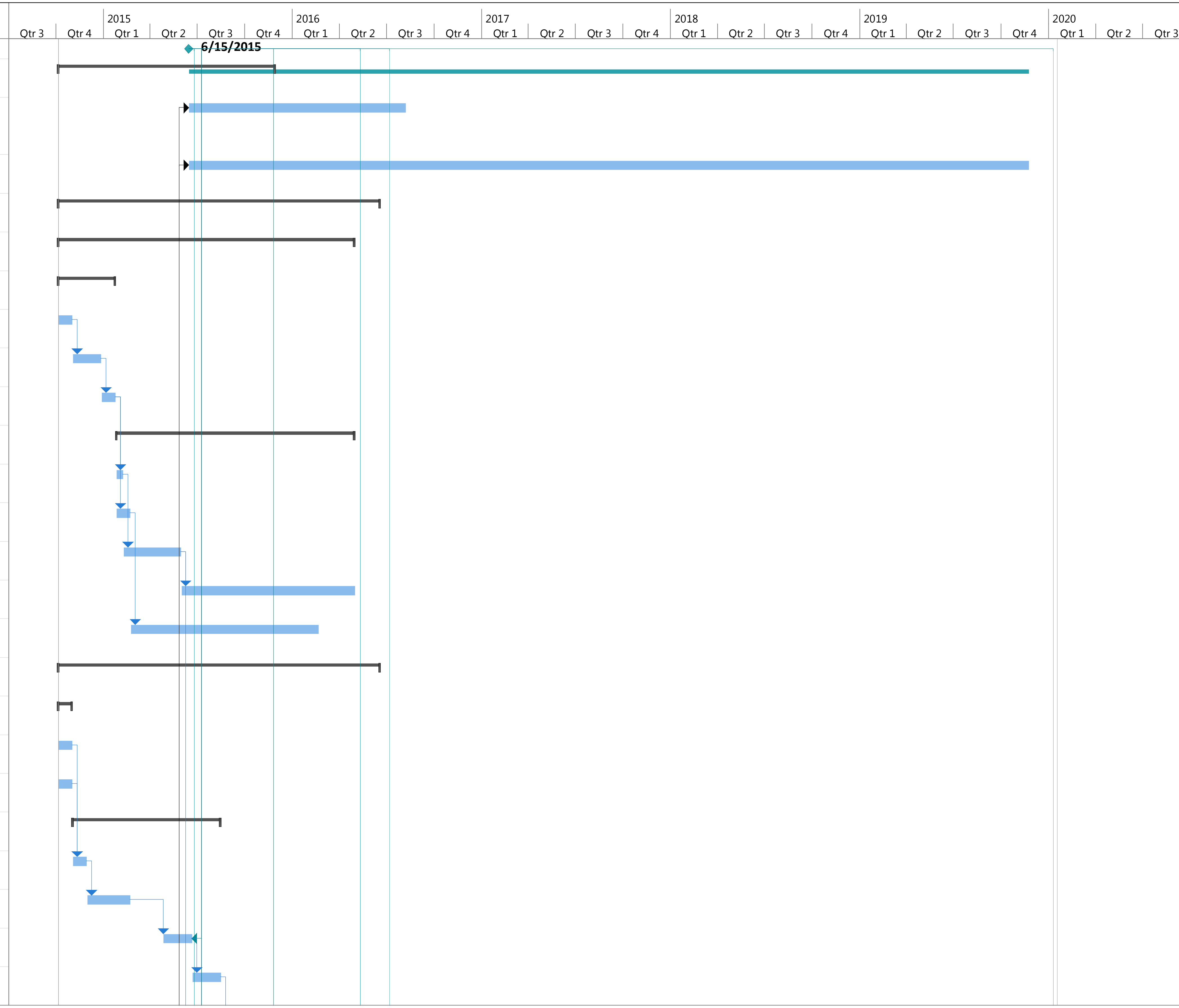
Description	Type	Mitigation
Selecting a qualified consultant who is capable of delivering the scope of the project, on time, and within budget.	Institutional	Ensure proper allocation of funds to cover the cost of expert consultants including the cost associated with there accommodations and other fringes. Develop strong qualifications statement and ensure
Sub-activity is in Tranche II of the compact and cannot be funded until	Institutional	Open and constant communication between MCC, MiDA and the GoG regarding the development of the PSP activity.
PSP operator may have own views about the investment program	Institutional	Tranche II project could be changed to the liking of the PSP operator as a compromise on the project in the investment program.
Integration of new systems and work methods into existing business practices	Institutional	Ensure that the technical advisors are engaged in the implementation and integration of the new system into the work procedures. The technical advisor shall also be responsible for reporting any deviation

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.
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 components 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 34.5/11kV 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.
33kV OH Sub-Transmission	km	$ 31,846	$ 106,154	$ 138,000	Cost based on ECG and verified by NRECA based on regional cost data
33kV UG Sub-Transmission	km	$ 93,000	$ 310,000	$ 403,000	Cost based on ECG and verified by NRECA based on regional cost data
11kV OH lines (Express feeders)	km	$ 4,385	$ 14,615	$ 19,000	Cost based on ECG and verified by NRECA based on regional cost data
11kV UG Lines (Express feeders)	km	$ 21,692	$ 72,308	$ 94,000	Cost based on ECG and verified by NRECA based on regional cost data
Distribution Transformer	Transformer	$ 2,307.69	$ 7,692	$ 10,000	Cost based on ECG and NEDCo and verified by NRECA (50 and 100 kVA 3 phases)
ABC Cable 120 mm2	km	$ 62	$ 205	$ 267	NRECA price list
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

Appendix E
ECG Work Plan

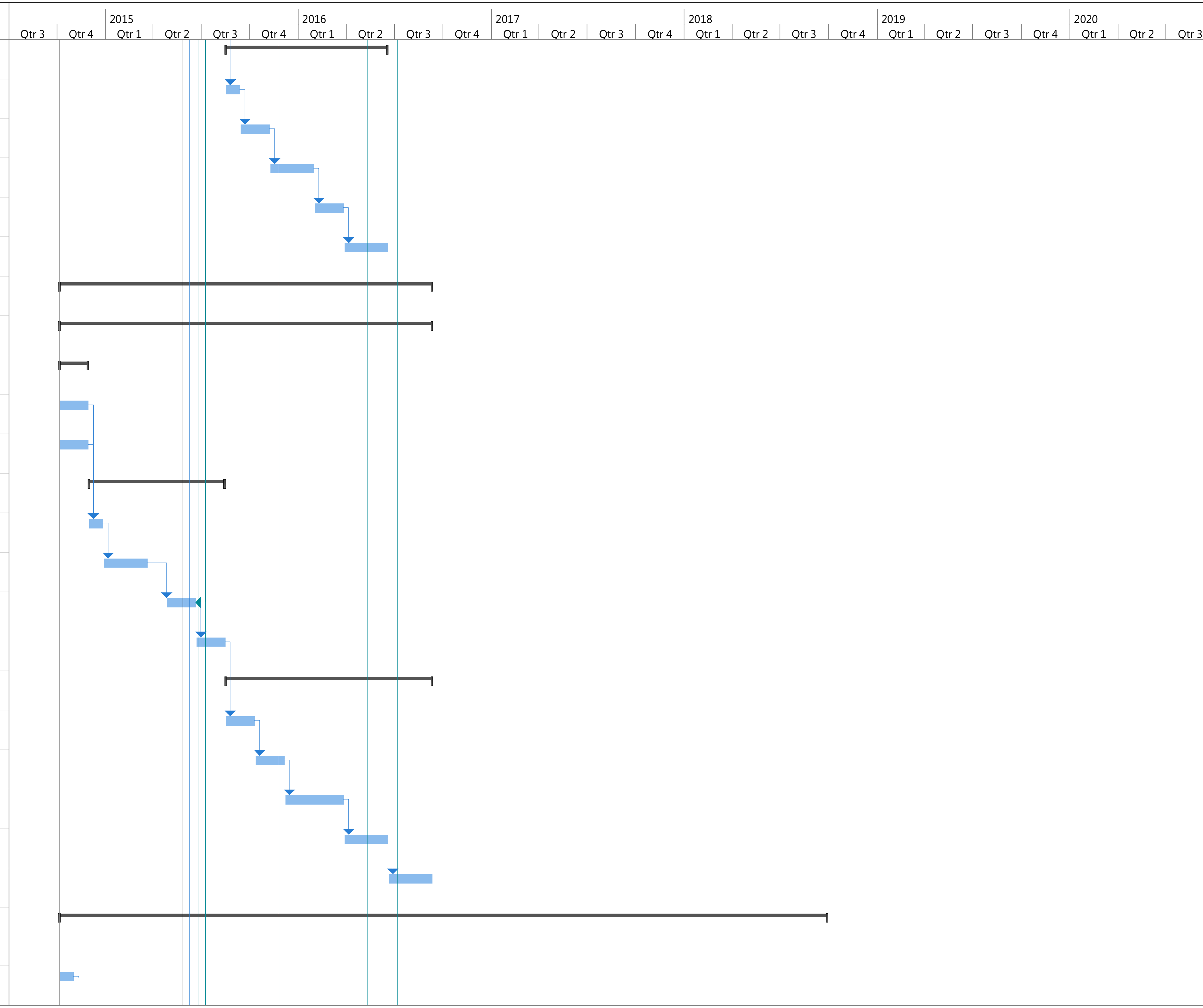
ID		Task Mode	Task Name	Duration	Start
1			Compact 5 year time clock start	0 mons	Mon 6/15/15
2			**Resettlement Action Plans (Impacting Substations, Bifercation, BulkSupply Point)**	**15 mons**	**Mon 10/6/14**
3			Field Evaluation of Proposed Activities and Public Engagement & Consulation and development of PAPs & Compensation	15 mons	Mon 6/15/15
4			Work with Land evaluation commission and conduct resettlment	58 mons	Mon 6/15/15
5			**GIS based distribution management system, grid digitization and customer census**	**22.25 mons**	**Mon 10/6/14**
6			**Grid Digitization and Customer Census (800,000 points)**	**20.5 mons**	**Mon 10/6/14**
7			**Procurement**	**4 mons**	**Mon 10/6/14**
8			Draft RFP	1 mon	Mon 10/6/14
9			Publish RFP, receive bids	2 mons	Mon 11/3/14
10			Evaluate and award	1 mon	Mon 12/29/14
11			**Conduct survey**	**16.5 mons**	**Mon 1/26/15**
12			Prepare Base Maps	0.5 mons	Mon 1/26/15
13			Build Geodatabase	1 mon	Mon 1/26/15
14			Conduct Sub-T and MV line survey	4 mons	Mon 2/9/15
15			Conduct LT lines and Consumer survey	12 mons	Mon 6/1/15
16			Populate Geodatabase	13 mons	Mon 2/23/15
17			**Install and Integrate Computer System**	**22.25 mons**	**Mon 10/6/14**
18			**Design Finalization**	**1 mon**	**Mon 10/6/14**
19			Detailed design and requirement specification	1 mon	Mon 10/6/14
20			Collection of data output and imput of all system to be integrated	1 mon	Mon 10/6/14
21			**Procurement**	**10.25 mons**	**Mon 11/3/14**
22			Draft RFP	1 mon	Mon 11/3/14
23			Publish RFP, receive bids	3 mons	Mon 12/1/14
24			Evaluate and award contracts	2 mons	Mon 4/27/15
25			Delivery of materials	2 mons	Mon 6/22/15



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	

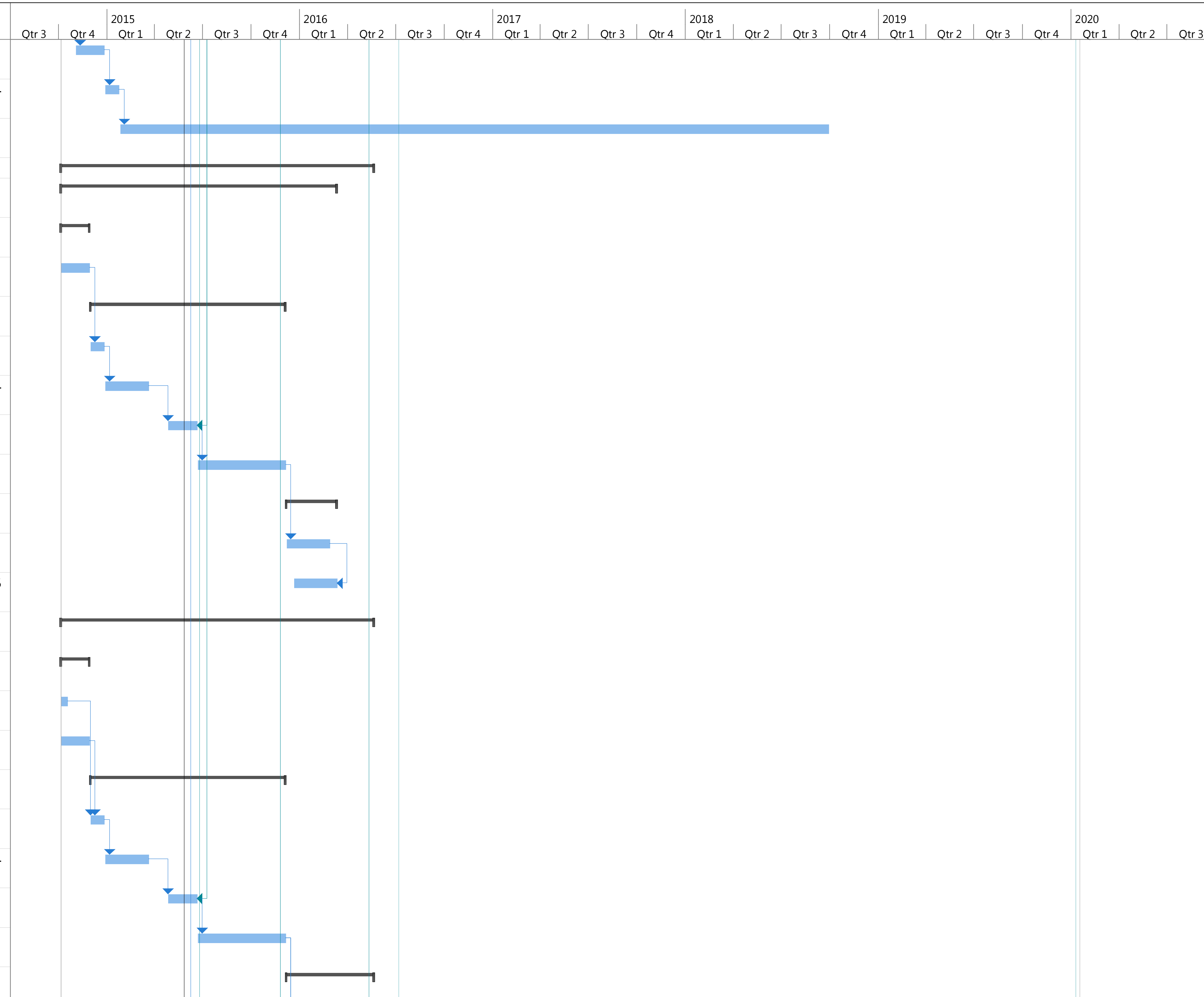
ID		Task Mode	Task Name	Duration	Start
26			**Installation**	**11 mons**	**Mon 8/17/15**
27			Installation of the system	1 mon	Mon 8/17/15
28			Integration with existing systems	2 mons	Mon 9/14/15
29			Beta testing	3 mons	Mon 11/9/15
30			Modifications based on beta testing	2 mons	Mon 2/1/16
31			Phased rollout	3 mons	Mon 3/28/16
32			**Installation of ERP system and integration with existing enterprise applications**	**25.25 mons**	**Mon 10/6/14**
33			**Install and Integrate Computer System**	**25.25 mons**	**Mon 10/6/14**
34			**Design Finalization**	**2 mons**	**Mon 10/6/14**
35			Detailed design and requirement specification	2 mons	Mon 10/6/14
36			Collection of data output and imput of all system to be integrated	2 mons	Mon 10/6/14
37			**Procurement**	**9.25 mons**	**Mon 12/1/14**
38			Draft RFP	1 mon	Mon 12/1/14
39			publish RFP, receive bids	3 mons	Mon 12/29/14
40			Evaluate and award contracts	2 mons	Mon 4/27/15
41			Delivery of materials	2 mons	Mon 6/22/15
42			**Installation**	**14 mons**	**Mon 8/17/15**
43			Installation of the system	2 mons	Mon 8/17/15
44			Integration with existing systems	2 mons	Mon 10/12/15
45			Beta testing	4 mons	Mon 12/7/15
46			Modifications based on beta testing	3 mons	Mon 3/28/16
47			Phased rollout	3 mons	Mon 6/20/16
48			**Technical assistance (management advisory services to implement new processes and practices for commercial loss reduction orientation)**	**52 mons**	**Mon 10/6/14**
49			Draft RFP	1 mon	Mon 10/6/14



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
50			Publish RFP, receive bids	2 mons	Mon 11/3/14
51			Evaluate and award contracts	1 mon	Mon 12/29/14
52			Provide consultancy services	48 mons	Mon 1/26/15
53			**Data Center and Communication Network**	**21.25 mons**	**Mon 10/6/14**
54			**Install Local Area Network**	**18.75 mons**	**Mon 10/6/14**
55			**Design Finalization**	**2 mons**	**Mon 10/6/14**
56			Detailed design and BOM Preparation	2 mons	Mon 10/6/14
57			**Procurement**	**13.25 mons**	**Mon 12/1/14**
58			Draft RFP	1 mon	Mon 12/1/14
59			Publish RFP, receive bids	3 mons	Mon 12/29/14
60			Evaluate and award contract	2 mons	Mon 4/27/15
61			Delivery of Material	6 mons	Mon 6/22/15
62			**Installation**	**3.5 mons**	**Mon 12/7/15**
63			Installation of LAN	3 mons	Mon 12/7/15
64			Testing and commisioning	3 mons	Mon 12/21/15
65			**Install Data center**	**21.25 mons**	**Mon 10/6/14**
66			**Design Finalization**	**2 mons**	**Mon 10/6/14**
67			ESI review	0.5 mons	Mon 10/6/14
68			Detailed design and BOM Preparation	2 mons	Mon 10/6/14
69			**Procurement**	**13.25 mons**	**Mon 12/1/14**
70			Draft RFP	1 mon	Mon 12/1/14
71			Publish RFP, receive bids	3 mons	Mon 12/29/14
72			Evaluate and award contract	2 mons	Mon 4/27/15
73			Delivery of Material	6 mons	Mon 6/22/15
74			**Installation**	**6 mons**	**Mon 12/7/15**



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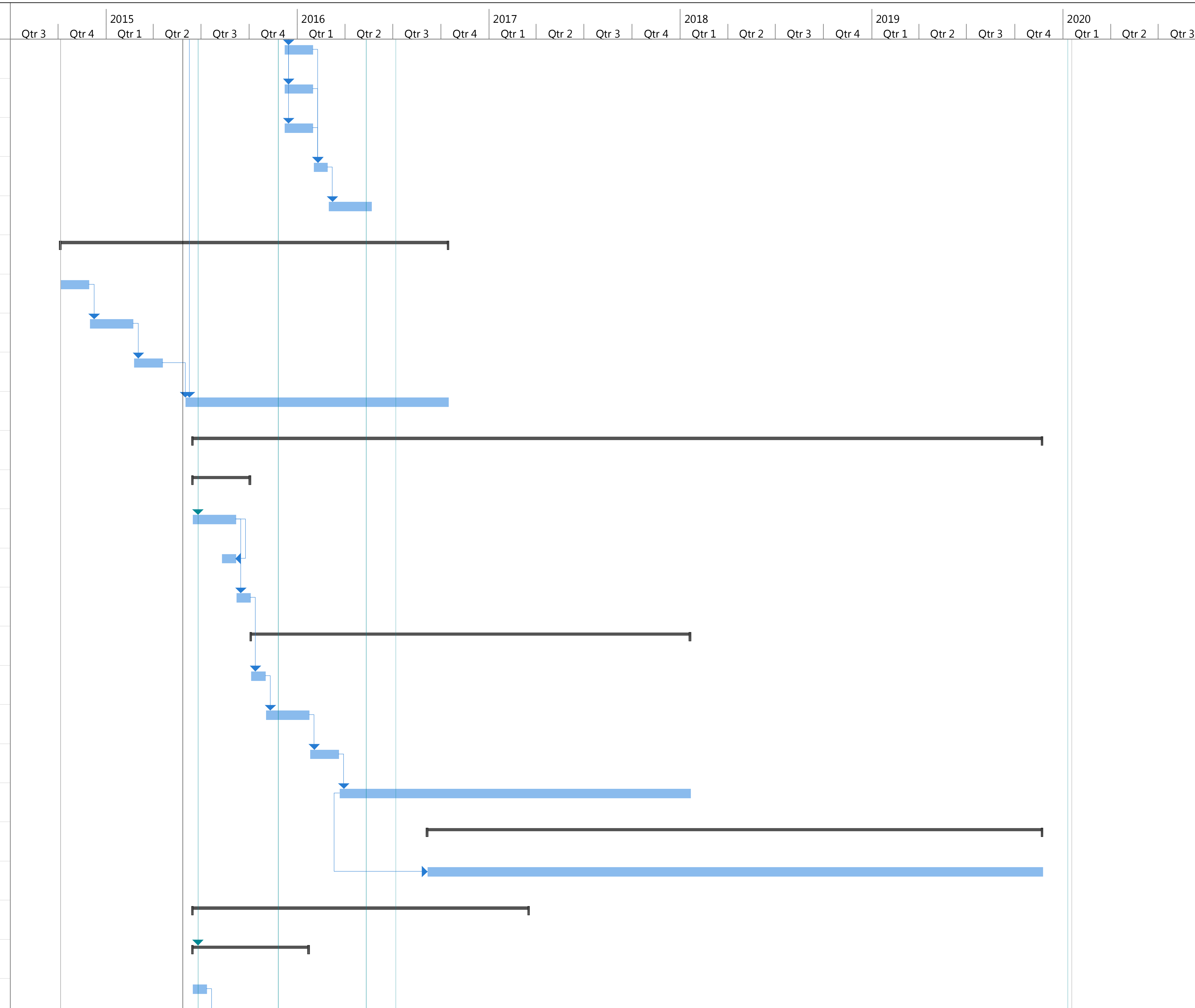
Date: Wed 5/28/14

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	

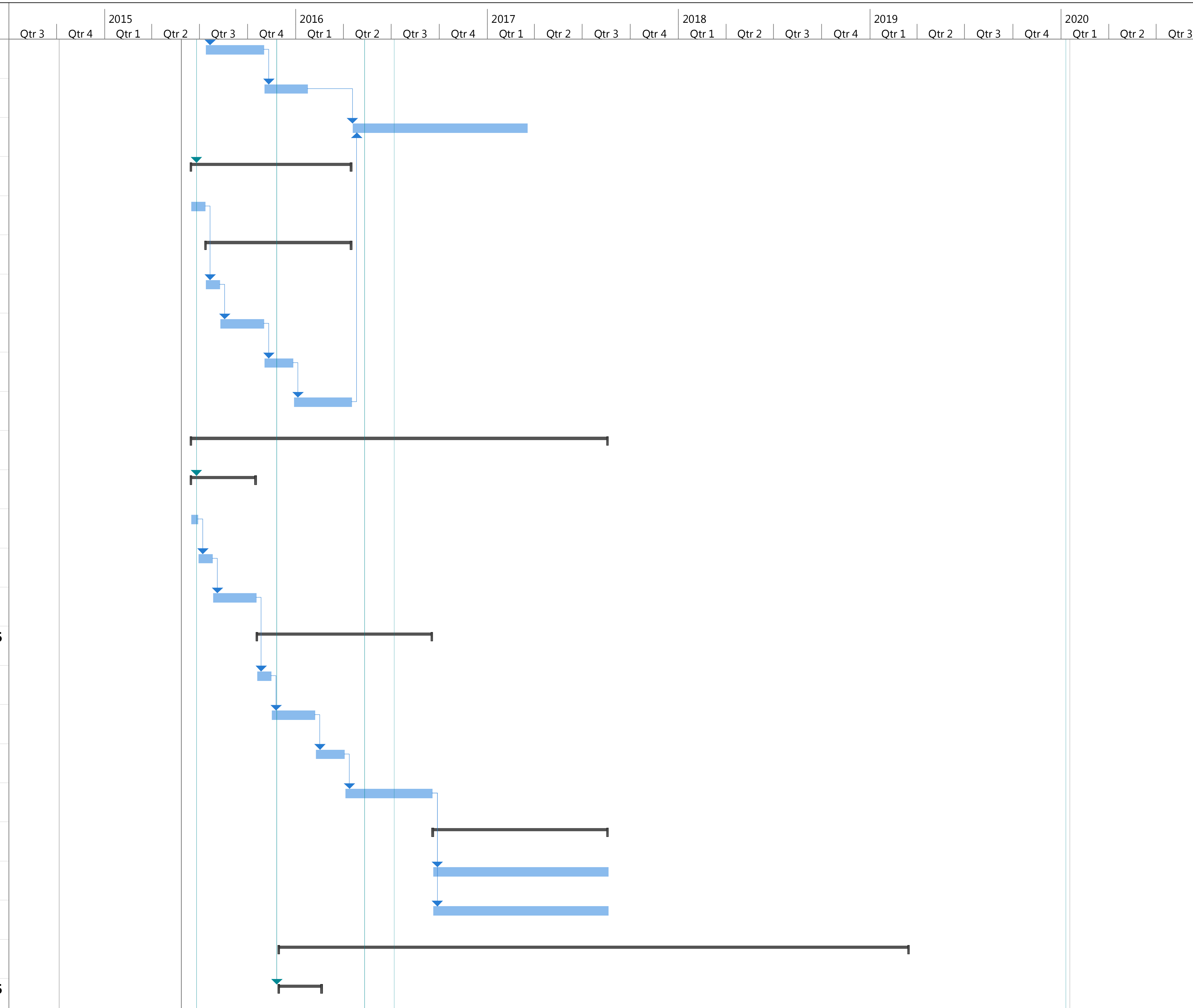
ID		Task Mode	Task Name	Duration	Start
75			Room preparation	2 mons	Mon 12/7/15
76			Back up power installtion	2 mons	Mon 12/7/15
77			Comunication installtion	2 mons	Mon 12/7/15
78			Server racking system installtion	1 mon	Mon 2/1/16
79			Migrtion of exisitn server to the data center	3 mons	Mon 2/29/16
80			**Distribution Master Plan (short & Long Term capital improvements)**	**26.5 mons**	**Mon 10/6/14**
81			Draft RFP	2 mons	Mon 10/6/14
82			Publish RFP, receive bids	3 mons	Mon 12/1/14
83			Evaluate and award contracts	2 mons	Mon 2/23/15
84			Distribution Master Plan	18 mons	Mon 6/1/15
85			**Service connection standards and normalization of customer connections**	**58 mons**	**Mon 6/15/15**
86			**Design Finalization**	**4 mons**	**Mon 6/15/15**
87			Develop service connection standards	3 mons	Mon 6/15/15
88			Environmental and Social Impact Review	1 mon	Mon 8/10/15
89			Detailed Design and BOM Preparation	1 mon	Mon 9/7/15
90			**Procurement**	**30 mons**	**Mon 10/5/15**
91			Draft RFPs	1 mon	Mon 10/5/15
92			Publish RFPs, receive bids	3 mons	Mon 11/2/15
93			Evaluate and award contracts	2 mons	Mon 1/25/16
94			Delivery of materials	24 mons	Mon 3/21/16
95			**Installation**	**42 mons**	**Mon 9/5/16**
96			Service Connection Normalization	42 mons	Mon 9/5/16
97			**Loss Control Units Strengthening (within Energy Loss Control Center)**	**23 mons**	**Mon 6/15/15**
98			**Consultancy procurement**	**8 mons**	**Mon 6/15/15**
99			Draft RFP	1 mon	Mon 6/15/15



Project: Activity_Gant_Chart
Date: Wed 5/28/14

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

ID		Task Mode	Task Name	Duration	Start
100			Publish RFP, receive bids	4 mons	Mon 7/13/15
101			Evaluate and award contracts	3 mons	Mon 11/2/15
102			Provide LC consultancy and training services	12 mons	Mon 4/18/16
103			**Material Procurement**	**11 mons**	**Mon 6/15/15**
104			Specification Finalization	1 mon	Mon 6/15/15
105			**Procurement**	**10 mons**	**Mon 7/13/15**
106			Draft RFP	1 mon	Mon 7/13/15
107			Publish RFP, receive bids	3 mons	Mon 8/10/15
108			Evaluate and award contract	2 mons	Mon 11/2/15
109			Delivery of material	4 mons	Mon 12/28/15
110			**Installation of meters at critical distribution network nodes**	**28.5 mons**	**Mon 6/15/15**
111			**Design Finalization**	**4.5 mons**	**Mon 6/15/15**
112			Metering points selection	0.5 mons	Mon 6/15/15
113			ESI review	1 mon	Mon 6/29/15
114			Detailed Design and BOM Preparation	3 mons	Mon 7/27/15
115			**Procurement**	**12 mons**	**Mon 10/19/15**
116			Draft RFP	1 mon	Mon 10/19/15
117			Publish RFP, receive bids	3 mons	Mon 11/16/15
118			Evaluate and award contract	2 mons	Mon 2/8/16
119			Delivery of Material	6 mons	Mon 4/4/16
120			**Installation**	**12 mons**	**Mon 9/19/16**
121			Install meters on distribution transformers	12 mons	Mon 9/19/16
122			Install meters at MV nodes	12 mons	Mon 9/19/16
123			**Replacement of legacy meters with prepayment meters**	**43 mons**	**Mon 11/30/15**
124			**Design Finalization**	**3 mons**	**Mon 11/30/15**



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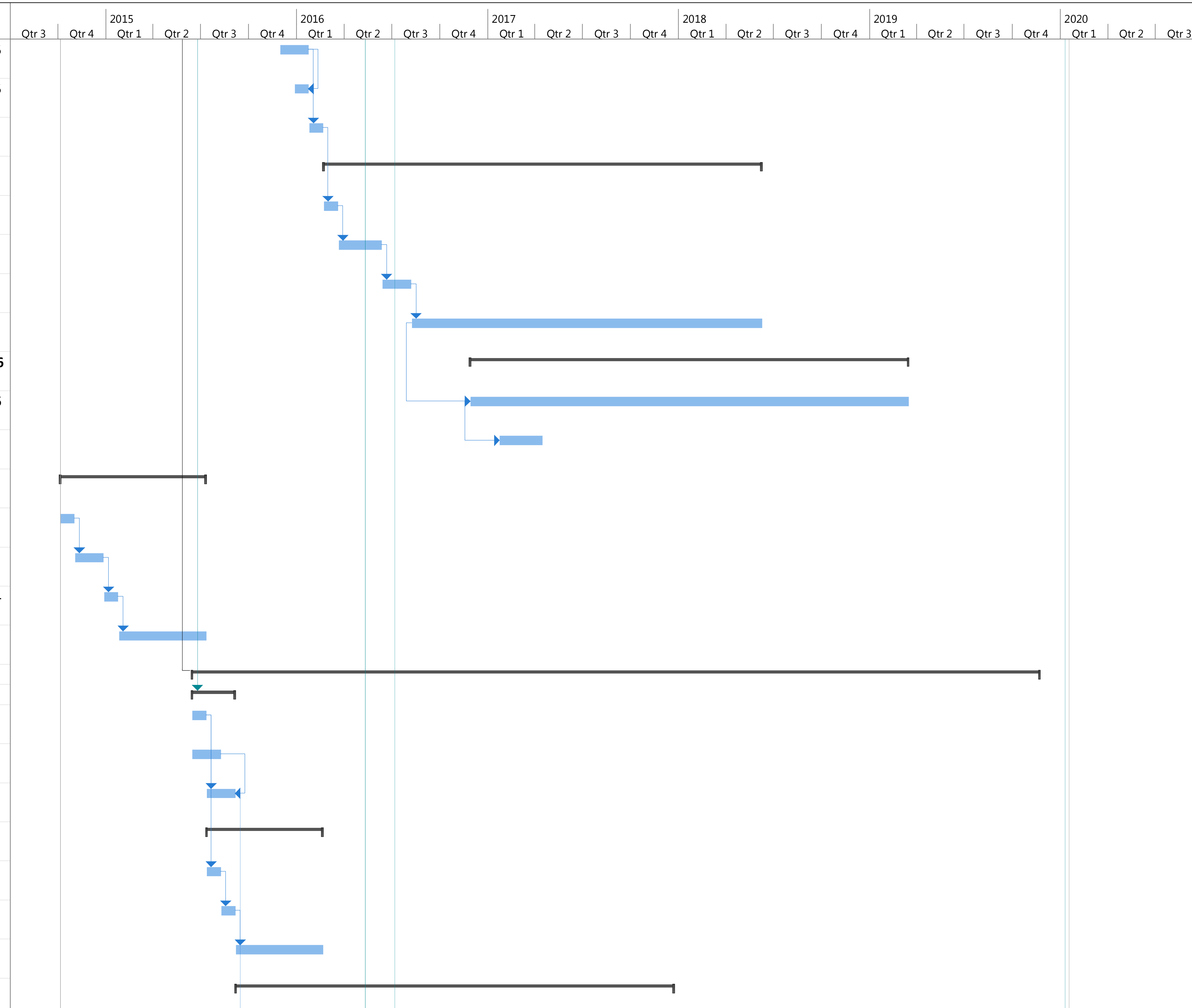
Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID		Task Mode	Task Name	Duration	Start
125			Metering Study	2 mons	Mon 11/30/15
126			ESI review	1 mon	Mon 12/28/15
127			Detailed Design and BOM Preparation	1 mon	Mon 1/25/16
128			**Procurement**	**30 mons**	**Mon 2/22/16**
129			Draft RFP	1 mon	Mon 2/22/16
130			Publish RFP, receive bids	3 mons	Mon 3/21/16
131			Evaluate and award contracts	2 mons	Mon 6/13/16
132			Delivery of materials	24 mons	Mon 8/8/16
133			**Installation**	**30 mons**	**Mon 11/28/16**
134			Install meters	30 mons	Mon 11/28/16
135			Integrate metering software	3 mons	Mon 1/23/17
136			**Update distribution design and construction standards to reflect best practice**	**10 mons**	**Mon 10/6/14**
137			Draft RFP	1 mon	Mon 10/6/14
138			Publish RFP, receive bids	2 mons	Mon 11/3/14
139			Evaluate and award contracts	1 mon	Mon 12/29/14
140			Update distribution design and construction standards	6 mons	Mon 1/26/15
141			**LV network improvements (Bifurcation)**	**58 mons**	**Mon 6/15/15**
142			**Design Finalization**	**3 mons**	**Mon 6/15/15**
143			Feeder Selection	1 mon	Mon 6/15/15
144			Environmental and Social Impact Review	2 mons	Mon 6/15/15
145			Detailed Design and BOM Preparation	2 mons	Mon 7/13/15
146			**Resettlement**	**8 mons**	**Mon 7/13/15**
147			Conduct Resettlement Field Assessment on proposed alignments	1 mon	Mon 7/13/15
148			Finalize Bifercation Resettlement Action Plan	1 mon	Mon 8/10/15
149			Conduct Resettlement	6 mons	Mon 9/7/15
150			**Procurement**	**30 mons**	**Mon 9/7/15**



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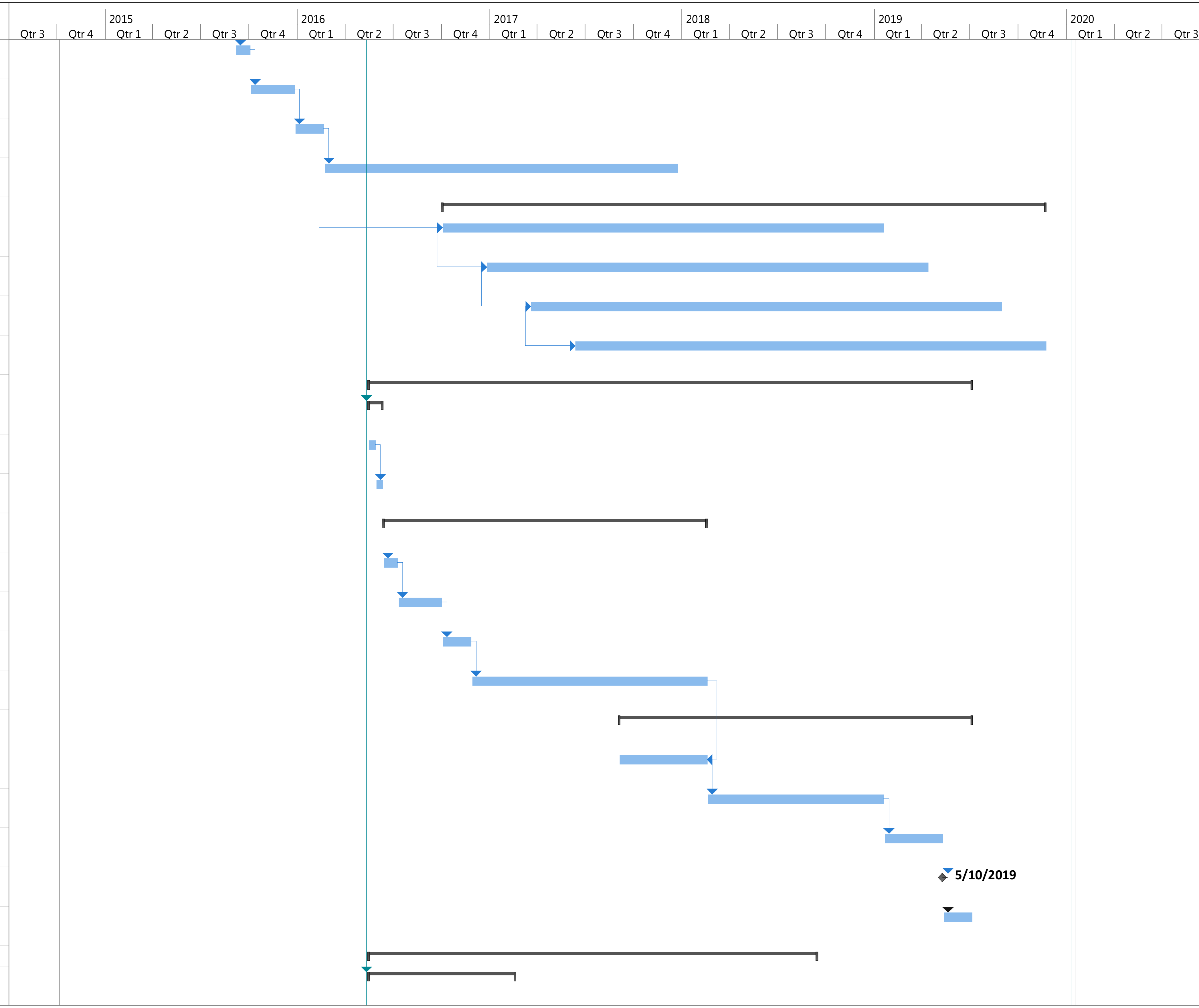
Date: Wed 5/28/14

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
151			Draft RFP	1 mon	Mon 9/7/15
152			Publish RFP, receive bids	3 mons	Mon 10/5/15
153			Evaluate and award contracts	2 mons	Mon 12/28/15
154			Delivery of materials	24 mons	Mon 2/22/16
155			**Installation**	**41 mons**	**Mon 10/3/16**
156			Pole Installation and Framing	30 mons	Mon 10/3/16
157			Wire stringing	30 mons	Mon 12/26/16
158			Equipment Installation and Transfers	32 mons	Mon 3/20/17
159			Removal of Existing Poles and Equipment	32 mons	Mon 6/12/17
160			**Capacitor banks for reactive power compensation**	**41 mons**	**Mon 5/16/16**
161			**Design Finalization**	**1 mon**	**Mon 5/16/16**
162			Substation Selection and ESI Review	0.5 mons	Mon 5/16/16
163			Detailed Design and BOM Preparation	0.5 mons	Mon 5/30/16
164			**Procurement**	**22 mons**	**Mon 6/13/16**
165			Draft RFP	1 mon	Mon 6/13/16
166			Publish RFP, receive bids	3 mons	Mon 7/11/16
167			Evaluate and award contracts	2 mons	Mon 10/3/16
168			Delivery of materials	16 mons	Mon 11/28/16
169			**Installation**	**24 mons**	**Mon 9/4/17**
170			Site preparation for additional CB retrofit	6 mons	Mon 9/4/17
171			Capacitor bank mounting structure installation	12 mons	Mon 2/19/18
172			Equipment wiring and testing	4 mons	Mon 1/21/19
173			Energization	0 mons	Fri 5/10/19
174			Site Restoration and Commissioning	2 mons	Mon 5/13/19
175			**Install Bulk Supply Points with 33kV links**	**30.5 mons**	**Mon 5/16/16**
176			**Design Finalization**	**10 mons**	**Mon 5/16/16**



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Date: Wed 5/28/14

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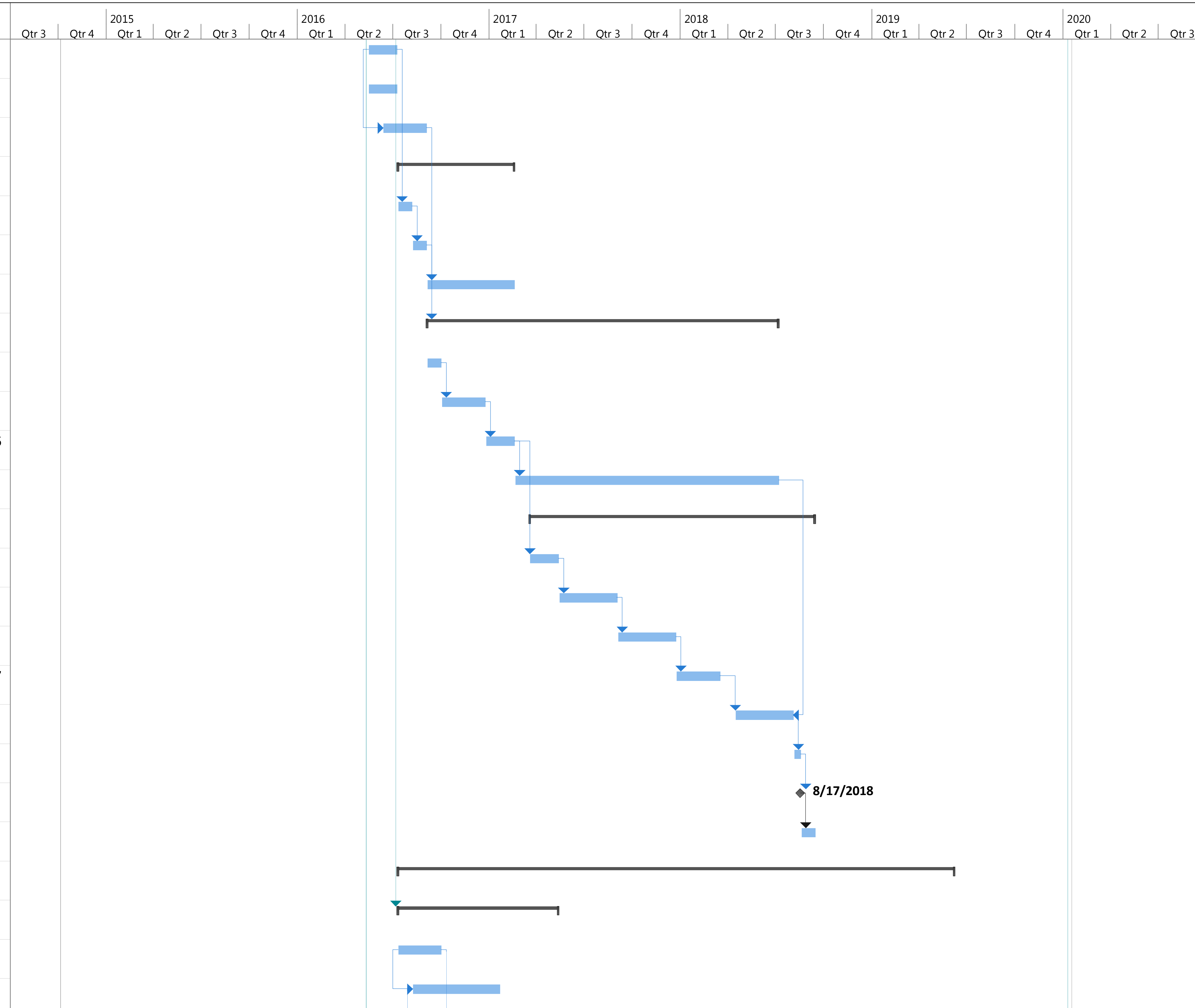
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Mode	Task Name	Duration	Start
177		Site Selection and ESI Review	2 mons	Mon 5/16/16
178		Conduct Environmental Assessment	2 mons	Mon 5/16/16
179		Detailed Design and BOM Preparation	3 mons	Mon 6/13/16
180		**Resettlement**	**8 mons**	**Mon 7/11/16**
181		Conduct Resettlement Field Assessment on proposed alignments	1 mon	Mon 7/11/16
182		Finalize Sub-activity Resettlement Action Plan	1 mon	Mon 8/8/16
183		Conduct Resettlement	6 mons	Mon 9/5/16
184		**Procurement**	**24 mons**	**Mon 9/5/16**
185		Draft RFP	1 mon	Mon 9/5/16
186		Publish RFP, receive bids	3 mons	Mon 10/3/16
187		Evaluate and award contracts	2 mons	Mon 12/26/16
188		Delivery of materials	18 mons	Mon 2/20/17
189		**Installation**	**19.5 mons**	**Mon 3/20/17**
190		Pre-Construction Site Work	2 mons	Mon 3/20/17
191		Site Preparation	4 mons	Mon 5/15/17
192		Concrete Work	4 mons	Mon 9/4/17
193		Steel Erection and Civil Construction	3 mons	Mon 12/25/17
194		Equipment installation	4 mons	Mon 4/16/18
195		Equipment Testing	2 wks	Mon 8/6/18
196		Energization	0 days	Fri 8/17/18
197		Site Restoration and Commissioning	1 mon	Mon 8/20/18
198		**Install primary substations with interconnecting 33kV links and 11kV offloading circuits (Eng11, 12, 13, 14, 15**	**38 mons**	Mon 7/11/16
199		**Design Finalization**	**11 mons**	**Mon 7/11/16**
200		Site Selection and ESI Review	3 mons	Mon 7/11/16
201		Detailed Design and BOM Preparation	6 mons	Mon 8/8/16



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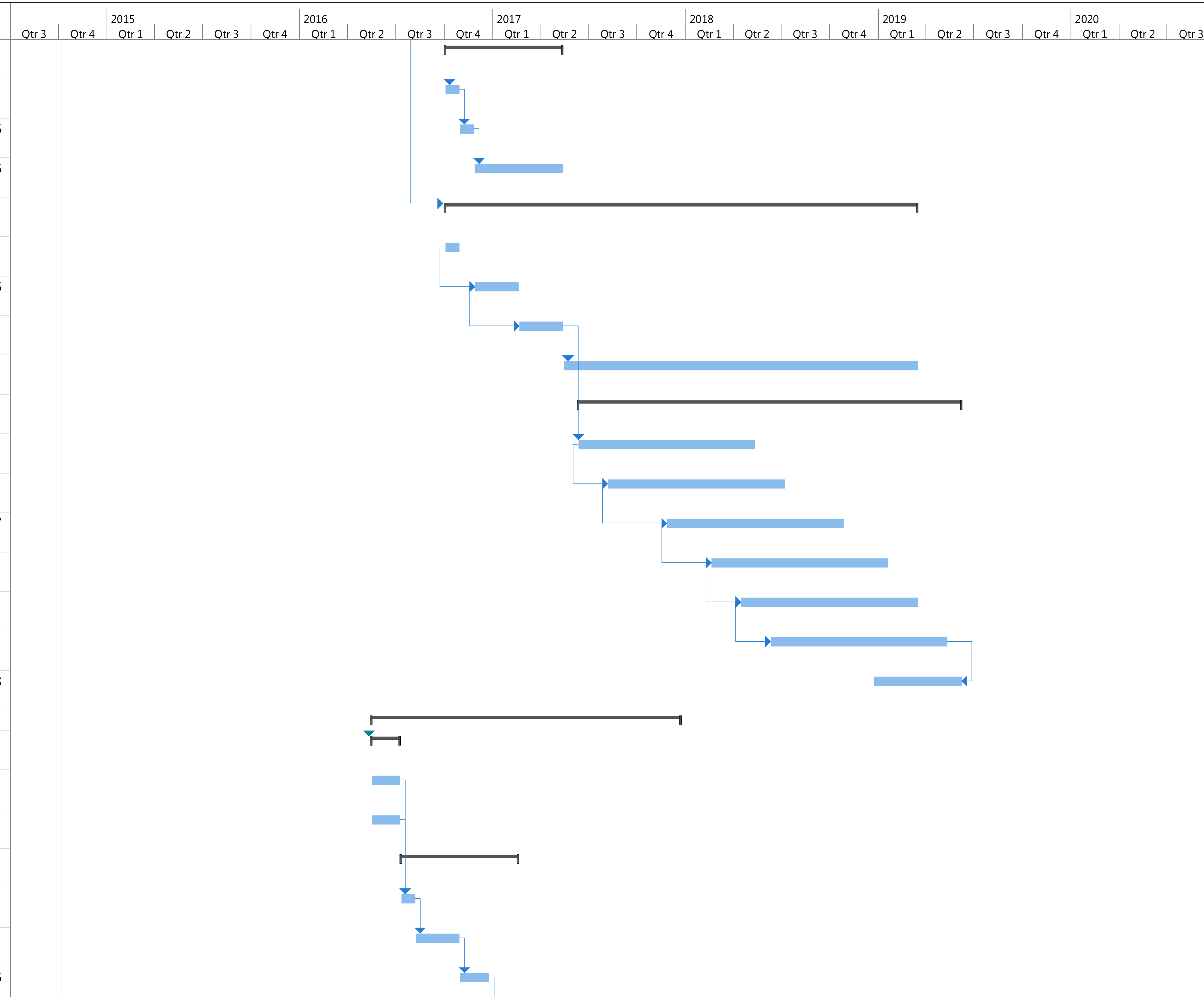
Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Mode	Task Name	Duration	Start
202		**Resettlement**	**8 mons**	**Mon 10/3/16**
203		Conduct Resettlement Field Assessment on proposed alignments	1 mon	Mon 10/3/16
204		Finalize Bifercation Resettlement Action Plan	1 mon	Mon 10/31/16
205		Conduct Resettlement	6 mons	Mon 11/28/16
206		**Procurement**	**32 mons**	**Mon 10/3/16**
207		Draft RFP	1 mon	Mon 10/3/16
208		Publish RFP, receive bids	3 mons	Mon 11/28/16
209		Evaluate and award contracts	3 mons	Mon 2/20/17
210		Delivery of materials	24 mons	Mon 5/15/17
211		**Installation**	**26 mons**	**Mon 6/12/17**
212		Pre-Construction Site Work	12 mons	Mon 6/12/17
213		Site Preparation	12 mons	Mon 8/7/17
214		Concrete Work	12 mons	Mon 11/27/17
215		Steel Erection and Civil Construction	12 mons	Mon 2/19/18
216		Equipment installation	12 mons	Mon 4/16/18
217		Equipment Testing	12 mons	Mon 6/11/18
218		Site Restoration and Commissioning	6 mons	Mon 12/24/18
219		**Installation of Outage Management System**	**21 mons**	**Mon 5/16/16**
220		**Design Finalization**	**2 mons**	**Mon 5/16/16**
221		Detailed design and requirement specification	2 mons	Mon 5/16/16
222		Collection of data output and imput of all system to be integrated	2 mons	Mon 5/16/16
223		**Procurement**	**8 mons**	**Mon 7/11/16**
224		Draft RFP	1 mon	Mon 7/11/16
225		publish RFP, receive bids	3 mons	Mon 8/8/16
226		Evaluate and award contracts	2 mons	Mon 10/31/16



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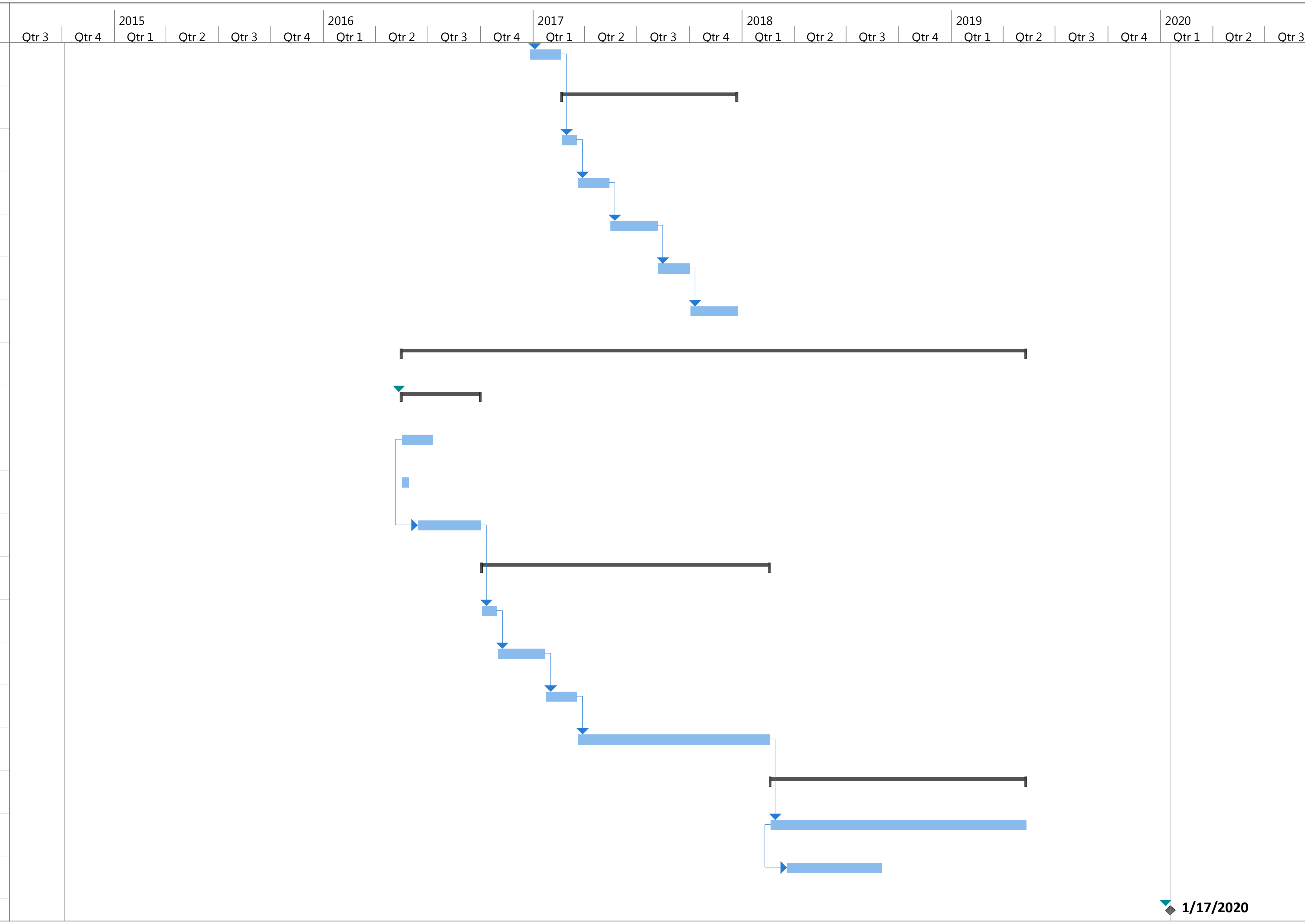
Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Mode	Task Name	Duration	Start
227		Delivery of materials	2 mons	Mon 12/26/16
228		**Installation**	**11 mons**	**Mon 2/20/17**
229		Installation of the system	1 mon	Mon 2/20/17
230		Integration with existing systems	2 mons	Mon 3/20/17
231		Beta testing	3 mons	Mon 5/15/17
232		Modifications based on beta testing	2 mons	Mon 8/7/17
233		Phased rollout	3 mons	Mon 10/2/17
234		**Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion**	**39 mons**	**Mon 5/16/16**
235		**Design Finalization**	**5 mons**	**Mon 5/16/16**
236		Conduct Sectionalizing Study	2 mons	Mon 5/16/16
237		ESI Review	0.5 mons	Mon 5/16/16
238		Detailed Design and BOM Preparation	4 mons	Mon 6/13/16
239		**Procurement**	**18 mons**	**Mon 10/3/16**
240		Draft RFP	1 mon	Mon 10/3/16
241		Publish RFP, receive bids	3 mons	Mon 10/31/16
242		Evaluate and award contracts	2 mons	Mon 1/23/17
243		Delivery of materials	12 mons	Mon 3/20/17
244		**Installation**	**16 mons**	**Mon 2/19/18**
245		Equipment Installtion	16 mons	Mon 2/19/18
246		System integration an SCADA expansion	6 mons	Mon 3/19/18
247		Compact 5 year mark	0 mons	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 ECG 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
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)

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 Electric Company of Ghana (ECG). This Framework Environmental and Social Impact Assessment (FESIA) addresses the distribution projects identified for the ECG 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 ECG Sub-Activities and to assess their potential for environmental and social impacts. The Sub-Activities addressed in this assessment are all located within the ECG service territory, within the greater Accra area, and are under consideration for inclusion in the MCC Ghana Compact II.

A total of 21 ECG Sub-Activities (projects) within four Activities have been identified as the top priority for funding under the MCC Ghana Compact II. 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 which was undertaken in parallel with the FESIA.

This FESIA is based on existing Sub-Activity information that includes the conceptual design and representative project locations, both of which will be refined as part of the MCC Ghana Compact II. Once actual Sub-Activity 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 four 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 20 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 subsections.

2.1 Status of Sub-activities

The Sub-Activities discussed in this assessment were developed by ECG and evaluated as part of Phases I and II of the MCC Ghana Compact II. The Sub-Activities encompass improvements to ECG'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 Environmental and Social Management Plans (ESMP) 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 ECG Sub-Activities was conducted. The evaluation was based on the Ghana EPA's *Guidelines for Environmental Impact Assessment for the Energy Sector* (2011) and the 2012 MCC Environmental Guidelines project classification system.

A summary of each of the 20 Sub-Activities is provided in Table 2-1. As the table indicates, 14 of the 20 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 six 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 on the information provided in the PEA. Similarly, 13 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 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. ESMPs focusing on the anticipated impacts will be required for the MCC Category B Sub-Activities.

2.3 Resettlement

Seven 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 can 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 standard international BMPs. Those Sub-Activities involving construction of substations and transmission lines 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. ECG 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. However, temporary and permanent impacts to ecological resources have the potential to be greater for new substations, as discussed in Section 7. 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 5, 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 Theft

Recent studies indicate that a considerable number of ECG 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 report on ECG Loss Control Units (LCUs), prepared by Global Energy Consulting Engineers Private Limited, India (2012) was conducted to assess losses from the ECG system due to the theft of electricity. The study sampled 1 percent (22,819) of the total number of ECG customers (2,281,879) and found 2,930 customers stealing electricity by various means. This number represents a theft rate of 12.8 percent. A wide range of customer types were found to be involved with pilfering of electricity. The LCU study showed that approximately 88 percent of the theft amount in 2011 was recovered by ECG, indicating that many of those with illegal connections were in fact capable of paying their electric bill but chose not to. 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 is considered 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 ECG. 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.

Theft of electricity can be accomplished by a number of means, including:

- Tampering with the meters to slow or disrupt their functioning
- On-selling where multiple customers are connected to a single meter
- Meter by-pass where high use appliance and possible on-selling lines are connected ahead of the installed meter, thus taking power that is not being registered by the meter
- Not paying the electric bill
- Direct connection to a distribution line without a meter or electricity account.

The following Sub-Activities have the potential to result in customers with currently illegal connection losing their service:

- ECG-Comm-01: Normalization of existing services to comply with improved service connection standard
- ECG-Comm-04: Replacement of legacy meters with prepayment meters
- ECG-Engr-01: Distribution system survey, geographic information system (GIS) system development, and customer census.

These Sub-Activities will involve ECG employees visiting customers, inspecting the existing electrical connections, modifying the connections, and installing prepaid meters. Through this process, some customers with illegal connections will be identified, and ECG'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. ECG's standard procedures for dealing with three types of illegal connections are presented below:

1. Illegal connection with no previous service being provided. Example: Someone just connects to the unmetered service conductors.
   - ECG employee documents the theft with pictures or video.
   - The local police are contacted.
   - ECG tries to identify who is stealing – this could be occurring in a vacant building and the land owner may not be aware of the theft.
   - ECG estimates billing for a maximum period of 36 months and gives the bill to the person stealing.
   - ECG sends crews to disconnect the illegal connection.
   - Matter may be turned over to new established “Energy Judge” in accordance with the judicial court system.
2. Illegal connection to existing metered service. (Meter tampering or connection to unmetered conductor by customer residing at this premise).
   - ECG employee documents the theft with pictures or video.
   - ECG talks to customer.
   - ECG estimates billing for a maximum period of 36 months and gives the bill to the person stealing (if identified).
   - ECG sends crews to disconnect illegal connection.
   - Matter may be turned over to new established “Energy Judge” in accordance with the judicial court system.
3. Meter tampering
   - ECG employee documents the theft with pictures or video.
   - ECG talks to customer.
   - ECG estimates billing for the length of time tampering occurred or error in metering existed (up to 10 years is possible).
   - ECG corrects the problem.
   - Matter is turned over to new established “Energy Judge” in accordance with the judicial court system.

Although 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, other segments of the population cannot. To minimize adverse impacts to the poor who could lose their current illegal access to electricity, the MCC and Millennium Development Authority (MiDA) will have to work closely with ECG 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 could 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.
- Improvements to ECG's electrical connection installation service and schedule.
- Provision of access to high-efficiency electric bulbs and other common household appliances to help reduce overall electric consumption and overall household electric costs.
- Revision of 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 by ECG, 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 ECG.

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

Sub-Activities	Ghana EPA Category[a]	MCC Category[b]	Potential Resettlement	Potentially Important Impacts
Activity: Commercial Losses Reduction and Collection Efficiency Improvement				
ECG-Comm-01: Normalization of existing services to comply with improved service connection standard	A	C	No	Potential customer disconnections
ECG-Comm-04: Replacement of legacy meters with prepayment meters	A	C	No	Potential customer disconnections
ECG-Comm-07: Metering at critical nodes of the distribution system	A	C	No	None
ECG-Comm-10: Strengthening loss control program	A	C	No	None
Activity: Institutional Support				
ECG-ENGR-01: Distribution system survey, GIS system development, and customer census	A	C	No	Potential customer disconnections
ECG-Ict-01: Data center and communication network	A	C	No	None
ECG-Service-01: Installation of enterprise resources planning (ERP) system and integration with existing enterprise applications	A	C	No	None
ECG-Service-03: Technical Assistance Program	A	C	No	None
ECG-Service-04: Distribution System Master Plan	A	C	No	None
Activity: Technical Losses Reduction				
ECG-ENGR-07: Reactive power compensation for primary substations	A	C	No	None
ECG-ENGR-10: Install bulk supply point (BSP) substation with feeders to existing primary substations in Accra	B	B	Yes	Possible resettlement
ECG-ENGR-11: Install Kotobabi/Nima primary substation with interconnecting sub-transmission links and medium voltage (MV) offloading circuits	B	B	Yes	Possible resettlement
ECG-ENGR-12: Install Ogbodzo/Madina primary substation with interconnecting sub-transmission links and MV offloading circuits	B	B	Yes	Possible resettlement
ECG-ENGR-13: Install Mataheko primary substation with interconnecting sub-transmission links and MV offloading circuits	B	B	Yes	Possible resettlement
ECG-ENGR-14: Install Teshie primary substation with interconnecting sub-transmission links and MV offloading circuits	B	B	Yes	Possible resettlement
ECG-ENGR-15: Install Airport Residential Area primary substation with interconnecting sub-transmission links and MV offloading circuits	B	B	Yes	Possible resettlement
ECG-ENGR-36: Low voltage feeder bifurcation with MV upgrade	A	B	Yes	Possible resettlement

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

Sub-Activities	Ghana EPA Category[a]	MCC Category[b]	Potential Resettlement	Potentially Important Impacts
ECG-ENGR-42: Update distribution construction standards based on current low loss practices	A	C	No	None
Activity: Outages Reduction				
ECG-ENGR-39: Sectionalizing study of Accra region, automation of MV networks within ECG's network and supervisory control and data acquisition (SCADA) system expansion	A	C	No	None
ECG-Ops-01: Outage management system	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 FESIA:

- 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 be made 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. Environmental and social review of Review of MCC projects is conducted under the MCC Environmental Guidelines, 2012. MCC recently amended its environmental guidelines to also 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 standards 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 operation 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. There are eight PSs, described 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 PSs listed above, the MCC screening process also incorporated the World Bank's general and industry-specific environmental health and safety guidelines.

SECTION 4

Resettlement Overview

4.1 Overview

Specific Sub-Activity proposals will only be finalized after Compact II has been signed and is in force. MCC has identified the Sub-Activities likely to be included in Compact II through discussions with ECG staff and the results of the initial feasibility studies. Although representative area locations of these Sub-Activities are known, design studies, including routing, have yet to be completed and therefore specific locations have yet to be identified, along with any ensuing involuntary resettlement impacts to physical displacement (relocation of shelter or business) 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).

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

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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,

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 ECG 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. Representative areas for the substations have been provided by ECG; although some sites have been identified, land has not yet been acquired. In line with current ECG practice, these sites are generally vacant or under-used and owned by institutions, thus reducing potential resettlement impacts (more detail is provided in section 6.2.1). The specific routes for the interconnecting 11-kilovolt (kV) and 33-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 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. However, it is important to note that it is ECG practice 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 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 ECG 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 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.
- 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.

Given that adherence to IFC PS 5 is a requirement of the MCC, this FESIA therefore requires that the executing authorities (ECG) 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 policies and measures related to these legislative gaps to ensure compliance with World Bank Operational Policy (OP) 4.12 or IFC PS 5. These include additional assistance to squatters, enhanced consultation, disclosure and grievance procedures: "a*s 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.

3 MCC, 2009, Resettlement Action Plan for Upgrading of the N1 Highway between Tetteh-Quarshie Interchange and Mallam Road Junction.

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:

- 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.
- Consultations and participation: Required consultation procedures to ensure that PAPs are adeqautely and effectively involved throughout the resettlement process.
- 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.
- Implementation arrangements: Agencies involved (e.g. MiDA, ECG, 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

The ECG Environmental Health and Safety (EHS) Unit is responsible for overseeing, developing and implementing EHS policies and procedures for the company. In addition to enforcing compliance with the requirements established by the Ghana EPA, the EHS Unit is also responsible for implementing the requirements of the IFC PSs and ECG internal standards for projects implemented under the MCC Ghana Compact II. Therefore it will be important that requirements of the IFC PSs, including the need for an ESMS are established early in the Compact schedule to incorporate the appropriate principles and good international industry practices into the design and planning for the various Sub-Activities.

The ECG has an Environmental Management Plan that was revised in 2013; however, this plan does not address social issues. This plan will need to be updated to reflect the needs of the various MCC Compact II Sub-Activities to be implemented and the ESMS requirements of the IFC PSs.

The existing in-house EHS Unit is small and relies on contractors to assist with projects on an as-needed basis. Any contractors that are assigned to assist with the MCC Compact II projects be brought on board must have adequate experience with the IFC PSs in a timely manner so that their knowledge and guidance can be applied during the project planning phase.

The ECG Environment Officer typically works with consultants during the implementation of a project. However, because it is likely that the workload under MCC Compact II will represent a significant increase in the overall number of projects being performed, the EHS Director will request additional environment personnel. ECG is in the process of upgrading the EHS Unit to a full department. Advertisements have been placed in newspapers for additional health and safety and environmental positions. Final recruitment is currently pending.

The EHS Unit typically depends on contractors for preparing ESIAs for projects. This will also be the case for preparation of the any project-specific impact assessments required for the MCC Compact II projects.

Currently, additional personnel will be required for monitoring the proposed projects. ECG has health and safety committees at regional and district levels that are made up of staff members from different sections of ECG. The role of the health and safety committees is to address safety hazards as appropriate, and they are also supposed to educate the general public on health and safety concerns. This process will become more effective when permanent health and safety officers are appointed.

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:

- BSP substations
- Primary substations
- Underground cables
- Sub-Transmission lines
- MV distribution lines
- Low voltage (LV) distribution lines
- LV feeder bifurcation.

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

6.1.1 BSP Substations

BSP substations are locations where electric power is transformed for the high voltage (HV) (161 kV) transmission system operated by Grid Company of Ghana (GRIDCo) to the MV (33 kV and 11 kV) and LV [440-volt (V)] distribution system operated by ECG. The three ECG BSP substations currently serving the greater Accra area will become overloaded based on current demand forecast. To avoid rolling blackouts, a new BSP substation will be required. BSP substations are made up of two sections: (1) the GRIDCo section, which includes transformers and the incoming HV transmission lines and (2) the ECG section, which includes the 33/11 kV switching equipment and 33 kV sub-transmission and 33 and 11 kV MV outgoing distribution lines. Meters are installed between the GRIDCo and ECG sections to account for ECG power purchase from GRIDCo.

A contractor will be hired to build a BSP substation that conforms to ECG's standard substation design. This will include the construction of the ECG section of the BSP that will serve the north-central portion of Accra's sub-transmission and distribution network. The BSP substations will have a footprint of up to approximately 100 by 100 m and will include a control house and switching yard that are fenced within the perimeter of the BSP substation. In addition, sub-transmission and MV distribution lines will be constructed from the BSP substation to other substations within the ECG service territory to offload the existing BSP substations currently feeding existing and future electrical loads. This Sub-Activity does not include the construction of the GRIDCo side of the BSP substation.

6.1.2 Primary Substations

The primary substations currently serving the ECG 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 ECG distribution system. As part of the functioning of the ECG distribution system, the electricity injected at the BSP substations will be transformed at the primary substations from 33 kV to 11 kV levels for distribution to customer areas. A final step down to 440V will be accomplished by transformers on distribution poles located at or near individual customer connection points.

A contractor will be hired to build the primary substations that conform to ECG's and standard substation design. The primary substations will have a footprint of up to approximately 100 by 100 m 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 ECG substitutions or lines.

6.1.3 Underground Cable

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 having 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.

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 ECG. Typical standard and minimum installation depths used for underground cable presented below (Table 6-1).

TABLE 6-1
Design Standards for Sub-Activities involving Underground Cables

Voltage	Relevant SADs	Installation Depth Standard	Installation Depth Minimum
33 kV	ECG 10,11,13-15	1,100 mm	900 mm
11 kV	ECG 11-15	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*, ECG, 2013

6.1.4 Sub-Transmission Lines

Sub-transmission lines are used to move power between two substations at a voltage of 33 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).

The standard and maximum span distances between sub-transmission structures are 170 and 200 meters, 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 6-1
ECG Sub-Activities with the Potential for Environmental and Social Impacts

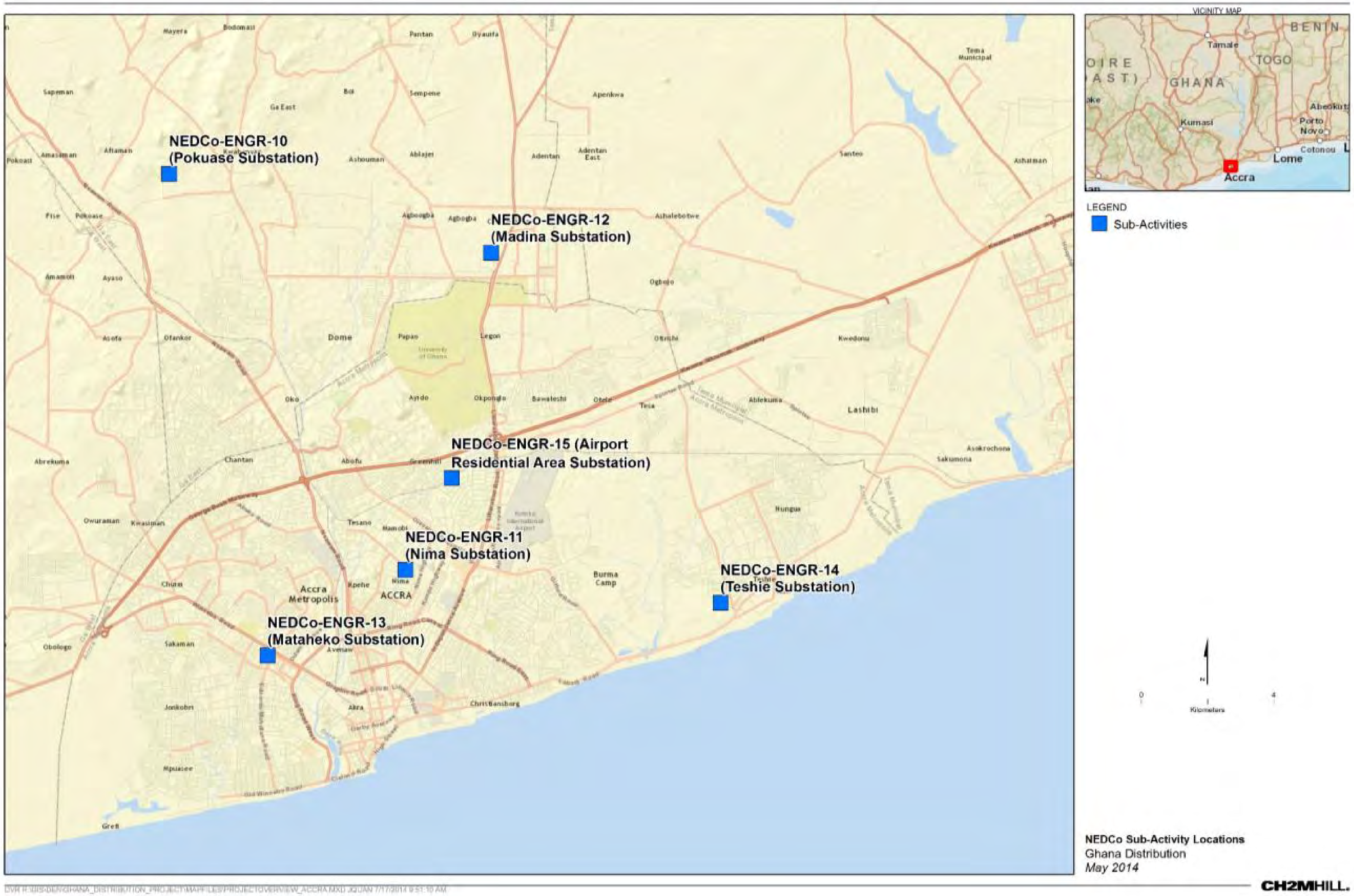


FIGURE 6-2
Horizontal Vertical Setback Standards

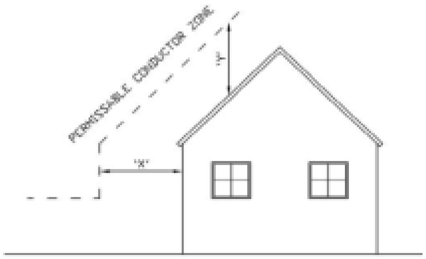
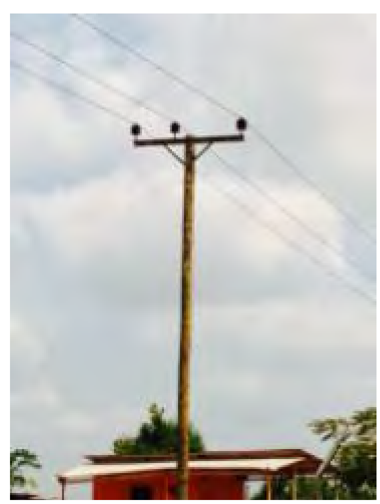


FIGURE 6-3
Foundation Construction and Base of Steel Lattice Tower

6.1.5 MV Distribution

MV distribution lines are used to move power at 33/11 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 meters 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.

6.1.6 LV Distribution

Low voltage distribution lines are used to move power at 440 volts (V) 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 meters, 2.5 meters 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.

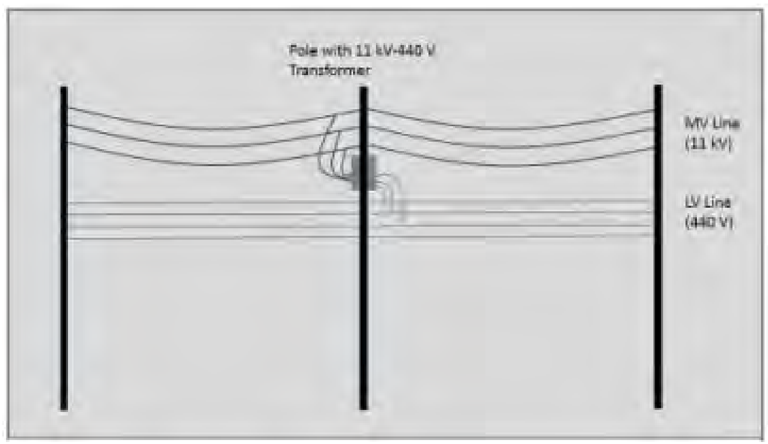
FIGURE 6-5
Typical LV Distribution Line

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, but 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 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.

6.1.7 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 installed 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. At the same time, the system of LV lines (totaling about 6,000 km), which are currently of the open wire construction type, will be replaced with multiplex (also called aerial bundled cable). This activity does not require new poles to be installed.

FIGURE 6-6
Low Voltage Bifurcation



Note: Figure not drawn to scale, for illustrative purposes only.

6.2 Siting and Routing of Sub-Activity Components

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

6.2.1 Substations

The locations of BSP and 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 100 m)[4] to support the new substation is conducted. ECG's practice is to identify a suitable parcel of land and then negotiate with a willing seller based on fair market value.

4 In practice, most parcels are much smaller than this, typically 02 to 0.5 ha.

ECG s practice is to identify a suitable parcel of land and then negotiate with a willing seller based on fair market value. If negotiations break down, normal practice is to search for an alternative site. In ECG's case, most sites are obtained from institutional land owners, such as churches, schools, or government departments.

It is apparent that the negotiations often involve some barter arrangements whereby, as a condition for obtaining the land, ECG upgrades the supply to the owner's facility. Although ECG obtains land through negotiations, it has the option of obtaining land through expropriation – but this appears to be very much the exception, and only one example was given of this occurring in the last 8 years.[5]

ECG has started identifying sites for the Compact II SADs; the current status of this process is summarized in Box 6-1.

Box 6-1. Status of Proposed ECG Sub-stations

ECG Sub-Activities

Although no sites have been finally selected, it seems likely that:

- Teshie will be located on ECG/ GRIDCo land along the current 33 kV alignment that runs between the old and new parts of this area. There is adequate space along this largely clear corridor.
- Pokuase (BSP, up to 1 ha: Land is being acquired by GRIDCo for joint use with ECG. It is understood that the site will be on or close to the existing GRIDCo 161 HV line ROW.
- Airport residential area: Not yet identified, could be difficult to identify.
- Nima: Site identified near the Kotobabi Police Station. Police authorities have been notified and acquisition is in progress.
- Mataheko: ECG owns a plot in the area. Application to authorities to rezone for use as a substation is in progress
- Madina: Site has been identified and acquisition is in progress.

Source: Based on information from ECG.

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. ECG'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 ECG to select routes that minimize impacts to existing infrastructure. In areas of dense development, underground cables should be used to minimize overall impacts. ECG'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; 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.

[5] Even if land is obtained through negotiation, the negotiation will have to be consistent with the requirements of PS 5.

SECTION 7

Sub-Activity Impact Assessment

Each of the 21 ECG 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 ECG 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 ECG-SERVICE-01 Installation of Enterprise Resource Planning System and Integration with Existing Enterprise Applications

7.1.1 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 to manage the connections to outside stakeholders.

ECG currently uses individual applications with disconnected databases by region in many of its business applications. The current ECG practice leads to inefficiencies and poor data availability and quality, which can result in compromised decision making.

Implementation. A contractor will be hired to develop ERP specifications for ECG. Another contractor will be hired to procure and install the ERP system to integrate and/or replace selected standalone business software applications including general ledger, customer information database, billing, human resources, payroll, and others. No construction will be included as part of this Sub-Activity.

7.1.2 Existing Conditions

The Sub-Activity will be implemented by an outside contractor and installed within existing ECG infrastructure. No additional construction will be required.

7.1.3 Environmental Impacts

The Sub-activity will not result in any environmental impacts.

7.1.4 Socioeconomic Impacts

The Sub-Activity will not result in any direct social or economic impacts. The Sub-Activity should improve communications and decision making both within ECG and with other stakeholders.

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																				
		Service-01 - Installation of Enterprise Resource Planning	Service-03 Technical Assistance Program	Service-04 Distribution System Master Plan	ICT-01 Project Data Center and Communication Network	Service-05 Assistance to ECG training center in Tema	ENGR-01 Distribution System Survey, GIS Development and Customer Census	Comm-01 Normalization of Existing Services	Comm-04 Replacement of Legacy Meters with Prepayment Meters	Comm-07 Metering at Critical Nodes of the Distribution System	Comm-10 Strengthening loss control program	Ops-01 Outage Management System	ENGR-39 Sectionalizing Study and Automation of MV NetwoOrks and SCADA Expansion	ENGR-07 Reactive Power Compensation for Primary Substations	ENGR-10 Bulk Supply Point Substation and Interconnections	ENGR-11 Kotonani/Nima Primary Substation and Interconnections	ENGR-12 Ogbodzo Primary Substation and Interconnections	ENGR-13 Mataheko Primary Substation and Interconnections	ENGR-14 Teshie Primary Substation and Interconnections	ENGR-15 Airport Area Primary Substation and Interconnect ions	ENGR-36 LV Bifurcation with MV Lines	ENGR-42 Update Construction Standards
Impacts to Soils (erosion)	6	4	4	4	4	4	4	4	4	3	4	4	4	3	3	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	4	4	4	4	4	4	4
Impacts on Vegetation	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Impacts to Wildlife and Habitat	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Impacts to Drainage, Surface Water Resources	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	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	4	4	4	4	4	4	4
Noise and Vibration	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	4
Air Emissions	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	4
Visibility	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	4	4
Wastes	3	4	4	4	3	4	4	4	4	4	3	4	4	4	3	3	3	3	3	3	3	4
Worker Health and Safety	2	4	4	4	3	4	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	4
Average Environmental Impact Score		4	4	4	3.82	4	3.91	3.91	3.91	3.82	3.82	4	3.91	3.82	3.36	3.36	3.36	3.36	3.36	3.36	3.45	4
Socioeconomic Impacts																						
Impacts to Archaeological and Cultural Heritage Resources	8	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Resettlement: Physical/Economic Displacement	5	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	4
Potential for Loss of Electrical Interconnection	5	4	4	4	4	4	2	2	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	3	3	3	3	3	3	3	4

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																				
		Service-01 - Installation of Enterprise Resource Planning	Service-03 Technical Assistance Program	Service-04 Distribution System Master Plan	ICT-01 Project Data Center and Communication Network	Service-05 Assistance to ECG training center in Tema	ENGR-01 Distribution System Survey, GIS Development and Customer Census	Comm-01 Normalization of Existing Services	Comm-04 Replacement of Legacy Meters with Prepayment Meters	Comm-07 Metering at Critical Nodes of the Distribution System	Comm-10 Strengthening loss control program	Ops-01 Outage Management System	ENGR-39 Sectionalizing Study and Automation of MV NetwoOrks and SCADA Expansion	ENGR-07 Reactive Power Compensation for Primary Substations	ENGR-10 Bulk Supply Point Substation and Interconnections	ENGR-11 Kotonani/Nima Primary Substation and Interconnections	ENGR-12 Ogbodzo Primary Substation and Interconnections	ENGR-13 Mataheko Primary Substation and Interconnections	ENGR-14 Teshie Primary Substation and Interconnections	ENGR-15 Airport Area Primary Substation and Interconnect ions	ENGR-36 LV Bifurcation with MV Lines	ENGR-42 Update Construction Standards
Economic Activity and Employment	1	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	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	4	4	3	3	3	3	4	4	3	4	3	3	3	3	3	3	3	4
Traffic and Infrastructure	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	4
Average Socioeconomic Impact Score		4	4	4	4	4	3.63	3.63	3.63	3.88	4	4	3.88	4	3.5	3.5	3.5	3.5	3.5	3.5	3.38	4

		Relative Severity Ranking for Potential Impacts		[1]IFC PSs
		Positive: *Will have a beneficial/positive impact.*	5	MCC-funded Activities must meet the IFC PSs 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	

7.1.5 Mitigation

No mitigation is required other than implementing the Sub-Activity in a manner that provides equal opportunities for ECG staff and contractors.

7.2 ECG-SERVICE-03 ECG Technical Assistance Program

7.2.1 Sub-Activity Description

Intervention. ECG will require 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 decision making practices.

The technical assistance effort will establish linkages between ECG departments that will be needed to coordinate Sub-Activities and to establish policies, practices, and procedures to reduce technical and commercial losses, reduce outages, and improve collections and the quality of service.

Implementation. It is recommended that this program be continued through 4 years of Compact implementation to provide the foundation for all other programs. A contractor will be hired to execute the technical assistance effort. The scope of work generally encompasses the following functions:

1. <u>Senior advisor for program direction and monitoring</u>. Provide support to ECG senior management with coordination among engineering, commercial management, 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 ECG management and donor agencies, and who will supervise the data verification process for loss reduction, revenue enhancement, and overall performance improvement.
2. <u>Engineer technical advisor for planning and GIS implementation assistance</u>. This includes training to develop and maintain geographically specific system maps with power line, transformer, and device characteristics. Once these maps and data sets are developed, the ECG team will require training to evaluate technical losses, sectionalizing characteristics and strategies, and performance improvement analyses. The training will be more effective if a planning engineer is embedded with ECG throughout implementation. It is anticipated the technical advisor will mentor multiple staff members through the various processes rather than providing incremental support through each of the implementation requirements.
3. <u>Commercial technical advisor to the Loss Control Unit</u>. The LCU within ECG needs to expand its scope of activities to become more effective in reducing non-technical losses. It is anticipated that the LCU will work with engineering planning to evaluate technical losses, and to systematically monitor total energy losses together with modeled technical losses as a means of identifying where non-technical losses are high. The team will require 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. This task will require a commercial specialist with practical experience in non-technical loss reduction programs, and with experience of metering systems, customer information system (CIS), and energy/loss reporting and monitoring programs.
4. <u>Operations technical advisor</u>. The operations advisor will begin with an evaluation of ECG call center practices, coordination between the call center and the dispatch center, and will evaluate practices and procedures designed to restore service after an outage has occurred. The advisor will review and evaluate maintenance materials, 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 sectionalization devices and improved linemen work practices.

7.2.2 Existing Conditions

The Sub-Activity will be implemented by hiring an outside contractor, and work will be conducted within existing ECG infrastructure. No additional construction will be required.

7.2.3 Environmental Impacts

The Sub-Activity will not result in any environmental impacts.

7.2.4 Socioeconomic Impacts

The Sub-Activity will not result in any direct social or economic impacts. The Sub-Activity will improve various corporate functions within ECG.

7.2.5 Mitigation

No mitigation is required other than implementing the Sub-Activity in a manner that provides equal opportunities for ECG staff and contractors.

7.3 ECG-SERVICE-04 Distribution System Master Plan

7.3.1 Sub-Activity Description

Intervention. The ECG distribution system Master Plan needs to be updated. The last plan was completed in 2008 and was based on 2007 data. Certain Sub-Activities need to be completed before a new Master Plan can be created, including population of the GIS database and updating the load forecast (correlated to actual loads). An updated Master Plan will allow increased operational efficiency at ECG. The objective of the Master Plan is to evaluate the existing systems and contribute to the development of the short and long-term Capital Improvement Plan for infrastructure capacity and facilities. The Capital Improvement Plan, based on the Master Plans' 5-year, 10-year and "build-out" scenarios, is then implemented on an annual basis as part of the overall capital plan for ECG services.

Implementation. A contractor will be hired to update the Master Plan. The plan will include a roadmap for the 5-year horizon to meet 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.

7.3.2 Existing Conditions

A contractor will be hired to prepare the Master Plan. The contractor will then work with ECG staff within the existing ECG facilities to integrate the plan into ECG's business practices. No additional construction will be required.

7.3.3 Environmental Impacts

The Sub-Activity will not result in any environmental impacts.

7.3.4 Socioeconomic Impacts

The Sub-Activity will not result in any direct social or economic impacts. The Sub-Activity will improve overall planning and customer service.

7.3.5 Mitigation

No mitigation is required other than implementing the Sub-Activity in a manner that provides equal opportunities for ECG staff and contractors.

7.4 ECG-SERVICE-05 Assistance to the ECG Training Center in Tema

7.4.1 Sub-Activity Description

Intervention. The ECG training center in Tema requires support to ensure continued development of personnel to execute companywide initiatives.

Implementation. A contractor will be hired to provide training, training tools and development of courses and curricula to support ECG personnel.

7.4.2 Existing Conditions

The ECG training center needs improvement.

7.4.3 Environmental Impacts

The Sub-Activity will not result in any environmental impacts.

7.4.4 Socioeconomic Impacts

The Sub-Activity may result in the advancement of more women in the workforce. The Sub-Activity will improve overall planning and customer service.

7.4.5 Mitigation

No mitigation is required other than implementing the Sub-Activity in a manner that provides equal opportunities for ECG staff and contractors.

7.5 ECG-ICT-01 Project Data Center and Communication Network

7.5.1 Sub-Activity Description

Intervention. ECG plans to install many systems that require enhanced information communication technology (ICT) services, including a decentralized CIS, an expanded SCADA system, a managed network, an outage management system (OMS), and GIS. The current ad-hoc approach of buying individual servers and software packages is not scalable and difficult to maintain. ECG expects to have access to fiber optic lines from a third party who is installing the lines on ECG poles and to use them to connect offices on the wide area network. The sub-activity will provide a data center and communication network to facilitate the flow of information within ECG.

Implementation A contractor will be hired to create a detailed design of the ECG data center and communication network based on the ECG ICT department technology roadmap. Another contractor will be hired to refurbish existing space to house an improved and expanded data center for Accra regions. The data center will provide climate control, access control, backup power, and fire suppression, and will be built to accommodate future growth and expansion of the ICT system. Initially, a limited number of servers will be installed. The space will prepared to accommodate additional servers envisioned by the ECG ICT team for system upgrades to be installed or migrated later. This Sub-Activity will connect the existing network to the data center and will upgrade the local area network in all the ECG offices in Accra. The currently used wide area network connections will also be evaluated during detailed design. For high-priority nodes (regional offices), a redundant connection will be installed if one does not exist.

7.5.2 Existing Conditions

Space within existing ECG district offices will be refurbished for the data centers. No new construction will be required beyond the refurbishment. The existing facilities will be modified to accommodate the necessary servers.

7.5.3 Environmental Impacts

Because this Sub-Activity will involve refurbishing existing buildings within Accra, 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, 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 this Sub-Activity.

7.5.4 Socioeconomic Impacts

Social and economic impacts associated with the Sub-Activity 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 and ultimately, customer service. There should be no adverse social or gender impacts associated with the Sub-Activity.

7.5.5 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 found, 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 ECG staff and contractors.

7.6 ECG-ENGR-01 Project Distribution System Survey, GIS Development, and Customer Census

7.6.1 Sub-Activity Description

Intervention. A properly maintained GIS is one of the operational foundations of a modern utility database. The GIS provides a medium to store a large amount of data on the utility system and allows for integration of multiple business applications. GIS data can be used in conjunction with an engineering model to calculate technical losses or with CIS data to calculate and visualize commercial losses. Other uses of GIS data will support creation of an OMS, a vehicle tracking system, asset management, workforce management, and many other uses. ECG does not have an up-to-date system map with a geographically referenced asset database. This intervention will establish an ECG GIS and provide a foundation for all subsequent loss and outage reduction efforts.

Implementation. This Sub-Activity will include a geographic survey of the region and integration of the survey data into a GIS (hardware and software) that is procured and managed within the Engineering Directorate. A contractor will be hired to perform the geographic survey. The survey will include the location and attributes of all electrical plant assets from the BSPs to the LV network (for example, substations, lines, poles, public streetlights, transformers, sectionalizing equipment, capacitor banks, and any other line equipment or asset).

In a parallel activity, the contractor will undertake a consumer census, during which all active and inactive connections will be identified by a unique location identifier. The consumer and meter information will be recorded, verified, and uploaded into the meter management module of the CIS and linked to the GIS database.

The contractor will also train the ECG staff to update the GIS asset data base, SCADA, CIS, and meter control module on a routine basis. The procedures to ensure control and accuracy of these modules will be drafted, tested, and deployed by the consultant hired to develop the GIS and asset control system. Training will also be provided to the ECG planning engineers in Accra on how to transfer the information to engineering analysis software and allow ECG to calculate technical losses and conduct other engineering studies of its system.

7.6.2 Existing Conditions

Sub-Activity field activities will take place throughout Accra; other office-related activities will talk place in existing ECG offices. No new construction will be needed for this Sub-Activity.

7.6.3 Environmental Impacts

Since this Sub-Activity will involve only field survey and office work, anticipated environmental impacts will be minimal. Risks of human health and safety impacts associated with the Sub-Activity can be effectively mitigated through the development and implementation of a worker health and safety plan that includes adequate training. There should be no adverse environmental impacts during operation of the Sub-Activity.

7.6.4 Socioeconomic Impacts

Social and economic impacts associated with the Sub-Activity 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 survey work. 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 Sub-Activity. 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.

7.6.5 Mitigation

Development and implementation of a worker health and safety plan as part of an overall ESMP for the Sub-Activity 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 should be implemented in a manner that provides equal opportunities for ECG staff and contractors. Because there is the potential for customers to be disconnected from the grid because of illegal connections that are identified through execution of the Sub-Activity, a protocol should be developed with ECG to mitigate this impact on the most vulnerable members of the community. A public information program should be implemented that informs customers of the Sub-Activity’s intent, processes, and schedule.

7.7 ECG-Comm-01 Normalization of Existing Services to Comply with Improved Service Connection Standards

7.7.1 Sub-Activity Description

Intervention. Electricity services and meter installations in the ECG service territory are often non-compliant with published ECG installation standards. Contractors hired to install new services do not follow ECG construction standards and have not been subject to routine inspection to make sure that the services meet these standards. This leads to service installations that are vulnerable to tampering, which is the leading cause of the commercial losses (according to the GEC loss study, about 75 percent of new services are connected in a non-standard format (GEC, 2012).

Implementation. ECG needs to update its service connection standards with a tamper-resistant, safe, and economic design for each customer category. A consultant will be hired to collect field information regarding the various structure types that require connection. Then, in consultation with ECG, the consultant will update the existing standards with either a new or revised design. During the customer census (Sub-Activity ECG-ENGR-01) locations will be identified that are in violation of these new standards. A team of trained linemen (either ECG employees or hired contractors) will then repair and upgrade non-conforming service connections, which will initially target inaccessible or tampered meters. Changes will be made to the areas where the service connection wires enter the various structures up until the electric meter. Subsequently, the ECG utility inspector and LCU personnel will be trained to enforce the new standards. Based on the GEC loss study field measurement work conducted in 2011, we assume that 18 percent of all the connected services in Accra fall into this category requiring upgrades.

7.7.2 Existing Conditions

The Sub-Activity will be implemented by inspecting residential and commercial electrical connections of existing customers in areas throughout Accra. The existing standards will then be reviewed and revised as appropriate at existing ECG facilities. ECG workers will then return to the field and make corrections as necessary to existing customers located in various residential and commercial areas of Accra.

7.7.3 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. There should be no impacts to air quality or visual resources, soil disturbance, or impacts to water bodies. Because all work will be in existing developed areas, impacts to critical habitat, vegetation, wildlife, and legally protected areas should not occur. 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 the electrical service connections. Risks of human health and safety impacts associated with the Sub-Activity can be effectively mitigated through developing and implementing a worker health and safety plan that includes adequate training. There should be no adverse environmental impacts during operation of the Sub-Activity. Small quantities of waste may be generated during connection modifications and should be disposed of in a licensed landfill.

7.7.4 Socioeconomic Impacts

Social and economic impacts associated with the Sub-Activity 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. Other than the potential for illegally connected customers to be disconnected, there should be no adverse social or gender impacts associated with the Sub-Activity. 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.

7.7.5 Mitigation

Development and implementation of a worker health and safety plan is recommended as part of an overall ESMP for the Sub-Activity that focuses on worker safety and hygiene and proper procedures for interacting with members of the public. Compliance with safe driving procedures and obeying all applicable traffic laws should be emphasized. The Sub-activity should be implemented in a manner that provide equal opportunities for the ECG 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 Sub-Activity, a protocol should be developed with ECG to mitigate this impact on the most vulnerable members of the community. A public information program should be implemented that informs customers of the Sub-Activity’s intent, processes, and schedule.

7.8 ECG-Comm-04 Replacement of Legacy Meters with Prepayment Meters

7.8.1 Sub-Activity Description

Intervention. Various government programs have been designed to increase access to electric service using various types of post-paid meter technology. As a result, there are a large number of legacy post-paid meters within ECG’s service territory. Over the past few years, ECG has been installing prepaid meters to improve collection efficiency. However, these pre-payment systems have been obtained from a variety of vendors, which has created some integration difficulties and timely closing of monthly financial documents. This Sub-Activity will be used to install pre-paid meters for customers who are not on the life-line tariff and do not exceed a 100 kW service size. The customer census (Sub-Activity ENGR-01) will identify the candidate non-special-load-tariff customers.

Implementation. The GIS data collection and customer census (Sub-Activity ENGR-01) will be the first step in a review of the existing meter installations in ECG service territory. Under this Sub-Activity, pre-paid systems will be evaluated to identify the system most compatible with the proposed CIS application. A contractor will then install specified pre-paid meters as prioritized by the customer census and historical usage data that do not fall under the service normalization Sub-Activity (Comm-01). Utility workers will remove the existing electric meters in residences and businesses with new pre-payment meters. Activities will be limited to the removal of the old meters and installation of the new meters.

7.8.2 Existing Conditions

This Sub-Activity will be implemented from existing ECG offices where an evaluation of pre-paid systems will be conducted to identify the system most compatible with the CIS application. The second part of the Sub-Activity will be implemented by replacing meters within existing homes and businesses throughout the Accra area.

7.8.3 Environmental Impacts

The replacement of existing residential and commercial electric meters with prepaid meters will not result in ground disturbance/soil erosion impacts, impacts to critical habitat, vegetation, wildlife and their habitats, protected and internationally recognized areas, or surface waters. The only environmental risks will be the potential for impacts to worker health and safety. As with any work-related activity, there will be some level of potential worker health and safety risk associated with meter replacement. These risks also include traffic accidents as well as injuries during replacement of the existing meters. Health and safety risks associated with meter replacement can be effectively mitigated by developing and implementing an ESMP and providing adequate training. Small quantities of waste may be generated during connection modifications and should be disposed of in a licensed landfill. There should be no additional adverse environmental impacts during operation of the pre-paid meters.

7.8.4 Socioeconomic Impacts

Pre-payment electric meters are currently in use in various areas throughout Accra. Social and economic impacts associated with the Sub-Activity 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. Other than the potential for illegally connected customers to be disconnected, there should be no adverse social or gender impacts associated with the Sub-Activity. 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 is recommended, as part of an overall Sub-Activity ESMP that focuses on worker safety and hygiene and proper procedures for interacting with members of the public. Compliance with safe driving procedures and obeying all applicable traffic laws should be emphasized. The Sub-activity should be implemented in a manner that provides equal opportunities for the ECG 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 Sub-Activity, a protocol should be developed with ECG to mitigate this impact on the most vulnerable members of the community. A public information program should be implemented that informs customers of the Sub-Activity's intent, processes, and schedule before the work begins.

7.9 ECG-Comm-07 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 ECG to identify and monitor where technical and commercial losses are occurring. The critical nodes are:

- The 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 ECG to identify losses that occur between node points, and high loss variations between these points will help ECG 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 critical nodes in the distribution system so that information can be relayed to the newly installed CIS system.

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 additional to the existing distribution infrastructure.

7.9.2 Existing Conditions

This Sub-Activity will be implemented at various points along the existing ECG distribution system in Accra, including substations and distribution transformers. The meters will be installed within existing facilities, which will not require expansion. The meters will be installed primarily in developed areas of Accra; specific locations will be defined as part of the detailed design and implementation phase of the Sub-Activity.

7.9.3 Environmental Impacts

Because all Sub-Activity activities will occur at existing ECG facilities, installation of the meters will not result in any 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 to 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 ESMP and providing adequate training. There should be no additional adverse environmental impacts during operation of the meters.

7.9.4 Socioeconomic Impacts

Social and economic 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.

7.9.5 Mitigation

Recommended mitigation for meter placement includes the development and implementation of a 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.

7.10 ECG-Comm-10 Strengthening Loss Control Program

7.10.1 Sub-Activity Description

Intervention. The key to reducing commercial loss is to strengthen the existing ECG LCU in Accra. According to the GEC loss study report (GEC, 2012), the LCU detected only about 2 percent of commercial losses. The report also notes that the LCU identified fewer cases in 2011 than in 2010, when in fact the number of loss cases identified should have increased. The metering at critical nodes of the distribution system Sub-Activity (Comm-07) will provide the LCUs with a tool to hone in on the specific areas with the highest commercial losses. However, metering alone is not enough to reduce the commercial losses. The LCU needs additional staff, training, and equipment to identify and respond to losses. ECG intends to increase the number of LCU teams from 4 to 10 (currently LCU teams consist of 4 personnel).

Implementation. This Sub-Activity has three parts: 1) Strengthen the ECG loss control team by hiring additional qualified engineering personnel to support loss control activities in each of the district offices of Accra East and Accra West; 2) provide equipment, including small trucks and load loggers, and 3) implement a training program and provide technical assistance via a loss control/commercial specialist. A loss control expert will be hired as part of an ECG technical assistance team, who will conduct on-the-job training at the district offices for a 1-year period. During that year, ECG employees will learn how to use data from the CIS, automatic meter reading, and SCADA systems and critical node points to evaluate energy use and losses. Employees will also learn how to systematically target the commercial loss sources in the field and complete the required service upgrades to prevent future recurrence of the losses. In addition to the field work, the loss control department will perform energy balances for high-loss substations in order to overcome endemic commercial losses that persist even after significant investment in loss control interventions.

7.10.2 Existing Conditions

Existing ECG offices will be refurbished in Accra East and in Accra West. No new construction will be undertaken. This Sub-Activity will therefore be implemented both within existing ECG facilities and throughout the Accra East and West service territories.

7.10.3 Environmental Impacts

Because this Sub-Activity will involve the refurbishing of existing offices in existing buildings within Accra, 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 the 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. There should be no adverse environmental impacts during operation of the Sub-Activity.

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, 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.

7.10.4 Socioeconomic Impacts

Social and economic impacts associated with the Sub-Activity will be minimal. There will be no land acquisition, economic displacement, or restriction of land uses or land use rights. Increasing the staff from 4 to 10 people will result in additional employment opportunities. There should be no adverse social or gender impacts associated with the Sub-Activity.

7.10.5 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 ECG staff and contractors.

7.11 ECG-OPS-01 Outage Management System

7.11.1 Sub-Activity Description

Intervention. ECG needs a computer-based OMS, which is a foundational requirement for a modern utility. Currently, the ECG customer call center receives trouble calls, which are recorded into an Excel database and are not tied to the existing CIS or SCADA system. The call center subsequently dispatches repair crews to the affected area for investigations and possible repairs as needed.

An OMS is used to monitor and quickly and effectively respond to outages without relying on consumer reporting. The predictive capabilities of the OMS allow for preliminary identification of the location of the outage and are based on the system configuration from the GIS data (ENGR-01) and the CIS. The call center assists the dispatched repair crews on the proper course of action in the field. One feature of the OMS that is of particular value is the link to the GIS database, which allows for prioritization efforts—for instance, if there is a hospital that is affected by the outage, then the repair crews know in advance where to focus their efforts first. The OMS is also an effective tool for estimating the size of the repair crew to dispatch, conserving resources for the utility. Once the repair crew restores service, the OMS platform is used for recording the duration of the outage, the cause, and the remedy.

Implementation. Under this Sub-Activity, a contractor will be hired to procure and install an OMS in Accra. This system will be integrated with the call center, GIS, CIS, and SCADA system. The OMS will be able to identify outage locations and causes, thereby reducing outage frequencies and durations. Also under this activity, an improved call center software module will be procured, and the call center staff will be trained in its use. ECG linemen will be trained on outage restoration practices using bucket trucks acquired as part of this Sub-Activity and other equipment.

7.11.2 Existing Conditions

This Sub-Activity will be implemented within existing ECG facilities and no new infrastructure will be required. The OMS will be installed by a contractor who will then work with the ECG staff within the existing ECG facilities to implement the OMS.

7.11.3 Environmental Impacts

The Sub-Activity will not result in any environmental impacts.

7.11.4 Socioeconomic Impacts

The Sub-Activity will not result in any direct social or economic impacts. The Sub-Activity will improve outage management and service to ECG customers.

7.11.5 Mitigation

No mitigation is required other than implementing the Sub-Activity in a manner that provides equal opportunities for the ECG staff and contractors.

7.12 ECG-ENGR-39 Sectionalizing Study of Accra Region, Automation of MV Networks within ECG's Network, and SCADA System Expansion

7.12.1 Sub-Activity Description

Intervention. System outages are affecting larger areas and more and more consumers. ECG’s current protection standards are basic and use only a breaker at the substation and fuses at the transformer. When a fault occurs, all of the customers on the feeder are out of power. One or two sectionalizers along the feeder can reduce the number of affected customers to a smaller number. Furthermore, a sectionalizer will help crews find the trouble spot more quickly and subsequently reduce outage time. Historically, ECG has employed limited sectionalizing on its MV lines; rather, the ECG approach has been to install costly switching stations to split 33 kV sub-transmission lines into 33 kV distribution lines.

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 the Accra network. The study results will be used to locate reclosers, switches, and other sectionalizing devices in the 11 kV network.

A contractor will be hired to implement the recommendations of the sectionalizing study in accordance with ECG specifications and standards. It is assumed that each feeder will require one recloser and four sectionalizers. All reclosers and sectionalizers will then be interconnected to the existing SCADA system for monitoring and remote operation. In addition, inline fuses will be installed as indicated by the study.

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. Most of the existing substations are located in residential and commercial areas of Accra.

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 this Sub-Activity. These impacts can be associated with traffic accidents as well as injuries during installation of the protection Sub-Activity equipment. Health and safety risks associated with Improvement Sub-Activities can be effectively mitigated by developing and implementing an ESMP plan that includes adequate training. There should be no adverse environmental impacts during operation.

7.12.4 Socioeconomic Impacts

Social and economic impacts associated with the protection Sub-Activities will be minimal. Temporary impacts to traffic may occur as a result of the protection 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 protection Sub-Activity 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 ECG-ENGR-07 Reactive Power Compensation for Primary Substations

7.13.1 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. This activity will evaluate reactive power levels for all MV circuits and will include purchasing and installing fixed and switched capacitor banks at existing substations to optimize reactive power levels at 33/11 kV substations. This activity will include the addition of a metal-clad cubicle in the control room and the installation of underground cable to an outdoor structure that will hold the capacitors. All work will be done at existing substations.

7.13.2 Existing Conditions

This Sub-Activity involves work within existing substations. Existing conditions surrounding the substations will differ, depending on the current location of the substation. Most of the existing substations are located in residential and commercial areas and all substations will be located within the Accra East and West ECG service territory.

7.13.3 Environmental Impacts

Because all Sub-Activity activities will occur at existing ECG substations, installation of the capacitor banks will result in minimal adverse impacts to the environment. Potential environmental impacts may include slight generation 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 capacitor banks. Health and safety risks associated with this Sub-Activity can be effectively mitigated by developing and implementing an ESMP and providing adequate training. There should be no additional adverse environmental impacts during operation of the capacitor banks.

7.13.4 Socioeconomic Impacts

Social and economic impacts associated with this Sub-Activity 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.

7.13.5 Mitigation

Recommended mitigation for capacitor bank installation includes the development and implementation of 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.

7.14 ECG-ENGR-10 Install Pokuase BSP Substation with 33 kV Feeders to Existing 33/11 kV Substations in Accra

7.14.1 Sub-Activity Description

Intervention. The three BSPs currently serving the greater Accra region will become overloaded based on the current demand forecast. To avoid rolling blackouts, a new BSP will be required. BSPs are the power injection point into the ECG distribution network from the GRIDCo transmission and generation system. They are made up of two sections: (1) the GRIDCo section, which includes the transformer and the incoming transmission lines, and (2) the ECG section, which includes the sub-transmission and distribution outgoing feeders and switching equipment. Meters are installed between the two sections to account for all of ECG’s power purchase.

Implementation. ECG will coordinate with GRIDCo for the procurement and installation of the new BSP. A contractor will be hired to procure and build a substation that conforms to ECG’s standard substation design. This will include the construction of the ECG section of the BSP that will serve the north-central portion of Accra’s sub-transmission and distribution network. Nsawam, Mampong, Aburi, Ofankor Kwabenya, and Adenta substations will become connected to the new BSP as part of this project. The construction will include a control house and switching yard that are fenced within the perimeter of the substation. In addition, lines will be built from the BSP to the various substations mentioned above to offload the other BSP currently feeding those loads. This Sub-Activity does not include the cost that will be incurred by GRIDCo to build its side of the substation. Additional information on BSP substations and associated distribution lines is provided in Section 6.1.

7.14.2 Existing Conditions

A site for the BSP is being selected by GRIDCo in the general Pokuase area (see Figures 7-1 and 7-2). Land will be acquired by GRIDCo for both the high voltage (161 kV) substation as well as the adjacent 33 kV BSP substation. Although the specific site for the BSP substation has not been finalized, the area within which the site will be located is primarily residential and commercial. The new BSP substation will be connected using both overhead and underground 33 kV lines to the Nsawam, Mampong, Aburi, Ofankor Kwabenya, and Adenta substations. For the line routes ECG uses utility reservations along the roads and streets. However, until a specific project site is identified and acquired or leased, the feeder route cannot be confirmed. The BSP substation will have a footprint of up to approximately 100 by 100 m and will be located adjacent to the GRIDCo 161 kV substation. While the exact dimensions of the GRIDCo portion of the BSP substation are not known, it is typical for the GRIDCo portion to be somewhat larger than the ECG portion.

7.14.3 Environmental Impacts

Ground disturbance will be associated with construction of the BSP substation and new 33 kV distribution lines. These activities have the potential to result in dust generation and sedimentation from disturbed soils, potentially leading to impacts to surface water drainages, wetlands, and water quality. 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 Sub-Activity. Final siting of the substation and line routes should screen for critical habitat, vegetation, wildlife and their habitat, and legally protected and internationally recognized areas. Avoidance of these features should be a priority and should be able to be accomplished. Because most of the distribution line construction will likely take place in existing ROWs adjacent to roads, these facilities should likewise have minimal impacts to vegetation, wildlife habitats, critical habitat, protected species, and legally protected and internationally recognized areas.

Construction of the new BSP 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 BSP substation and overhead distribution lines will result in "visual impacts" to the aesthetic quality and unobstructed views of the landscape. However, because the new BSP substation will be located adjacent to a 161 kV substation, impacts to visibility will be incremental and less noticeable. 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 Sub-Activity.

As with any work related activity, there will be some level of potential worker health and safety risk associated with substation Sub-Activities. 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 Sub-Activities can be effectively mitigated by developing and implementing an ESMP and providing adequate training. There should be no additional adverse environmental impacts during operation of the substation and new distribution lines.

Environmental impacts associated with the GRIDCo portion of the BSP substation would be similar in nature and extent to those discussed above since similar facilities would be installed. It is likely that the combined environmental impacts would have to be addressed in a single environmental document provided to the Ghana EPA and possibly to MCC.

7.14.4 Socioeconomic Impacts

New land will be required for the BSP substation. GRIDCo will be responsible for land acquisition for both the high-voltage substation as well as the BSP substation. GRIDCo typically purchases land from a willing seller for substations; therefore, it is unlikely that involuntary resettlement of residents or economic displacement will occur as a result of the BSP. However, it will be important that the land acquisition is done in a free and transparent manner in compliance with IFC PS 5 on Land Acquisition and involuntary Resettlement. The new distribution lines will likely be located primarily within ROWs along existing roads. Depending on the final location of the BSP and the routes selected for the distribution lines, involuntary resettlement and economic displacement requiring compensation may occur. Efforts to ensure the careful siting, layout, and final design of the BSP and new distribution lines should take all reasonable efforts to minimize the potential for involuntary resettlement and economic disruption. Construction of the BSP substations will result in short-term positive impacts on local economic activity and employment because of the need for construction and maintenance workers.

A screening for cultural resources in the area of the proposed BSP 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.

Social impacts associated with the GRIDCo portion of the BSP substation would be similar in nature and extent to those discussed above since similar facilities would be installed. It is likely that the combined environmental impacts would have to be addressed in a single environmental document provided to the Ghana EPA and possibly to MCC.

7.14.5 Mitigation

Careful site selection, layout, and final design of the BSP substation and new distribution lines should avoid or minimize impacts to existing residents and commercial facilities. Cases of involuntary resettlement and/or economic displacement should be appropriately compensated based on the guidelines set out by the GoG and the MCC.

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 development and implementation of 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. A Resettlement Action Plan should be prepared if resettlement is required. A Resettlement Action Plan should be prepared if resettlement is required.

FIGURE 7-1
Map of Representative Project Area for ECG-ENGR-10 Pokuase BSP Substation

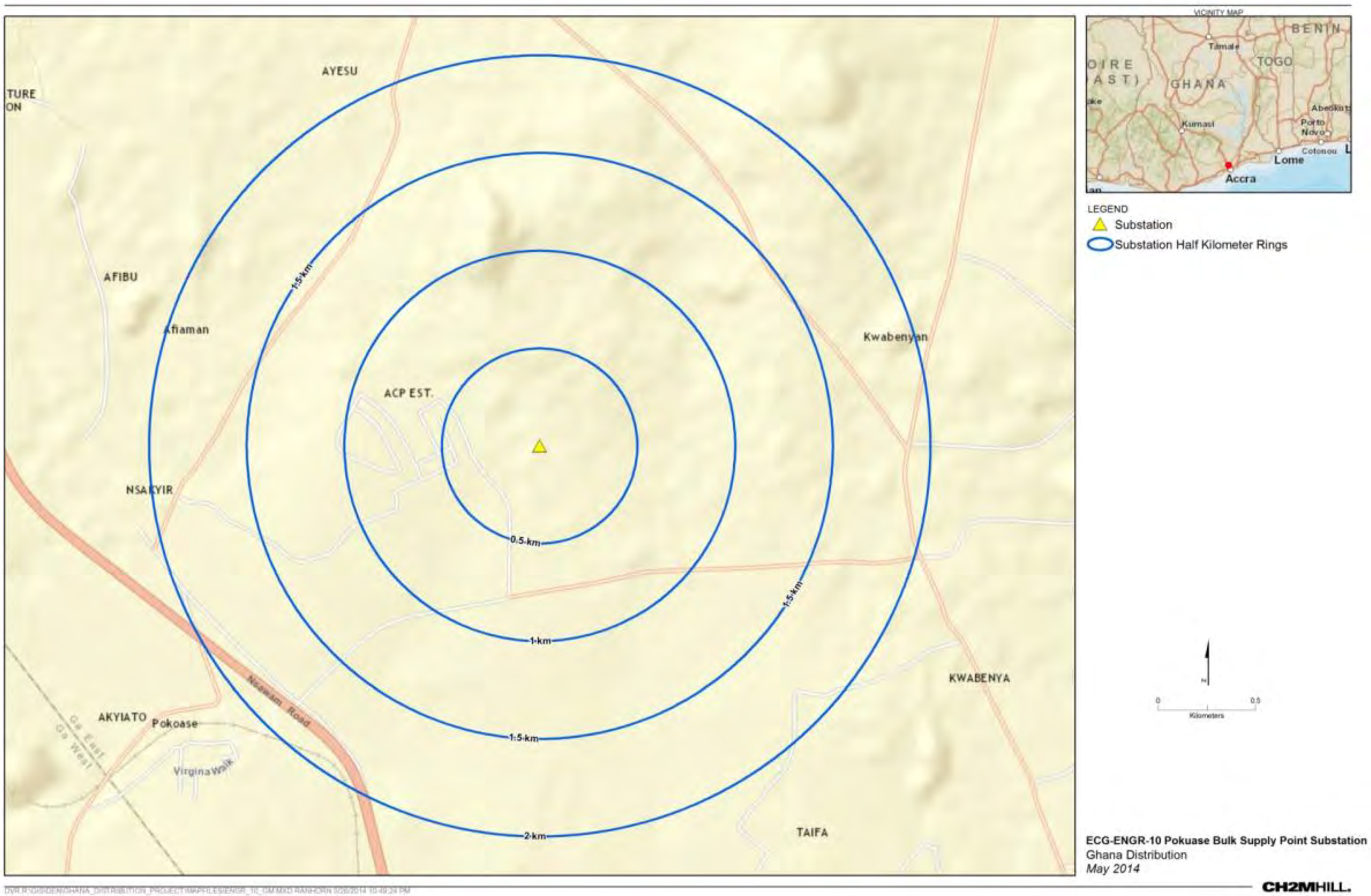
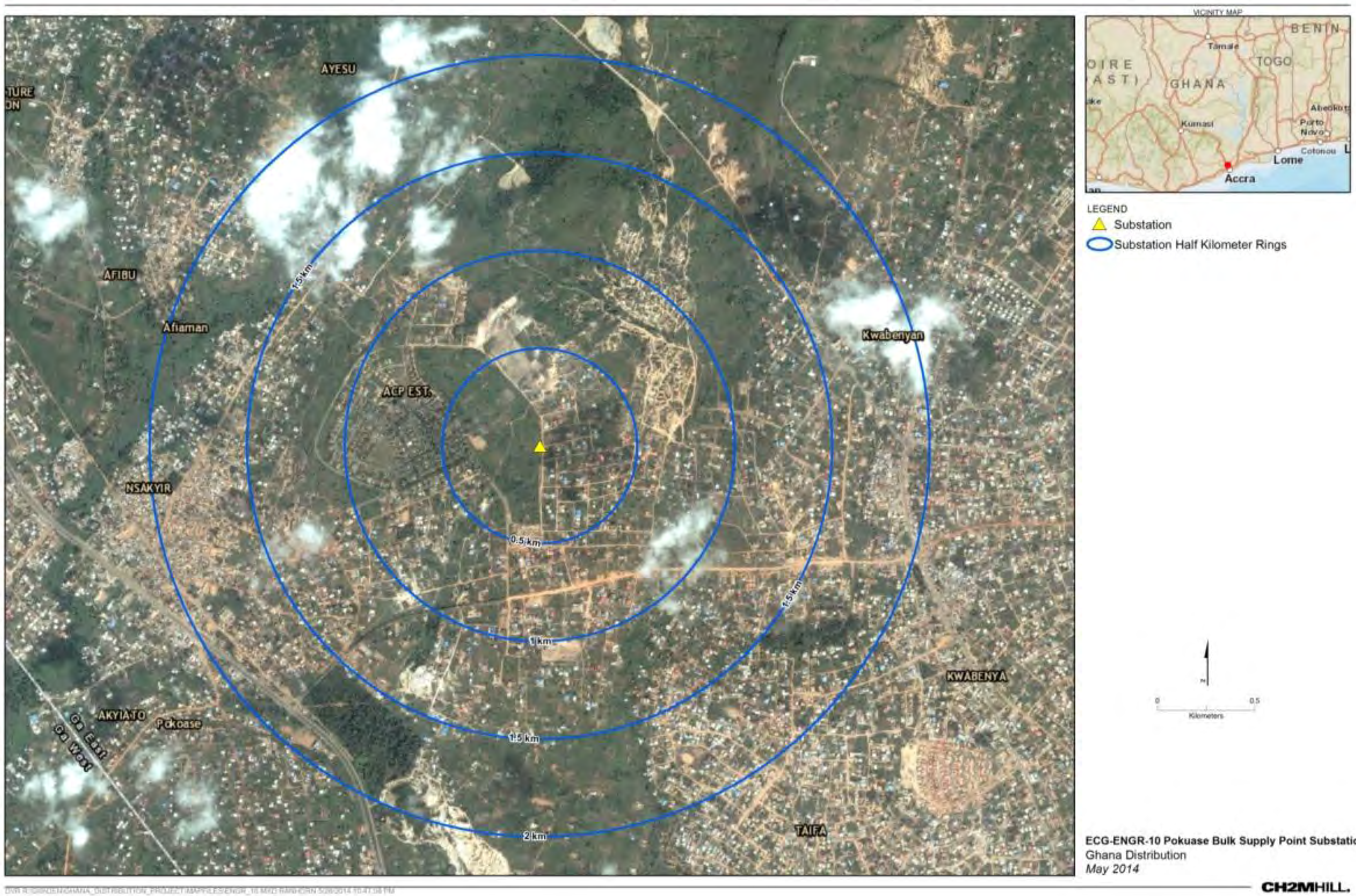


FIGURE 7-2
Aerial View of Representative Project Area for ECG-ENGR-10 Pokuase BSP Substation



7.15 ECG-ENGR-11 Install Kotobabi/Nima 33/11 kV Primary Substation with Interconnecting 33 kV Links and 11 kV Offloading Circuits

7.15.1 Sub-Activity Description

Intervention. The primary substations currently serving the greater Accra region will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the newly installed BSP, a primary substation will be installed at Kotobabi/Nima. Before the energy injected by the BSP can be used by most loads (consumers) in Accra, voltage has to be transformed to bring it to a level that can be consumed by standard electric equipment. The voltage transformation occurs at the primary substation, where the voltage is stepped down to 11 kV levels. The new substation will also help reduce technical losses and avoid extended outages caused by failures or maximum capacity reached at geographically adjacent substations.

Implementation. A contractor will be hired to build a substation that conforms to ECG's standard substation design. This will include the construction of a new 33/11 kV 2x20/26 MVA substation to meet the forecasted load. The typical primary substation in the Accra region has two matched transformers, a switch yard, capacitor banks, and a control house within the fenced perimeter of the substation. It also includes lines for the incoming sub-transmission feeders and outgoing feeders that extend for distances ranging from 500 m to multiple km to a point where they connect with existing ECG substitutions or lines. Additional information on primary substations and associated distribution lines is provided in Section 6.1.

7.15.2 Existing Conditions

It is understood that ECG has already identified a site near to the Kotobabi Police Station; the police authorities have been notified and acquisition is in progress. Because no further information is available, a representative site for the primary substation is shown on Figures 7-3 and 7-4. Further studies will need to be done to finalize the design of this site. The general area for the substation is proposed to be located between Nima and Maamobi, a few km from Accra city center. The general area is characterized by fairly dense residential and commercial development. Residential facilities in the general area are poorly planned, and the roads are lined with commercial activities. Hawking (street vendors) along the main road occurs daily when vehicular traffic flow is slowed.

7.15.3 Environmental Impacts

Ground disturbance will be associated with construction of the primary substation and new 33 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 Sub-Activity. Final siting of the substation and line routes should screen for critical habitat, vegetation, wildlife and their habitat, and legally protected and internationally recognized areas. However, due to the heavily developed nature of the surrounding area, it is unlikely that any of these areas will be found in the general vicinity of the project.

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 Sub-Activity.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with substation Sub-Activities. 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 Sub-Activities can be effectively mitigated by developing and implementing an ESMP and providing adequate training. There should be no additional adverse environmental impacts during operation of the substation and new distribution lines.

7.15.4 Socioeconomic Impacts

Acquisition procedures are already underway to obtain a site from the police for the substation. Therefore, it is unlikely that involuntary resettlement of residents or economic displacement will occur as a result of the substation. However, it will be important that any resulting physical or economic displacement of current occupants is done in compliance with IFC PS 5 on Land Acquisition and involuntary Resettlement. The new distribution lines will likely be located primarily within ROWs along existing roads. Many of the roads in the immediate area are highly developed with small commercial establishments, a number of which appear to be located within the utility ROW. Although the exact routes that will be used for the distribution lines have not been identified, it is highly likely that these lines will result in involuntary resettlement, especially for the small commercial establishments. Various distribution line designs and possible undergrounding of the cable may be considered in some cases to minimize resettlement. Efforts to ensure the 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 because of 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.

7.15.5 Mitigation

The proposed substation area should be evaluated to see if involuntary resettlement impacts can be minimized. Various line routes and construction methods should also be considered to minimize resettlement impacts from the construction of the distribution lines. Risks of human health and safety impacts can be effectively mitigated by developing and implementing an ESMP that includes adequate training. Health and safety risks can be associated with traffic accidents as well as injuries during installation of the substation and distribution lines. A health and safety plan that focuses on worker safety and health must be developed and implemented to minimize these risks. This plan should be part of the overall ESMP prepared for the Sub-Activity. 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 incorporated into the ESMP. Cases of involuntary resettlement and/or economic displacement should be appropriately compensated based on the guidelines set out by the GoG and the MCC. A Resettlement Action Plan should be prepared if resettlement is required.

FIGURE 7-3
Map of Representative Project Area for ECG-ENGR-11 Kotobabi/Nima Primary Substation

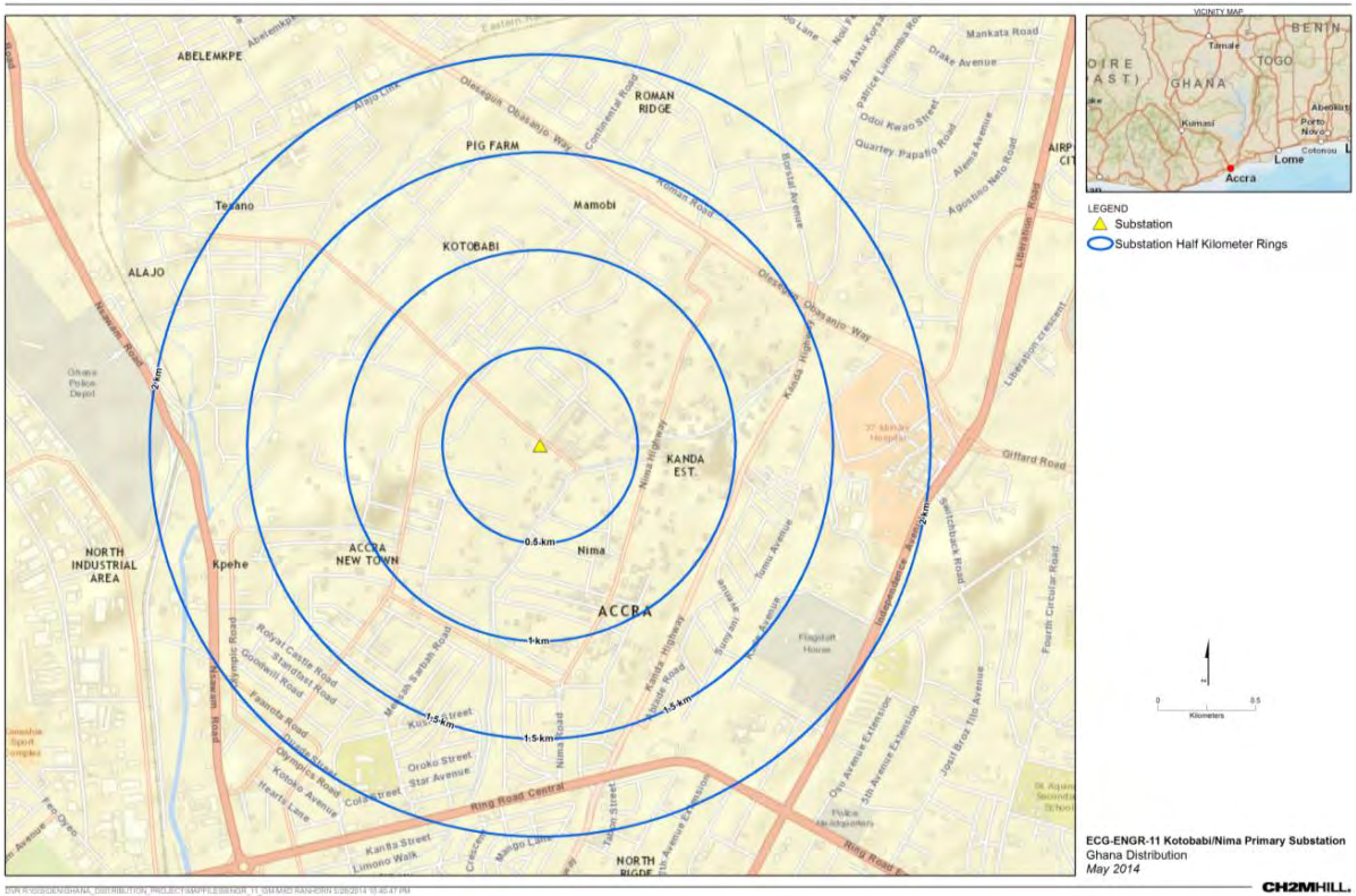
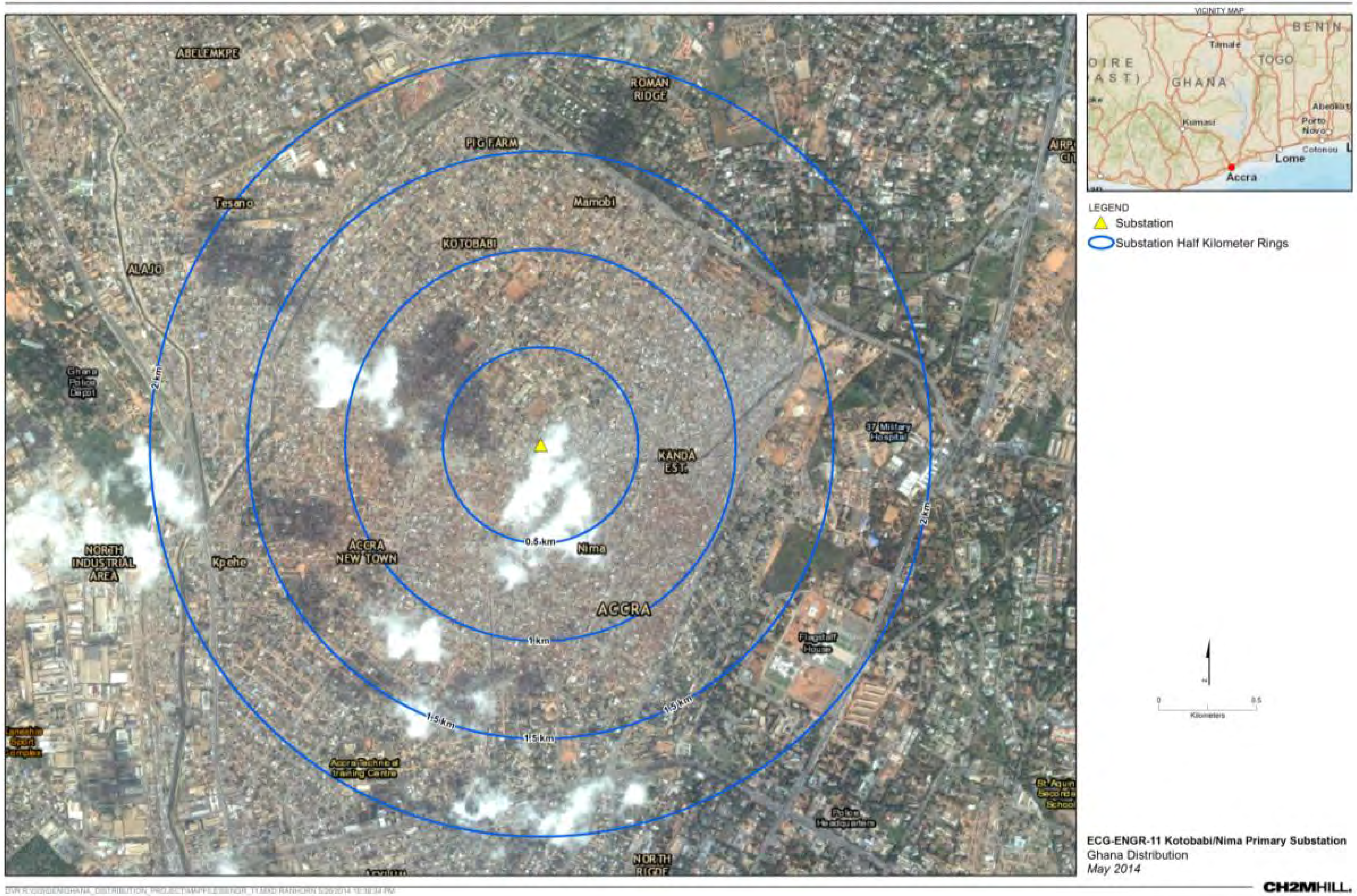


FIGURE 7-4
Aerial View of Representative Project Area for ECG-ENGR-11 Kotobabi/Nima Primary Substation



7.16 ECG-ENGR-12 Install Ogbodzo/Madina 33/11 kV Primary Substation with Interconnecting 33 kV Links and 11 kV Offloading Circuits

7.16.1 Sub-Activity Description

Intervention. The primary substations currently serving the greater Accra region will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the newly installed BSP, a primary substation will be installed at Ogbodzo/Madina. Before the energy injected by the BSP can be used by most loads (consumers) in Accra, its voltage has to be transformed a few times to bring it to a level that can be consumed by standard electric equipment. The next transformation happens at the primary substation, where the voltage is stepped down to 11 kV levels. The new substation will also help reduce technical losses and avoid extended outages caused by failures or maximum capacity reached at geographically adjacent substations.

Implementation. A contractor will be hired to build a substation that conforms to ECG's standard substation design. This will include the construction of a new 33/11 kV 2x20/26 MVA substation to meet the forecasted load. The typical primary substation in the Accra region has two matched transformers, a switch yard, capacitor banks, and a control house within the fenced perimeter of the substation. It also includes lines for the incoming sub-transmission feeders and outgoing feeders that extend for distances ranging from 500 meters to multiple km to a point where they connect with existing ECG substitutions or lines. Additional information on primary substations and associated distribution lines is provided in Section 6.1.

7.16.2 Existing Conditions

It is understood that ECG has already identified a site and has initiated acquisition procedures. Because no further information is available, Figures 7-5 and 7-6 show a representative location for this primary substation. . The representative substation area is close to Madina, northeast of Accra. Much of the area surrounding the representative area is residential, with few street hawkers and small vendors along the roadsides. The land has no vegetation cover or wildlife. The substation will have a footprint of up to approximately 100 by 100 m.

7.16.3 Environmental Impacts

Ground disturbance will be associated with construction of the primary substation and new 33 and 11 kV offloading lines. Construction of these facilities has the potential to result in dust generation, sedimentation from disturbed soils and resultant impacts to surface water drainages, wetlands, and water quality. 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 Sub-Activity. Final siting of the substation and line routes should be screened for any unknown environmentally sensitive areas. However, due to the heavily developed nature of the surrounding area, it is unlikely that any of these areas will be found in the general Sub-Activity area.

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 Sub-Activity.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with substation Sub-Activities. 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 Sub-Activities can be effectively mitigated by developing and implementing an ESMP 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

Although acquisition procedures are already underway for a site for the substation, it will be necessary during the resettlement work for the Compact to ensure that this process has proceeded in a free and transparent manner in compliance with IFC PS 5 on Land Acquisition and involuntary Resettlement; likewise, that any resulting involuntary resettlement of residents or economic displacement has been compensated in accordance with this standard. 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 likely that the distribution lines will result in some involuntary resettlement cases. Efforts to ensure the 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 because of 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.

7.16.5 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 Sub-Activity 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. A Resettlement Action Plan should be prepared if resettlement is required.

FIGURE 7-5
Map of Representative Project Area for ECG-ENGR-12 Ogbodzo/Madina Primary Substation

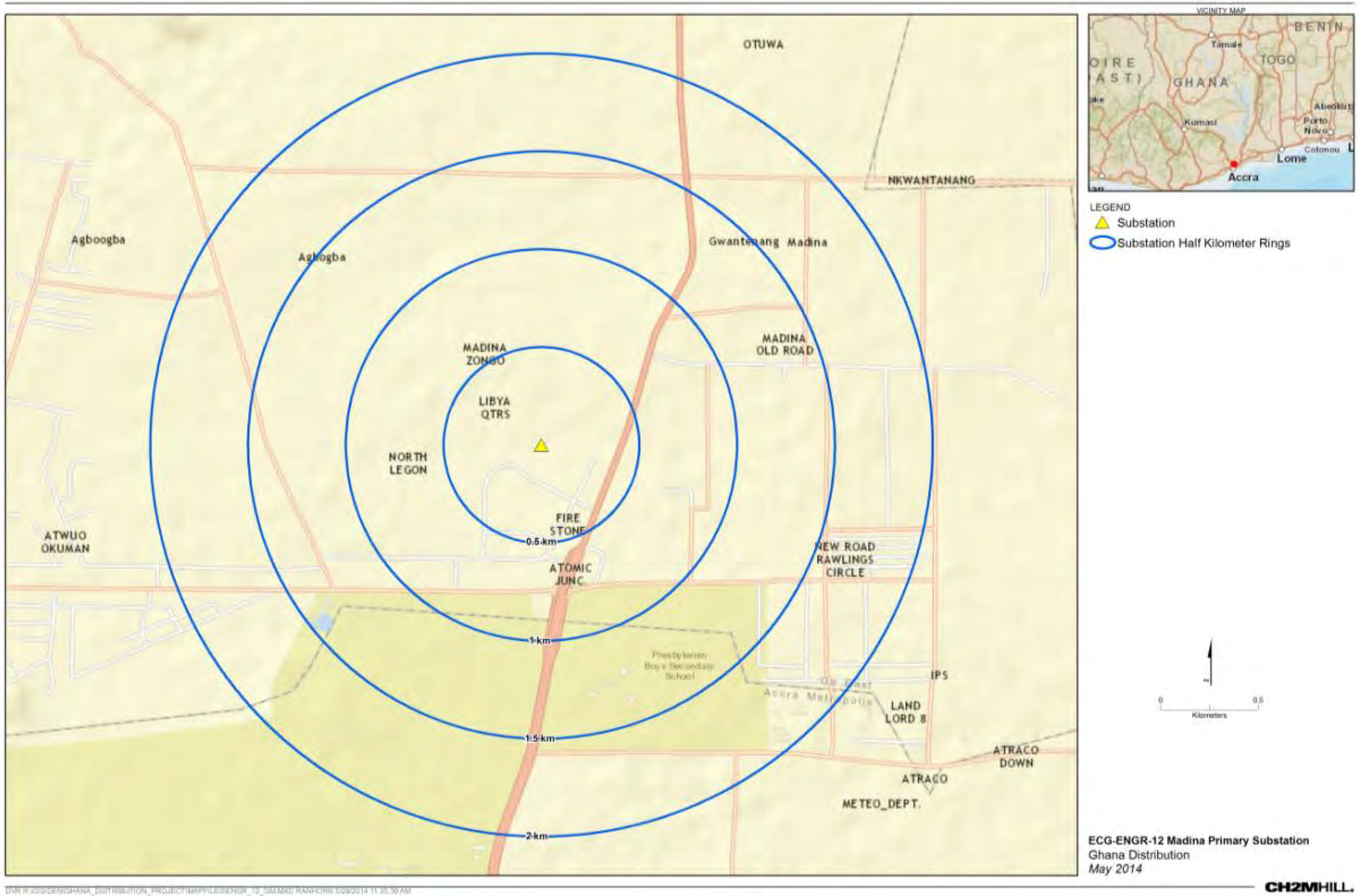
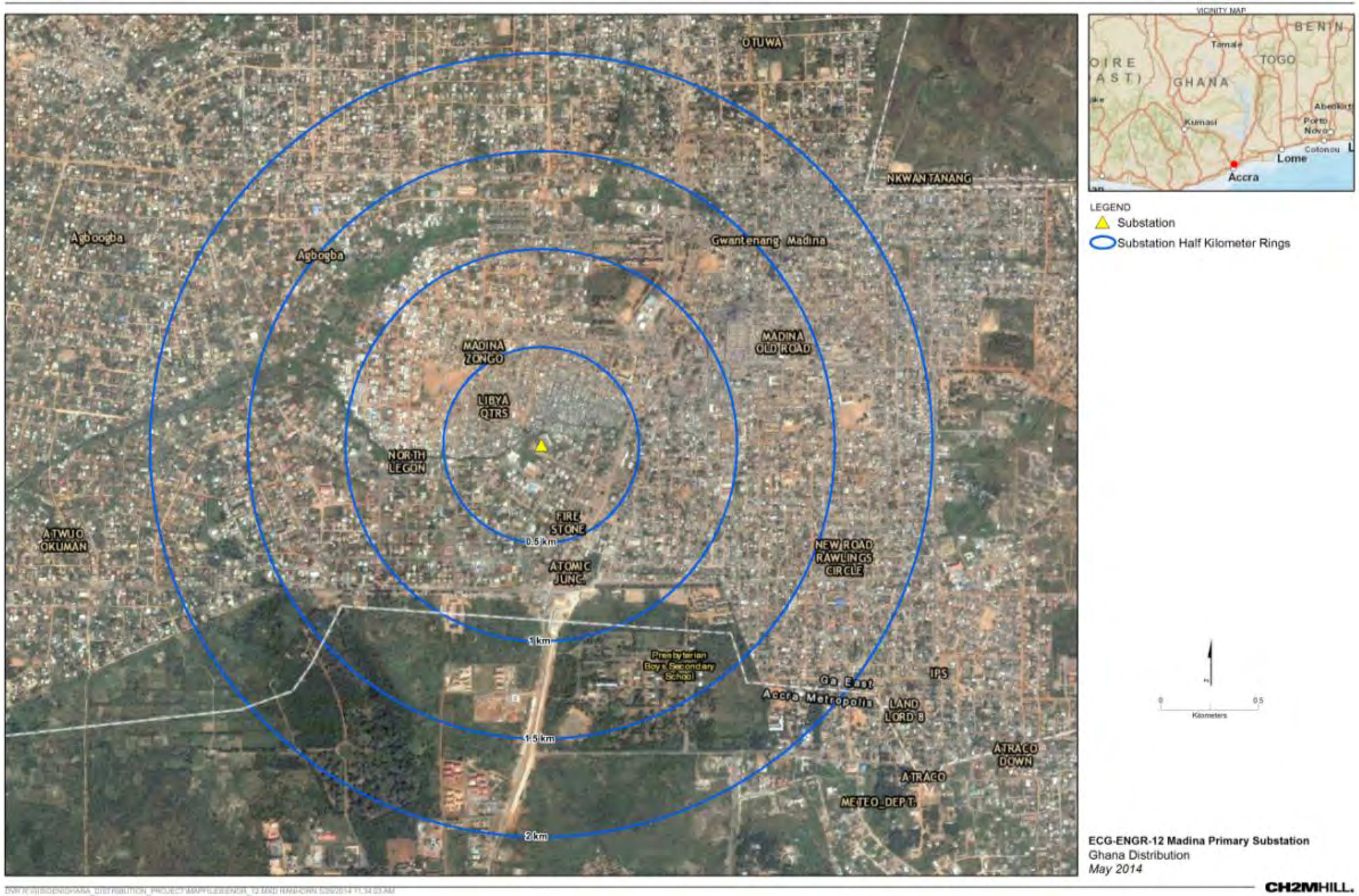


FIGURE 7-6
Aerial View of Representative Project Area for ECG-ENGR-12 Ogbodzo/Madina Primary Substation



7.17 ECG-ENGR-13 Mataheko 33/11 kV Primary Substation with Interconnecting 33 kV Links and 11 kV Offloading Circuits

7.17.1 Sub-Activity Description

Intervention. The primary substations currently serving the greater Accra region will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the newly installed BSP, a primary substation will be installed at Mataheko. Before the energy injected by the BSP can be used by most loads (consumers) in Accra, voltage has to be transformed to bring it to a level that can be consumed by standard electric equipment. The voltage transformation occurs at the primary substation, where the voltage is stepped down to 11 kV levels. The new substation will also help reduce technical losses and avoid extended outages caused by failures or maximum capacity reached at geographically adjacent substations.

Implementation. A contractor will be hired to procure and build a substation that conforms to ECG's standard substation design. This will include the construction of a new 33/11 kV 2x20/26 MVA substation to meet the forecasted load. The typical primary substation in the Accra region has two matched transformers, a switch yard, capacitor banks, and a control house within the fenced perimeter of the substation. It also includes lines for the incoming sub-transmission feeders and outgoing feeders that extend for distances ranging from 500 meters to multiple km to a point where they connect with existing ECG substitutions or lines. Additional information on primary substations and associated distribution lines is provided in Section 6.1.

7.17.2 Existing Conditions

It is understood that ECG already owns a plot in the area and has applied to the authorities to rezone it for use as a substation.. A representative site for the primary substation is shown on Figures 7-7 and 7-8. Existing structures in the general representative area are residential and commercial facilities, some of which could be affected by the Sub-Activity. The land use changes in various directions from the substation representative area and includes numerous street hawkers and small commercial establishments along the roadside. The substation will have a footprint of up to approximately 100 by 100 m.

7.17.3 Environmental Impacts

Ground disturbance will be associated with construction of the primary substation and new 33 and 11 kV offloading lines. Construction of these facilities has the potential to result in dust generation, sedimentation from disturbed soils, and associated impacts to surface water drainages. However, these highly localized erosion risks can be mitigated using standard mitigation practices 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 Sub-Activity. The proposed substation area void of vegetation and many of the surrounding areas are heavily developed with residential and commercial land uses. Final siting of the substation and line routes should be screened for any unknown environmentally sensitive areas. However, due to the heavily developed nature of the surrounding area, it is unlikely that any of these areas will be found in the general Sub-Activity area.

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 Sub-Activity.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with substation Sub-Activities. 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 Sub-Activities can be effectively mitigated by developing and implementing an EHS 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

The fact that ECG has identified a site under its ownership for the new sub-station implies that it is largely unencumbered; therefore, it is unlikely that involuntary resettlement of residents or economic displacement will occur as a result of this SAD component. However, it will be important that any activities and persons affected by the construction of the sub-station are addressed in compliance with IFC PS 5 on Land Acquisition and Involuntary Resettlement. 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. However, the number of street hawkers and roadside vendors increases significantly with distance from the representative area. Although the exact routes that will be used for the distribution lines have not been identified, efforts to ensure the 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 because of the need for construction and maintenance workers.

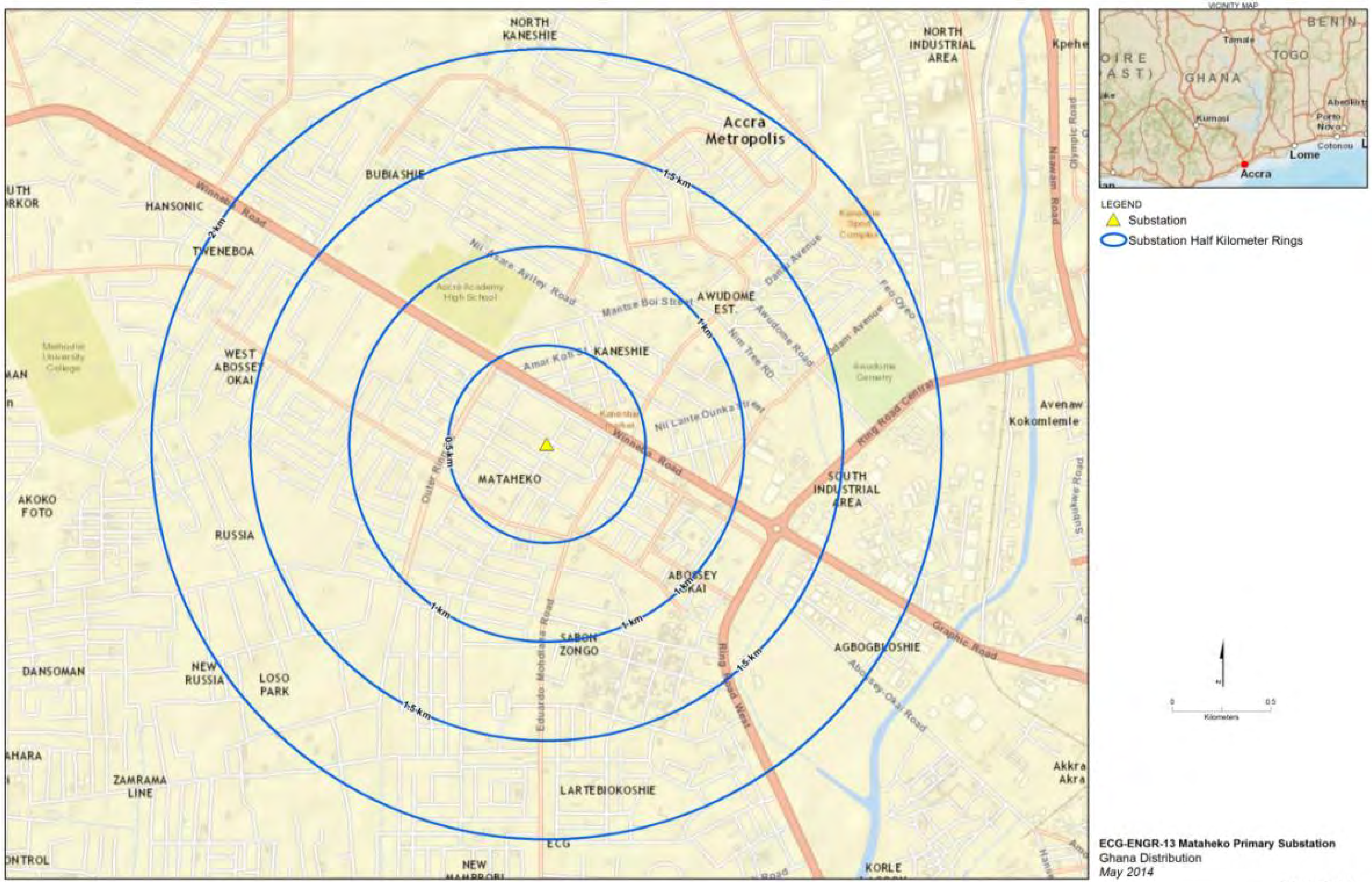
A screening for cultural resources in the area of the proposed substation should be undertaken as part of the site selection process. The screening process will include consultations with local elders and long-standing residents to assist in identifying any sites of cultural importance.

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.

7.17.5 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 an attempt to minimize resettlement impacts. 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. 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. This plan should be part of the overall Sub-Activity ESMP. 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. A Resettlement Action Plan should be prepared if resettlement is required.

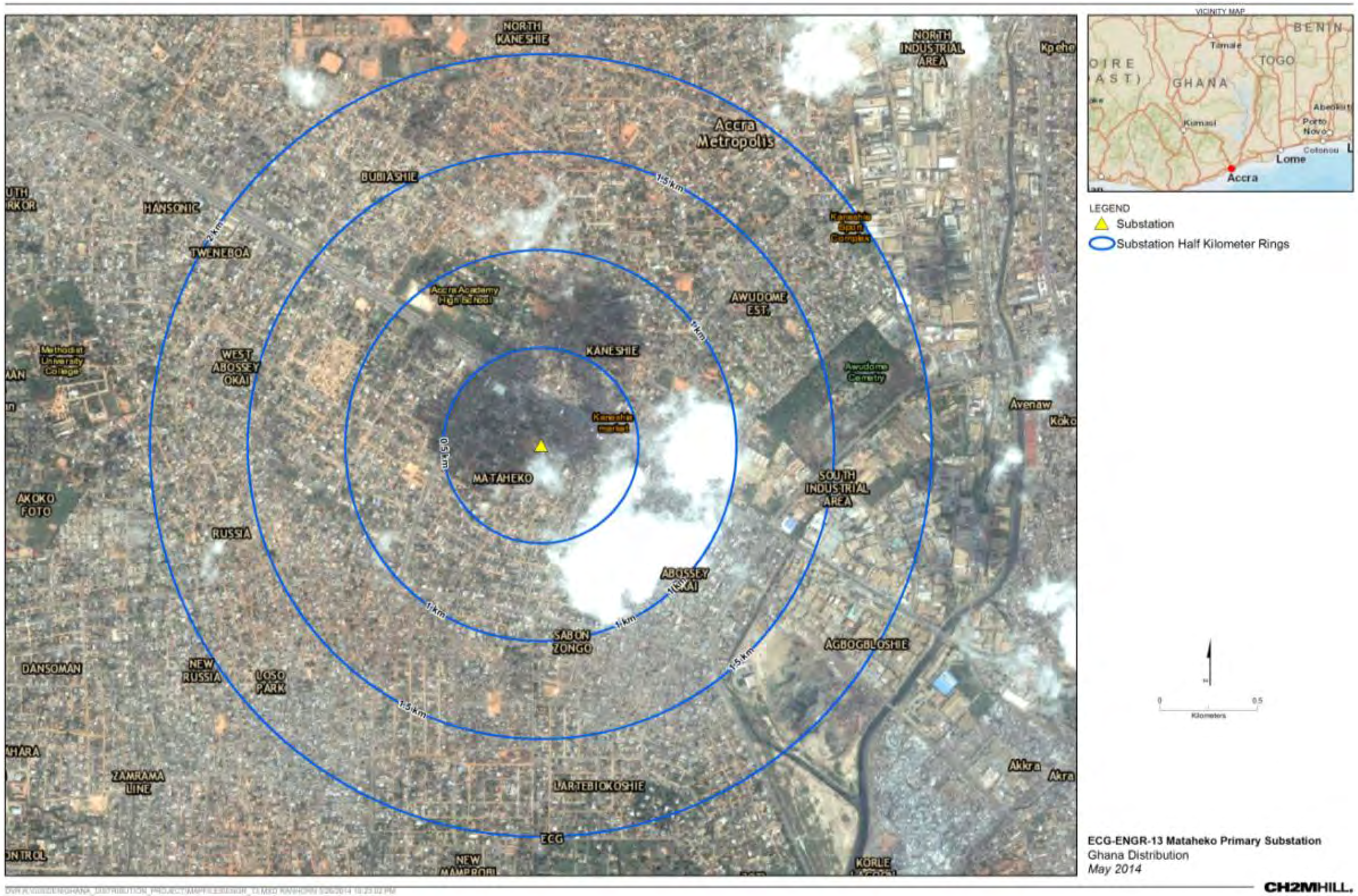
FIGURE 7-7
Map of Representative Project Area for ECG-ENGR-13 Mataheko Primary Substation



ECG-ENGR-13 Mataheko Primary Substation
Ghana Distribution
May 2014

CH2MHILL.

FIGURE 7-8
Aerial View of Representative Project Area for ECG-ENGR-13 Mataheko Primary Substation



7.18 ECG-ENGR-14 Teshie 33/11 kV Primary Substation with Interconnecting 33 kV Links and 11 kV Offloading Circuits

7.18.1 Sub-Activity Description

Intervention. The primary substations currently serving the greater Accra region will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the newly installed BSP, a primary substation will be installed at Teshie. Before the energy injected by the BSP can be used by most loads (consumers) in Accra, its voltage has to be transformed a few times to bring it to a level that can be consumed by standard electric equipment. The next transformation happens at the primary substation, where the voltage is stepped down to 11 kV levels. The new substation will also help reduce technical losses and avoid extended outages caused by failures or maximum capacity reached at geographically adjacent substations.

Implementation. A contractor will be hired to build a substation that conforms to ECG's standard substation design. This will include the construction of a new 33/11 kV 2x20/26 MVA substation to meet the forecasted load. The typical primary substation in the Accra region has two matched transformers, a switch yard, capacitor banks, and a control house within the fenced perimeter of the substation. It also includes lines for the incoming sub-transmission feeders and outgoing feeders that extend for distances ranging from 500 meters to multiple km to a point where they connect with existing ECG substitutions or lines. Additional information on primary substations and associated distribution lines is provided in Section 6.1.

7.18.2 Existing Conditions

Currently, no specific site has been selected for this substation, although investigations are underway and a site in the largely clear GRIDCo corridor to the east of Teshie is being considered. Further studies will be needed to finalize the Sub-Activity site. The proposed representative area for this substation is southeast of Accra, close to the Kofi Annan International Peacekeeping Training Center in Teshie. There are residential and commercial facilities in the general location. Hawking also occurs daily during heavy traffic hours in the morning and late afternoon. There is little vegetation cover in the general area, no critical wildlife habitat. The substation will have a footprint of up to approximately 100 by 100 m.

7.18.3 Environmental Impacts

Ground disturbance will be associated with construction of the primary substation and new 33 and 11 kV offloading lines. Construction of these facilities has the potential to result in dust generation, sedimentation from disturbed soils, and resultant impacts to surface water drainages. However, these highly localized erosion risks can be mitigated by using standard mitigation practices. 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 Sub-Activity. Final siting of the substation and line routes should be screened for any unknown environmentally sensitive areas. However, due to the heavily developed nature of the general substation area, it is unlikely that any of these areas will be found in the general Sub-Activity area.

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 Sub-Activity.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with substation Sub-Activities. 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 Sub-Activities can be effectively mitigated by developing and implementing an ESMP 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. ECG typically obtains vacant or under-used land for sub-stations most often by negotiation with institutional owners; therefore, it is unlikely that involuntary resettlement of residents or economic displacement will occur as a result of the substation. However, it will be important that the land acquisition is done in a free and transparent manner in compliance with IFC PS 5 on Land Acquisition and involuntary Resettlement. 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 likely 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 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 because of 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 Sub-Activity 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. This plan should be part of the overall Sub-Activity ESMP. 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. A Resettlement Action Plan should be prepared if resettlement is required.

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FIGURE 7-9
Map of Representative Project Area for ECG-ENGR-14 Teshie Primary Substation

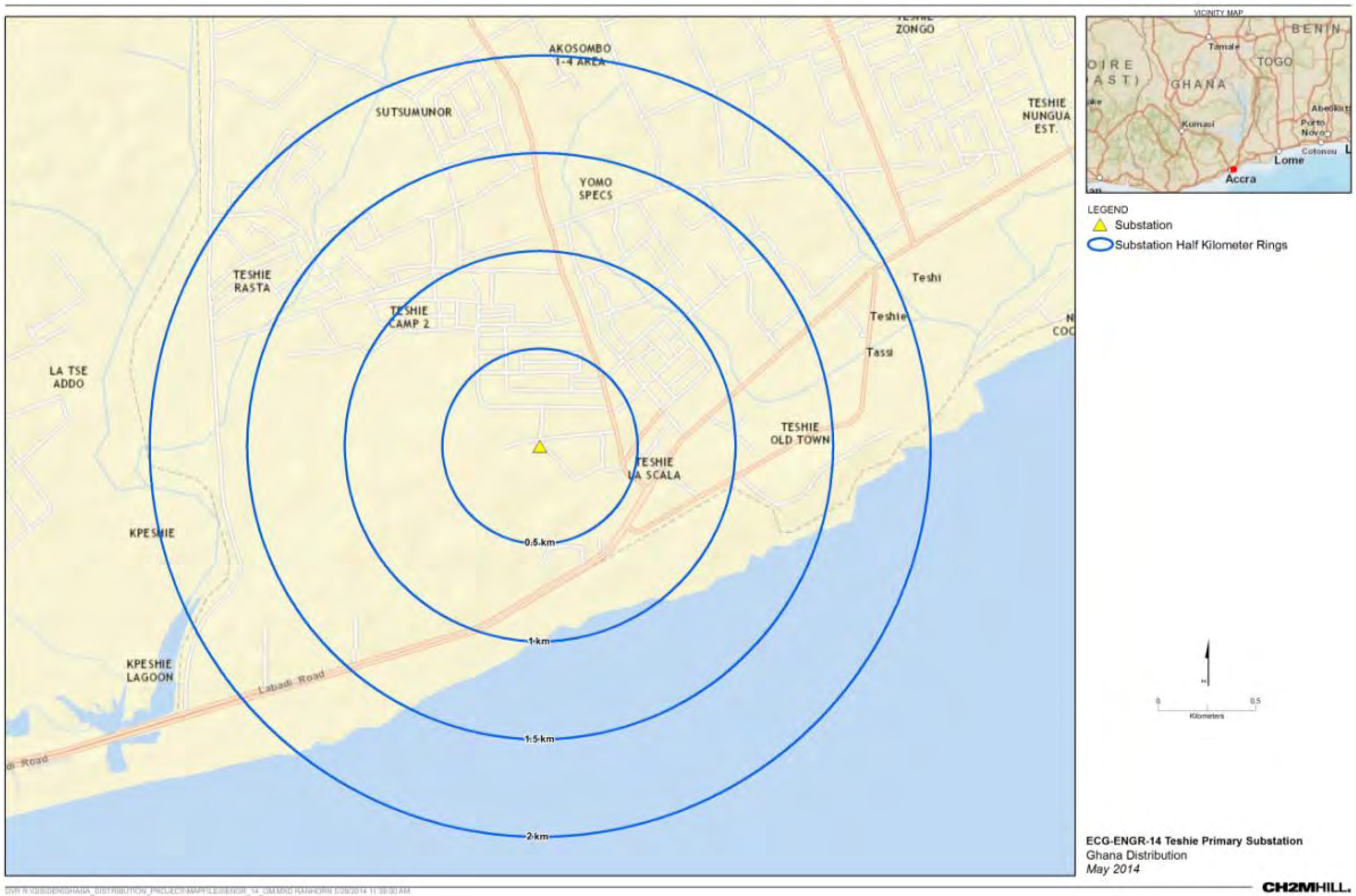
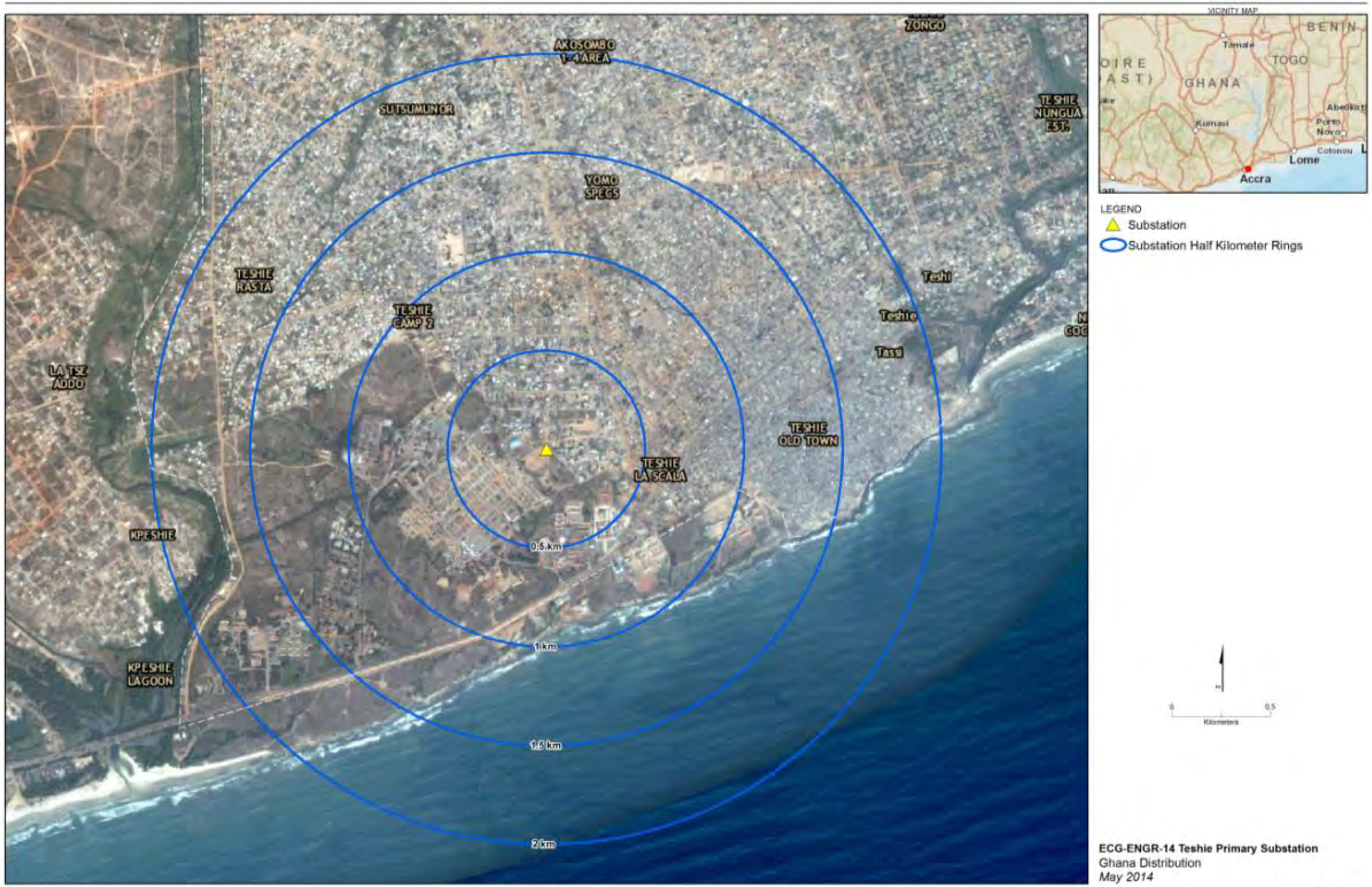


FIGURE 7-10
Aerial View of Representative Project Area for ECG-ENGR-14 Teshie Primary Substation



7.19 ECG-ENGR-15 Airport Residential Area 33/11 kV Primary Substation with Interconnecting 33 kV Links and 11 kV Offloading Circuits

7.19.1 Sub-Activity Description

Intervention. The primary substations currently serving the greater Accra region will become overloaded based on current demand forecast. To avoid rolling blackouts, and to be able to use the power from the newly installed BSP, a primary substation will be installed at Airport Residential Area. Before the energy injected by the BSP can be used by most loads (consumers) in Accra, its voltage has to be transformed a few times to bring it to a level that can be consumed by standard electric equipment. The next transformation happens at the primary substation, where the voltage is stepped down to 11 kV levels. The new substation will also help reduce technical losses and avoid extended outages caused by failures or maximum capacity reached at geographically adjacent substations.

Implementation A contractor will be hired to build a substation that conforms to ECG's standard substation design. This will include the construction of a new 33/11 kV 2x20/26 MVA substation to meet the forecasted load. The typical primary substation in the Accra region has two matched transformers, a switch yard, capacitor banks, and a control house within the fenced perimeter of the substation. It also includes lines for the incoming sub-transmission feeders and outgoing feeders that extend for distances ranging from 500 meters to multiple km to a point where they connect with existing ECG substitutions or lines. Additional information on primary substations and associated distribution lines is provided in Section 6.1.

7.19.2 Existing Conditions

Currently, no specific site has been selected for this substation. A representative site for the primary substation is shown on Figures 7-11 and 7-12. Further studies will be needed to done to finalize the Sub-Activity site. The proposed representative area for the substation is approximately 2 km west of the Accra Airport in Dzorwulu. The land use in the general area is mixed residential and commercial. The substation will have a footprint of up to approximately 100 by 100 m.

7.19.3 Environmental Impacts

Ground disturbance will be associated with construction of the primary substation and new 33 and 11 kV offloading lines. Construction of these facilities has the potential to result in dust generation, sedimentation from disturbed soils, and associated impacts to surface water drainages. However, these highly localized erosion risks can be mitigated by using standard mitigation measures. 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 Sub-Activity. Final siting of the substation and line routes should be screened for any unknown environmentally sensitive areas. However, due to the heavily developed nature of the surrounding area, it is unlikely that any of these areas will be found in the general Sub-Activity area.

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 Sub-Activity.

As with any work-related activity, there will be some level of potential worker health and safety risk associated with substation Sub-Activities. 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 Sub-Activities can be effectively mitigated by developing and implementing an EHS plan and providing adequate training. There should be no additional adverse environmental impacts during operation of the substation and new distribution lines.

7.19.4 Socioeconomic Impacts

New land will be required for the substation. ECG 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. However, it will be important that the land acquisition is done in a free and transparent manner in compliance with IFC PS 5 on Land Acquisition and involuntary Resettlement. 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 likely 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 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 because of 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.

7.19.5 Mitigation

The proposed general area for the substation should be evaluated 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 Sub-Activity 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, which is part of the overall Sub-Activity ESMP, 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. A Resettlement Action Plan should be prepared if resettlement is required.

FIGURE 7-11
Map of Representative Project Area for ECG-ENGR-15 Airport Residential Area Primary Substation

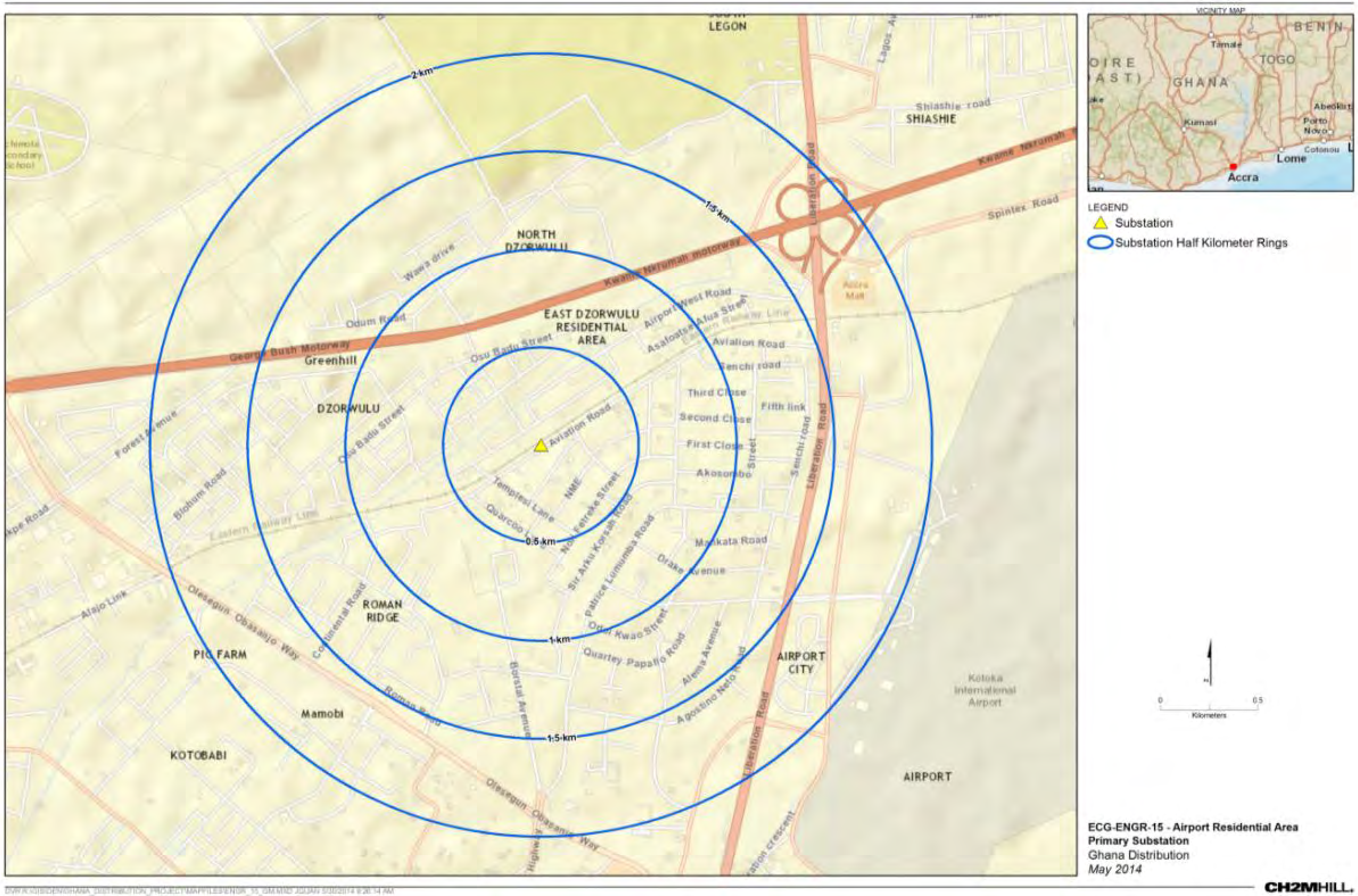
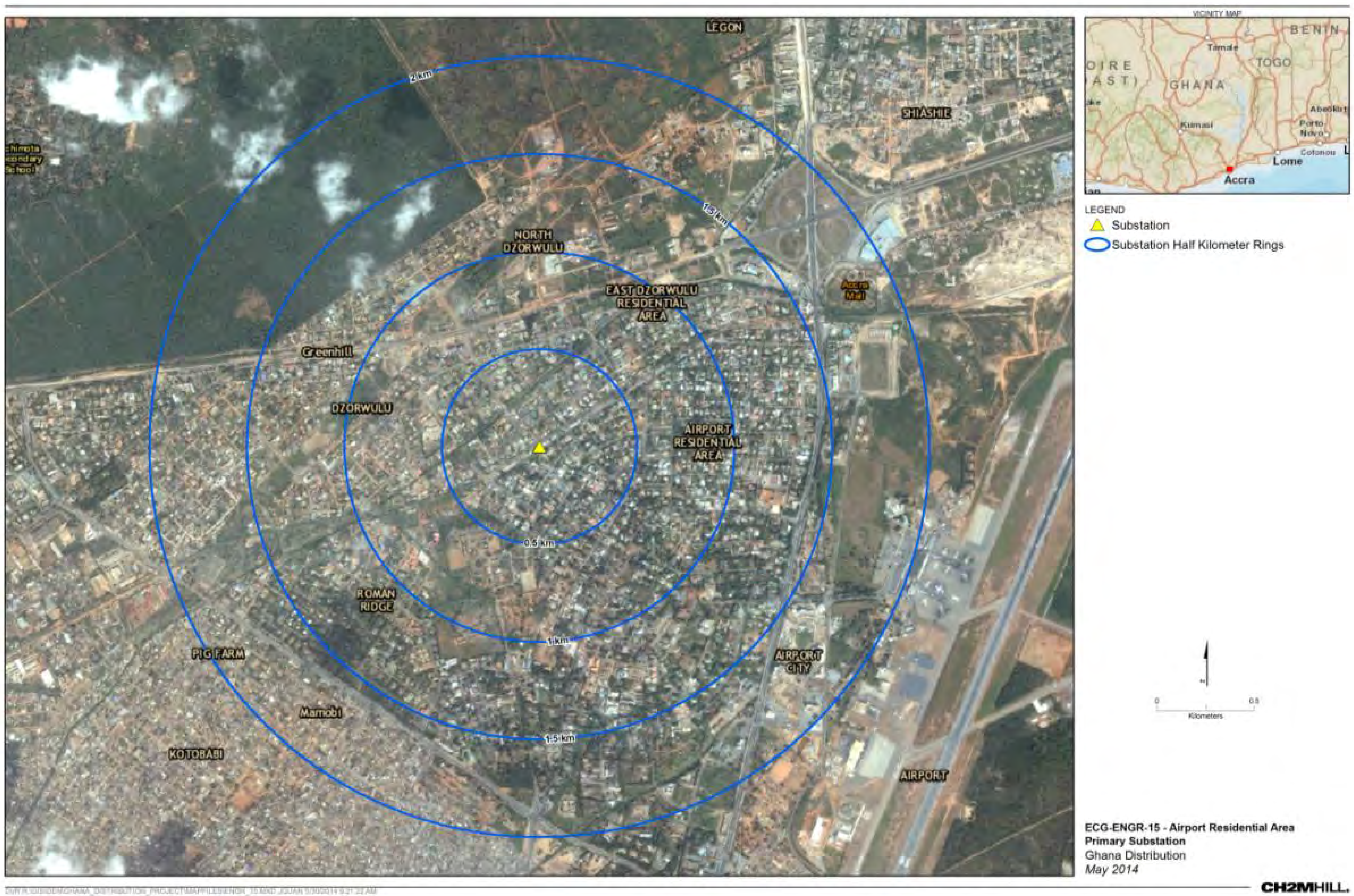


FIGURE 7-12
Aerial View of Representative Project Area for ECG-ENGR-15 Airport Residential Area Primary Substation



7.20 ECG-ENGR-36 Accra LV Feeder Bifurcation with MV Upgrade

7.20.1 Sub-Activity Description

Intervention. 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 Accra has been reported to be between 1:3 and 1:5 (GEC, 2012). LV lengths will be customized for ECG from the Sub-Activity (ENGR-42) to improve service quality and reliability while lowering technical losses.

When LV lines are long (such as in Accra) 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 network drops below allowable standards for quality of service to the customer. The purpose of this project is to reduce the length of the 440V (LV) circuits (segmenting large circuits into multiple smaller ones) to ensure that the 440V trunk lines do not exceed a length that affects the quality of service to the customer and a technical loss target.

Implementation. ECG will design the line bifurcation upgrades based on new distribution design standards prepared under Sub-Activity ENGR-42. A contractor will be hired to construct and improve the power system based on these new standards. The scope of work includes extending the 11 kV overhead (MV) lines, replacing the poles currently carrying LV lines with taller poles, and installing additional transformers. It is assumed that 25 percent of the LV lines will be replaced with MV lines and LV installed under the MV lines. Although the final length of the line will be determined after the GIS Sub-Activity (ENGR-01) and associated engineering analysis is completed and a detailed design is completed for each LV network, it has been assumed that approximately 436 km of MV line will be constructed. The MV line will be constructed within the ROW of the existing LV lines. A more complete description of this Sub-Activity is presented in Section 6.1.7.

7.20.2 Existing Conditions

The bifurcation Sub-Activity will be implemented throughout the Accra area and will cross multiple land use types and communities. Exact locations of the bifurcation lines will be developed after the GIS Sub-Activity and engineering analysis is completed. The bifurcated lines will be located in the same general ROW as the original LV lines.

7.20.3 Environmental Impacts

Because the bifurcation Sub-Activity will require minimal construction of new facilities, which will replace existing structures, overall environmental impacts will be minimal. There will be some ground disturbance associated with the replacement of existing distribution poles, which can be mitigated by 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 from 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 of exposed soils. Because no new 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 the Sub-Activity. 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 the bifurcation Sub-Activity 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 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.

This Sub-Activity will result in some resettlement due to its extensive geographical coverage, ~6,000 km. The extent of relocation, acquisition, and damage to property will be low, however, given the nature of the operations involved and flexibility in the final routing of the bifurcated lines and location of new poles.

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 will be related to 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. Because of the nature of the Sub-Activity, power outages may occur locally, but they 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. A Resettlement Action Plan should be prepared if resettlement is required.

7.21 ECG-ENGR-42 Update Distribution Construction Standards Based on Current Low-Loss Practices

7.21.1 Sub-Activity Description

Intervention. ECG currently has an engineering and construction standard that dates from 1998. Some of the standard specifications need to be updated (for example, move from open wire LV to multiplex LV cable, to reduce illegal connections).

Implementation. Under this Sub-Activity, a contractor will be hired to conduct a complete review of the engineering and construction standards used by ECG and to draft updated standards that comply with international best practice for low loss and economical designs.

The contractor will conduct training for designers and planners at ECG on the updated material. Enforcement is anticipated to be the responsibility of ECG management.

7.21.2 Existing Conditions

The Sub-Activity will be implemented by an outside contractor who will then work with the ECG staff within existing ECG infrastructure. No additional construction will be required.

7.21.3 Environmental Impacts

The Sub-Activity will not result in any environmental impacts.

7.21.4 Socioeconomic Impacts

The Sub-Activity will not result in any direct social or economic impacts. The Sub-Activity should improve ECG construction standards, which will indirectly benefit both ECG and other stakeholders.

7.21.5 Mitigation

No mitigation is required other than ensuring that the Sub-Activity will be implemented in a manner that provides equal opportunities for ECG 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 ECG to ensure that similar conditions are incorporated in:
  - Standard ECG operating policies and procedures, if they are not already so included.
  - All contracts made by ECG 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

Amongst 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 ECG 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 ECG to ensure that similar conditions are incorporated in:
  - Standard ECG operating policies and procedures, if they are not already so included.
  - All contracts made by ECG 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.*[6]

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.[7] 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[8] and are key end-users of energy for household purposes. Women also participate strongly in the informal small scale commercial sector.[9] A number of studies highlight the link between energy and gender within an Africa context, and specific to Ghana.[10] 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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6 MCC, 2011, Gender Policy, Washington; https://www.mcc.gov/documents/guidance/mcc-policy-gender.pdf

7 I.e., through the reduction of power outages that currently affect business and household activities alike.

8 Wamukonya, Njeri. 2002. A critical look at gender and energy mainstreaming in Africa; http://www.un.org/womenwatch/daw/forum-sustdev/Njeri-paper.pdf.

9 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 .

10 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)

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

9.3 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 ECG 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, ECG, 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 PSs, World Bank EHS guidelines, ISO 14001, corporate EHS policies and procedures, all project-specific permits and EHS requirements.

10.2 EHS Policy and Procedures

ECG 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 protocols (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, prior to 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 PSs

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 ECG 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 ECG 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 ECG'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 Arrangements

Resources needed to implement the ESMP are personnel and funding. The key stakeholders in the ESMP implementation are ECG, contractors, consultants, EPA[11], and the MCC. ECG 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

ECG 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 ECG 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, ECG 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 grievance redress mechanism (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.

[11] The EPA will be involved in reviewing and approving any documents that fall under its statutory obligations.

- 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[12] , 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 ECG. 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 ECG 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?

[12] Not needed for grievances involving only requests for information that were dealt with when the grievance was lodged.

- 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
- 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 ECG 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

ECG 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 for the staff. 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. This will be achieved by:

- Identifying 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
- Filling out a training needs matrix to target the training to a specific audience
- Ensuring 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, ECG 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 PSs
- 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 ECG 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

ECG 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 ECG 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	ECG 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, including women, 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 (PAPs), if any, of entitlement to compensation and framework/process Disseminate relevant impact assessment findings	ECG 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.	ECG 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.	ECG 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.	ECG 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	ECG 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
		Ensure that period of inaccessibility to land is as short a possible			
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 ECG Supervisors, site managers, 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.	ECG and Contractor with consultant support	Periodically throughout construction and operations Annual EHS Compliance Audits	ECG 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.	ECG with consultant support	Prior to and periodically throughout construction	Accident statistics Community training records 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, 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	ECG 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	ECG 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 ECG EHS policies, procedures, protocols, environmental BMP manuals, and training programs/modules needed to implement ESMP, permit requirements, and PEA/ESIA commitments	ECG	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) ECG and contractors; and (ii) between contractors and their sub-contractors/ suppliers.	ECG/ 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) ECG and contractors; and (ii) between contractors and their sub-contractors/ suppliers.	ECG/ 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.	ECG 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	ECG	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	ECG 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 Above Ground 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	ECG 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.	ECG 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 and primary substations.	Site avoidance/selection via screening for cultural and archaeological sites Shovel tests undertaken by specialist personnel during the PEA/ESIA at potential archaeological sites that cannot be avoided Implementation of chance finds procedure	ECG 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 bunded, 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	ECG 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	ECG 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)
Soil Stabilization and Replanting of Vegetation in Temporary Work Areas	Beneficial Impact: Enhancement of flora, fauna, soil conservation and habitat quality	Reseed or plant and mulch temporarily disturbed soils and degraded habitats with local (native) species common in the area to complement existing vegetation and	ECG	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

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
	Control of exotic, invasive vegetation	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			
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	ECG	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	ECG	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 bunded, 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	ECG	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 ECG 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	ECG	Daily inspection and monthly reporting	Manifests and receipts for truck transport and landfill tipping fees Records of illegal dumping prosecutions
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	ECG	Periodic emptying throughout project	Contamination of water bodies Instances of water-borne disease

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
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 PEA/ESIA, and the ESMP	ECG 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	ECG 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.	Public awareness campaigns to publicize introduction of new meters, tariffs, and payment methods (e.g., pre-payment cards). Strengthening of ECG customer service department, with special emphasis on issues relating to vulnerable groups and, where appropriate, women.	ECG	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	ECG	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, paying special attention to the removal of asbestos. Remove all access roads Revegetate sites	ECG	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
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	ECG 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

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
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	ECG 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

ECG Financial Model - Version D

Financial Summary (GHS 000)

	Year									
	Historical	Projected								
Category	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Operating Revenue	1,435,358	1,683,509	2,850,813	3,020,422	3,185,149	3,341,433	3,552,581	3,740,081	3,934,354	4,114,795
Cost of Wholesale Power	1,014,178	1,074,565	2,141,257	2,366,926	2,496,524	2,621,144	2,790,258	2,940,108	3,095,398	3,239,392
Gross Margin	421,180	608,944	709,556	653,496	688,625	720,289	762,323	799,972	838,956	875,403
Operating Costs										
Operations and Maintenance	83,771	89,711	93,944	99,884	105,824	111,764	117,704	123,644	129,584	135,524
Distribution Expenses	56,233	62,830	66,082	69,327	72,695	74,545	76,443	78,389	80,384	82,430
Administration Expenses	163,417	182,588	192,039	201,469	211,256	216,633	222,148	227,802	233,601	239,548
Other Operating Income/Expenses	6,907	7,717	8,117	8,515	8,929	9,156	9,389	9,628	9,873	10,125
Total	296,515	327,412	343,948	362,164	380,845	393,786	406,905	420,207	433,696	447,378
Depreciation	219,424	222,355	226,826	235,321	249,315	263,310	277,305	291,299	305,294	319,288
Financing Costs	16,185	29,228	30,607	32,543	34,478	36,413	38,349	40,284	42,219	44,155
Operating Profit/Loss	(110,944)	29,949	108,175	23,468	23,986	26,780	39,765	48,182	57,747	64,582
Non-Operating Income/Expenses	2,158	2,489	4,043	4,269	4,489	4,697	4,978	5,228	5,486	5,727
Net Profit/Loss	(108,786)	32,438	112,218	27,738	28,475	31,476	44,743	53,410	63,233	70,309
Collection Losses		(306,436)	(530,769)	(562,549)	(593,351)	(622,969)	(663,162)	(698,777)	(735,685)	(769,908)
Net Profit/Loss after Collection Losses	(108,786)	(273,998)	(418,550)	(534,811)	(564,875)	(591,493)	(618,419)	(645,367)	(672,452)	(699,599)

	Year										
	Projected										
Category	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Operating Revenue	4,299,384	4,486,692	4,671,326	4,852,262	5,028,457	5,198,861	5,362,429	5,518,127	5,664,949	5,811,495	5,961,833
Cost of Wholesale Power	3,386,690	3,536,130	3,683,332	3,827,460	3,967,666	4,103,098	4,232,904	4,356,242	4,472,292	4,588,038	4,706,781
Gross Margin	912,694	950,561	987,995	1,024,802	1,060,790	1,095,763	1,129,525	1,161,886	1,192,656	1,223,456	1,255,052
Operating Costs											
Operations and Maintenance	141,464	147,405	153,345	159,285	165,225	171,165	177,105	183,045	188,985	194,925	200,866
Distribution Expenses	84,529	86,680	88,887	91,149	93,470	95,849	98,289	100,791	103,357	105,988	108,686
Administration Expenses	245,645	251,898	258,311	264,886	271,629	278,543	285,634	292,905	300,361	308,007	315,847
Other Operating Income/Expenses	10,382	10,647	10,918	11,196	11,481	11,773	12,073	12,380	12,695	13,018	13,350
Total	461,256	475,336	489,624	504,125	518,843	533,784	548,955	564,361	580,008	595,902	612,049
Depreciation	333,283	347,277	361,272	375,267	389,261	403,256	417,250	431,245	445,240	459,234	473,229
Financing Costs	46,090	48,025	49,960	51,896	53,831	55,766	57,702	59,637	61,572	63,508	65,443
Operating Profit/Loss	72,065	79,922	87,138	93,515	98,855	102,956	105,618	106,643	105,837	104,813	104,331
Non-Operating Income/Expenses	5,973	6,222	6,468	6,709	6,943	7,170	7,388	7,596	7,791	7,986	8,186
Net Profit/Loss	78,037	86,144	93,606	100,224	105,798	110,126	113,006	114,238	113,628	112,799	112,517
Collection Losses	(804,917)	(840,434)	(875,420)	(909,675)	(942,998)	(975,186)	(1,006,037)	(1,035,351)	(1,062,933)	(1,090,442)	(1,118,664)
Net Profit/Loss after Collection Losses	(726,880)	(754,290)	(781,814)	(809,451)	(837,199)	(865,060)	(893,031)	(921,113)	(949,305)	(977,643)	(1,006,146)

ECG Financial Model - Alternate D-1 (Includes improvements in Technical and Commercial Losses and improved Collection Efficiency)

Financial Summary (GHS 000)

Explanation	Year																				
	Historical	Projected																			
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Operating Revenue	1,435,358	1,683,509	2,850,813	3,034,425	3,214,739	3,388,126	3,618,991	3,810,205	4,008,338	4,192,383	4,380,500	4,571,387	4,759,548	4,943,935	5,123,488	5,297,136	5,463,813	5,622,466	5,772,067	5,921,385	6,074,567
Cost of Wholesale Power - Revised	1,014,178	1,074,565	2,141,257	2,366,926	2,487,096	2,601,724	2,760,068	2,898,028	3,051,211	3,193,270	3,338,471	3,485,783	3,630,889	3,772,964	3,911,175	4,044,679	4,172,636	4,294,218	4,408,616	4,522,714	4,639,766
Gross Margins	421,180	608,944	709,556	667,499	727,644	786,403	858,923	912,177	957,127	999,113	1,042,029	1,085,604	1,128,659	1,170,971	1,212,313	1,252,458	1,291,177	1,328,248	1,363,451	1,398,671	1,434,801
Operating Costs																					
Operations and Maintenance	83,771	89,711	93,944	99,884	105,824	111,764	117,704	123,644	129,584	135,524	141,464	147,405	153,345	159,285	165,225	171,165	177,105	183,045	188,985	194,925	200,866
Distribution Expenses	56,233	62,830	66,082	69,327	72,695	74,545	76,443	78,389	80,384	82,430	84,529	86,680	88,887	91,149	93,470	95,849	98,289	100,791	103,357	105,988	108,686
Administration Expenses	163,417	182,588	192,039	201,469	211,256	216,633	222,148	227,802	233,601	239,548	245,645	251,898	258,311	264,886	271,629	278,543	285,634	292,905	300,361	308,007	315,847
Other Operating Income/Expenses	6,907	7,717	8,117	8,515	8,929	9,156	9,389	9,628	9,873	10,125	10,382	10,647	10,918	11,196	11,481	11,773	12,073	12,380	12,695	13,018	13,350
Total	296,515	327,412	343,948	362,164	380,845	393,786	406,905	420,207	433,696	447,378	461,256	475,336	489,624	504,125	518,843	533,784	548,955	564,361	580,008	595,902	612,049
Depreciation	219,424	222,355	226,826	235,321	249,315	263,310	277,305	291,299	305,294	319,288	333,283	347,277	361,272	375,267	389,261	403,256	417,250	431,245	445,240	459,234	473,229
Financing Costs	16,185	29,228	30,607	32,543	34,478	36,413	38,349	40,284	42,219	44,155	46,090	48,025	49,960	51,896	53,831	55,766	57,702	59,637	61,572	63,508	65,443
Operating Profit/Loss	(110,944)	29,949	108,175	37,471	63,005	92,893	136,365	160,387	175,918	188,293	201,400	214,965	227,802	239,684	250,378	259,651	267,270	273,005	276,631	280,027	284,080
Non-Operating Income/Expenses	2,158	2,489	4,043	4,288	4,528	4,759	5,066	5,321	5,585	5,830	6,081	6,335	6,585	6,831	7,070	7,301	7,523	7,735	7,934	8,133	8,337
Net Profit/Loss	(108,786)	32,438	112,218	41,759	67,533	97,652	141,431	165,708	181,503	194,123	207,481	221,300	234,388	246,515	257,448	266,952	274,793	280,739	284,565	288,160	292,417
Collection Losses - Revised	(242,938)	(285,795)	(495,017)	(479,453)	(512,356)	(499,452)	(496,265)	(482,327)	(507,810)	(531,441)	(555,606)	(580,123)	(604,272)	(627,917)	(650,919)	(673,137)	(694,433)	(714,667)	(733,706)	(752,694)	(772,175)
Net Profit/Loss after Collection Losses - Revised	(351,723)	(253,357)	(382,799)	(437,694)	(444,823)	(401,800)	(354,834)	(316,619)	(326,307)	(337,318)	(348,125)	(358,823)	(369,884)	(381,402)	(393,471)	(406,185)	(419,639)	(433,927)	(449,141)	(464,535)	(479,758)

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 Company 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

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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 ECG

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).

EXHIBIT 5

Economic Modeling Results: Without Access Scenarios by Project, ECG

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
ECG-Comm-01: Normalization of existing services to comply with improved service connection standard	$8,569,935	22.7%	$10,935,905	25.7%	$11,576,312	27.3%	$13,342,683	30.6%	$2,521,762	14.1%
ECG-Comm-04: Replacement of legacy meters with prepayment meters	$8,071,554	25.2%	$11,129,583	29.9%	$12,086,350	32.2%	$14,572,133	37.1%	($381,730)	10.4%
ECG-Comm-07: Metering at critical nodes of the distribution system	($2,359,232)	3.3%	($1,963,621)	4.7%	($1,666,128)	5.5%	($1,170,829)	7.0%	($4,155,471)	-1.5%
ECG-Comm-10: Strengthening loss control program	$1,238,221	58.5%	$1,905,004	95.5%	$1,955,761	106.0%	$2,334,689	153.5%	$35,017	12.1%
ECG-Engr-01: Distribution system survey, GIS system development, and customer census	$5,171,584	53.1%	$6,191,995	63.9%	$9,696,148	133.9%	$19,279,924	#NUM!	$4,609,345	41.1%
ECG-Engr-07: Reactive power compensation for primary substations	$3,230,164	27.2%	$4,017,420	31.2%	$4,211,477	33.4%	$3,618,566	31.1%	$3,297,923	24.9%
ECG-Engr-10: Install Bulk Supply Point (BSP) substation with feeders to existing primary substations in Accra	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!
ECG-Engr-11: Install Kotobabi/Nima primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!
ECG-Engr-12: Install Ogbodzo/Madina primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!

EXHIBIT 6

Economic Modeling Results: Without Access Scenarios by Project, ECG

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
ECG-Engr-13: Install Mataheko primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!
ECG-Engr-14: Install Teshie primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!
ECG-Engr-15: Install Airport Residential Area primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!	$0	#NUM!
ECG-Engr-36: Accra low voltage feeder bifurcation with medium voltage upgrade	$45,750,214	28.6%	$54,650,219	31.5%	$56,404,018	33.0%	$50,800,171	32.0%	$45,651,555	26.1%
ECG-Engr-39: Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion	($2,995,283)	#NUM!	($228,644)	-1.0%	$51,690,283	746.0%	$190,730,663	1652.5 %	$13,158,989	260.5%
ECG-Engr-42: Update distribution construction standards based on current low loss practices	$230,266	25.4%	$283,492	28.5%	$300,740	30.3%	$287,580	30.4%	$194,263	21.5%
ECG-Ops-01: Outage management system	($2,648,564)	#NUM!	($1,172,448)	#NUM!	$26,574,792	374.8%	$100,801,761	1455.8 %	$5,788,110	76.5%
ECG-Ict-01: Data center and communication network	($1,985,456)	2.5%	($967,247)	7.2%	$11,498,367	57.4%	$44,674,537	271.2%	$339,238	12.2%
ECG-Service-01: Installation of ERP system and integration with existing enterprise applications	$9,012,300	46.6%	$11,168,842	55.2%	$22,466,540	109.7%	$53,133,011	296.3%	$9,236,452	41.6%

EXHIBIT 7

Economic Modeling Results: Without Access Scenarios by Project, ECG

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
ECG-Service-03: ECG Technical Assistance Program	($6,177,930)	-2.6%	($5,573,793)	-0.9%	($865,220)	9.4%	$11,187,281	35.8%	($7,192,166)	-2.2%
ECG-Service-04: Distribution System Master Plan	$3,129,577	84.6%	$3,559,015	96.0%	$5,041,257	144.4%	$23,137,698	799.2%	($5,373,370)	#NUM!
Total Proposed Investment NPV and EIRR	**$68,237,351**	**21.35%**	**$93,935,722**	**25.04%**	**$210,970,697**	**41.96%**	**$526,729,867**	**87.68%**	**$67,729,917**	**20.47%**

Notes:

#NUM! indicates an invisible number

EXHIBIT 8

Economic Modeling Results: With Access Scenarios by Project, ECG

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
ECG-Comm-01: Normalization of existing services to comply with improved service connection standard	$8,610,098	22.7%	$10,980,530	25.8%	$11,620,937	27.3%	$13,382,848	30.7%	$2,566,793	14.1%
ECG-Comm-04: Replacement of legacy meters with prepayment meters	$8,071,554	25.2%	$11,129,583	29.9%	$12,086,350	32.2%	$14,572,133	37.1%	($381,730)	10.4%
ECG-Comm-07: Metering at critical nodes of the distribution system	($2,359,232)	3.3%	($1,963,621)	4.7%	($1,666,128)	5.5%	($1,170,829)	7.0%	($4,155,471)	-1.5%
ECG-Comm-10: Strengthening loss control program	$1,238,221	58.5%	$1,905,004	95.5%	$1,955,761	106.0%	$2,334,689	153.5%	$35,017	12.1%
ECG-Engr-01: Distribution system survey, GIS system development, and customer census	$5,220,335	53.5%	$6,246,162	64.5%	$9,746,512	135.5%	$19,324,113	#NUM!	$4,658,689	41.5%
ECG-Engr-07: Reactive power compensation for primary substations	$4,165,068	32.0%	$5,056,202	36.8%	$5,250,259	39.4%	$4,553,507	36.7%	$4,346,126	29.3%
ECG-Engr-10: Install Bulk Supply Point (BSP) substation with feeders to existing primary substations in Accra	$16,874,885	33.3%	$19,910,166	36.8%	$32,228,769	52.1%	$180,484,093	219.9%	($53,902,750)	#NUM!

EXHIBIT 8

Economic Modeling Results: With Access Scenarios by Project, ECG

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
ECG-Engr-11: Install Kotobabi/Nima primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	$16,041,107	31.6%	$19,008,135	34.9%	$31,342,007	49.2%	$179,680,826	193.3%	($54,888,897)	#NUM!
ECG-Engr-12: Install Ogbodzo/Madina primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	$18,279,362	47.6%	$21,166,978	53.0%	$33,033,290	77.9%	$177,275,301	392.2%	($50,218,826)	#NUM!
ECG-Engr-13: Install Mataheko primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	$15,853,733	36.0%	$18,741,349	40.2%	$30,733,581	59.2%	$175,090,578	295.5%	($53,131,735)	#NUM!
ECG-Engr-14: Install Teshie primary substation with interconnecting sub-transmission links and medium voltage offloading circuits	$15,075,555	35.9%	$17,874,943	40.0%	$29,514,758	59.2%	$169,475,093	295.5%	($51,858,105)	#NUM!
ECG-Engr-15: Install Airport Residential Area primary substation with interconnecting sub-transmission links and	$15,283,839	37.8%	$17,803,540	41.3%	$28,198,779	55.7%	$154,094,036	158.5%	($44,635,912)	#NUM!

EXHIBIT 8

Economic Modeling Results: With Access Scenarios by Project, ECG

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
medium voltage offloading circuits										
ECG-Engr-36: Accra low voltage feeder bifurcation with medium voltage upgrade	$46,666,058	29.0%	$55,660,520	32.0%	$57,408,229	33.5%	$51,665,293	32.5%	$46,764,726	26.5%
ECG-Engr-39: Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion	($2,864,622)	#NUM!	($83,465)	7.3%	$51,777,390	746.8%	$190,791,638	1652.8%	$13,224,320	261.4%
ECG-Engr-42: Update distribution construction standards based on current low loss practices	$270,430	27.7%	$328,118	31.0%	$345,366	32.9%	$327,745	32.9%	$239,294	23.7%
ECG-Ops-01: Outage management system	($2,578,851)	#NUM!	($1,094,989)	#NUM!	$26,621,267	375.4%	$100,834,294	1456.2%	$5,822,967	76.8%
ECG-Ict-01: Data center and communication network	($1,954,668)	2.7%	($933,038)	7.3%	$11,518,892	57.5%	$44,688,905	271.3%	$354,632	12.3%
ECG-Service-01: Installation of ERP system and integration with existing enterprise applications	$9,040,186	46.7%	$11,199,826	55.3%	$22,485,130	109.8%	$53,146,024	296.4%	$9,250,395	41.7%

EXHIBIT 8

Economic Modeling Results: With Access Scenarios by Project, ECG

Scenario	P_{90}		P_{50}		P_{10}		Best		Worst	
Description	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**	**NPV**	**EIRR**
ECG-Service-03: ECG Technical Assistance Program	($6,167,198)	-2.5%	($5,561,869)	-0.8%	($858,065)	9.4%	$11,192,290	35.8%	($7,186,800)	-2.1%
ECG-Service-04: Distribution System Master Plan	$3,217,390	86.9%	$3,656,585	98.6%	$5,138,827	147.4%	$23,225,515	802.5%	($5,274,915)	#NUM!
Total Proposed Investment NPV and EIRR	**$167,983,248**	**25.78%**	**$211,030,659**	**29.34%**	**$398,481,913**	**45.53%**	**$1,564,968,093**	**108.14%**	**($238,372,184)**	**#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
ECG Procurement Plan

ECG Procurement Plan

Priority	Sub-Activity Name		Pre-Design Requirements (basis for RFP)	Bundling Options	Procurement Method and Contract Type
1	**ECG-Service-03: Technical Assistance Program**				
The hiring of the technical assistance team is critical to helping ECG focus early on the task at hand and to be sure the critical path of the SADs 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 ECG to develop scope of services.*	N/A	
	LABOR:	Advisory Team will assist owners PMU			Best-Value selection. Time and Materials Contract
2	**ECG-Engr-01: Distribution system survey, GIS system development, and customer census**				
The GIS contractor needs to be procured as the very first step in the process because all other SAD's follow with the field work and data captured from this SAD. Key component of data collection is gathering the proper data and the integration of data in the CMS. This is the most critical path element of to the Compact. Internal process and procedures must be reviewed and adopted.			*MiDA, Program Management Contractor, and Loss Management Technical Assistance Contractor to verify scope and parameters.*		
	LABOR:	GIS Data Collection Consulting Firm		N/A	Best-Value selection; Unit-rate contract (based on volume of information collected)
	Equipment	Purchase of ArcGIS license for ECG - owner of data			Best Value Selection; Lump-sum agreement
3	**ECG-Service-01: Installation of ERP system and integration with existing enterprise applications**				
4	**ECG-Ict-01: Data center and communication network**				
The ERP integration has been laid out in the ECG ICT Master Plan, but the details of the decentralization of ECG processes have not been fully developed with the new CMS, GIS, OMS and will require a new integration plan be studied as part of the WiPro report. This updated ICT Master plan may take three months to complete before the RFP can be drafted to reflect the desired goals and objectives of the ERP.			*Program Management Contractor and MiDA work with ECG to verify ERP requirements. Likely need to update the WiPro report*		

Priority	Sub-Activity Name		Pre-Design Requirements (basis for RFP)	Bundling Options	Procurement Method and Contract Type
	LABOR:	ERP firm		N/A	Best Value Selection. May be a combination of T/M (consulting services) and fixed costs (installation, training, etc.)
	Equipment:	Server & communications equipment and installation		N/A	Lowest Price Technically Acceptable. Fixed price contract
	LABOR:	Communications firm for development of updated ICT master plan		N/A	Best Value Selection. Likely a T/M not to exceed contract.
5	**ECG-Service-04: Distribution System Master Plan**				
Engineering modeling can begin on the completed GIS substations and feeders. The technical advisor will assist ECG staff to determine the corrective course of action to reduce losses through bifurcation. Usage data will be extracted from the CMS to populate the model ensuring the integration of CMS to the GIS and engineering software.			*Program management contractor and Technical Advisor should support MiDA / ECG in developing SOW*		
	LABOR:	Engineering Firm for master plan development		Bundled with ECG-Eng 42- engineering standards and SCADA design	Best Value Selection - T/M contract with fixed rates
6	**ECG-Engr-42: Update distribution construction standards based on current low loss practices**				
A review of construction and 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 ECG will ensure these new standards are implemented.			*Program management contractor and Technical Advisor should support MiDA / ECG in developing SOW*		
	LABOR:	Consultant - engineering firm		Bundled with ECG-Service-04-Distribution master Plan	Best Value Selection - T/M contract with fixed rates
7	**ECG-Comm-07: Metering at critical nodes of the distribution system**				

ECG Procurement Plan

Priority	Sub-Activity Name		Pre-Design Requirements (basis for RFP)	Bundling Options	Procurement Method and Contract Type
New transformer locations have been established as part of the engineering model and to support the bifurcation SAD. ECG is currently using AMR meters and procurement needs to use these standards to develop the RFP. A report needs to be developed for transformer metering since GIS and CMS is sharing data from the engineering model.			ECG engineering & technical advisor to ensure finalization of metering standard.		
	Equipment:	(existing locations: 3190 plus 800 new trf sites-meter & CT's)		All network equipment could be purchased through a blanket purchase agreement (multiple agreements)	Lowest Price Technically Acceptable. Fixed-unit rate blanket agreement
	LABOR:			ECG-Comm-07; Comm-1; Engr-36; Engr-39 could be bundled together as a fixed unit-rate cost for specific activities.	Lowest Price Technically Acceptable. Unit-rate installation contract
8	**ECG-Comm-04: Replacement of legacy meters with prepayment meters**				
The GIS and customer census data will give us the locations for legacy meter replacements to prepayment meter locations. Existing ECG prepayment systems will provide the specifications required for the RFP and adherence to IEC prepayment standards are required.			ECG engineering & technical advisor to verify interface requirements. May require engineering services for verification		
	Equipment			All network equipment could be purchased through a blanket purchase agreement (multiple agreements)	Lowest Price Technically Acceptable. Fixed-unit rate blanket agreement
	LABOR:			ECG-Comm-07; Comm-1; Engr-36; Engr-39 could be bundled together as a fixed unit-rate cost for specific activities.	Lowest Price Technically Acceptable. Unit-rate installation contract
9	**ECG-Comm-01: Normalization of existing services to comply with improved service connection standard**				

Priority	Sub-Activity Name	Pre-Design Requirements (basis for RFP)	Bundling Options	Procurement Method and Contract Type
10	**ECG-Engr-36: Low voltage feeder bifurcation with MV upgrade**			
Com-04, Comm-01 and Engr-36 could be handled under a labor only unit rate contract with one contractor and bulk-purchase of materials. The prior work completed with the GIS, customer census and standards allow for a unit price. By the time the RFP is drafted the GIS work should be 50% complete with field collection to give base unit quantities for evaluation.		*Engineering construction standards developed.*		
	Equipment		All network equipment could be purchased through a blanket purchase agreement (multiple agreements)	Lowest Price Technically Acceptable. Fixed unit-rate blanket agreement
	LABOR:		ECG-Comm-07; Comm-1; Engr-36; Engr-39 could be bundled together as a fixed unit-rate cost for specific activities.	Lowest Price Technically Acceptable. Unit-rate installation contract
11	**ECG-Comm-10: Strengthening loss control program**			
Work cannot start to develop, train, and strengthen the LCU. Recommend the LCU work begins 3 months after the contractors have started work with the bifurcation and service normalization to support if meter tampering or theft has reoccurred in certain neighborhoods.				
	Equipment		Equipment procured - possibly with other communications equipment and with a blanket agreement	Lowest Price Technically Acceptable. Fixed unit-rate blanket agreement

Priority	Sub-Activity Name		Pre-Design Requirements (basis for RFP)	Bundling Options	Procurement Method and Contract Type
	LABOR	LCU Specialists		Procured with ECG-Service-01-The Technical Assistance Contractor	Best Value Procurement. T/M contract
12	**ECG-Ops-01: Outage management system**				
The implementation of the OMS should occur after the completion of the GIS and CMS integration and near completion of the ERP implementation. Initial review of existing outage reports, processes and procedures should take place by the advisor team starting in mid-2016 with rollout of OMS in January 2017			*Development of OMS requirements and verified by PM Contractor and Technical Assistance Contractor*		
	Vendor	OMS Vendor		N/A - specialized vendor	
13	**ECG-Engr-39: Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion**				
This should follow the OMS implementation and occur after the GIS and engineering modeling has been completed. Key accounts, priority feeders and contingency plan modeling can be major inputs to sectionalizing study and outage reduction plan. Engr 39 & 07 can be with one labor contract			*System modeling and Distribution system master plans*		
	Equipment			All network equipment could be purchased through a blanket purchase agreement (multiple agreements)	Lowest Price Technically Acceptable. Fixed price contract
	LABOR			ECG-Comm-07; Comm-1; Engr-36; Engr-39 could be bundled together as a fixed unit-rate cost for specific activities.	Lowest Price Technically Acceptable. Unit-rate installation contract

Priority	Sub-Activity Name		Pre-Design Requirements (basis for RFP)	Bundling Options	Procurement Method and Contract Type
14	**ECG-Engr-07: Reactive power compensation for primary substations**				
Implementation of this SAD can begin once the distribution master plan has been completed and shows the required locations for capacitor bank placement. Engr 39 & 07 can be with one labor contract			*System modeling and Distribution system master plans*		
	Equipment			All network equipment could be purchased through a blanket purchase agreement (multiple agreements)	Lowest Price Technically Acceptable. Fixed price contract
	LABOR			ECG-Comm-07; Comm-1; Engr-36; Engr-39 could be bundled together as a fixed unit-rate cost for specific activities.	Lowest Price Technically Acceptable. Unit-rate installation contract
15-20	**ECG-Engr-10-15-Multiple Substation**				
These projects were given to the CH2M Hill team from ECG 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.			*Master Plan and Construction Standards to include standard substation design.*	All Substations can be bundled	Lowest Price Technically Acceptable.
15	ECG-Engr-10: Install Bulk Supply Point (BSP) substation with feeders to existing primary substations in Accra				
16	ECG-Engr-11: Install Kotobabi/Nima primary substation with interconnecting sub-transmission links and MV offloading circuits				
17	ECG-Engr-12: Install Ogbodzo/Madina primary substation with interconnecting sub-transmission links and MV offloading circuits				

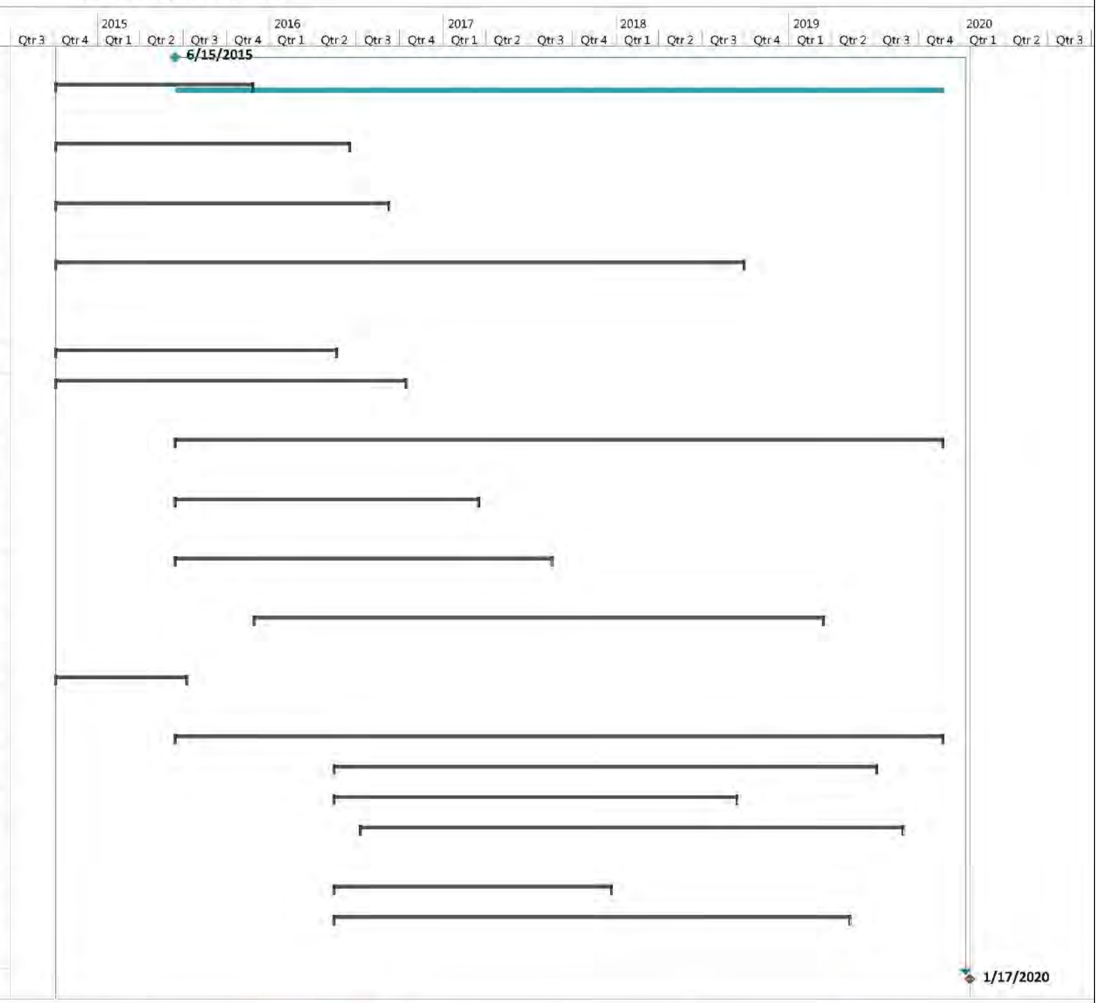
ECG Procurement Plan

<table>
<tr><th>Priority</th><th colspan="2">Sub-Activity Name</th><th>Pre-Design Requirements (basis for RFP)</th><th>Bundling Options</th><th>Procurement Method and Contract Type</th></tr>
<tr><td>18</td><td colspan="2">ECG-Engr-13: Install Mataheko primary substation with interconnecting sub-transmission links and MV offloading circuits</td><td></td><td></td><td></td></tr>
<tr><td>19</td><td colspan="2">ECG-Engr-14: Install Teshie primary substation with interconnecting sub-transmission links and MV offloading circuits</td><td></td><td></td><td></td></tr>
<tr><td>20</td><td colspan="2">ECG-Engr-15: Install Airport Residential Area primary substation with interconnecting sub-transmission links and MV offloading circuits</td><td></td><td></td><td></td></tr>
<tr><td>21</td><td colspan="5">ECG-Service-05: Assistance to the ECG training center in Tema</td></tr>
<tr><td colspan="3">The utility has a training center in Tema that require technical support and equipment to accommodate the need of ECG personal</td><td>MiDA, Program Management Contractor, and Loss Management Technical Assistance Contractor to verify scope and parameters.</td><td></td><td></td></tr>
<tr><td></td><td>LABOR:</td><td>Expert electric utility trainers</td><td></td><td>N/A</td><td>Best-Value selection; Unit-rate contract (based on volume of information collected)</td></tr>
<tr><td></td><td>Equipment</td><td>Purchase of training equipment</td><td></td><td></td><td>Best Value Selection; Lump-sum agreement</td></tr>
</table>

Level 1 Gantt Chart

ECG_Gant_Chart_2014-04-12_SK

ID	Task Mode	Task Name	Duration	Start	Finish
1		Compact 5 year time clock start	0 mons	Mon 6/15/1	Mon 6/15/15
2		**Resettlement Action Plans (Impacting Substations, Bifercation, BulkSupply Point)**	**15 mons**	**Mon 10/6/14**	**Fri 11/27/15**
5		**GIS based distribution management system, grid digitization and customer census**	**22.25 mons**	**Mon 10/6/14**	**Fri 6/17/16**
32		**Installation of ERP system and integration with existing enterprise applications**	**25.25 mons**	**Mon 10/6/14**	**Fri 9/9/16**
48		**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**
53		**Data Center and Communication Network**	**21.25 mons**	**Mon 10/6/1**	**Fri 5/20/16**
80		**Distribution Master Plan (short & Long Term capital improvements)**	**26.5 mons**	**Mon 10/6/14**	**Fri 10/14/16**
85		**Service connection standards and normalization of customer connections**	**58 mons**	**Mon 6/15/15**	**Fri 11/22/19**
97		**Loss Control Units Strengthening (within Energy Loss Control Center)**	**23 mons**	**Mon 6/15/15**	**Fri 3/17/17**
110		**Installation of meters at critical distribution network nodes**	**28.5 mons**	**Mon 6/15/15**	**Fri 8/18/17**
123		**Replacement of legacy meters with prepayment meters**	**43 mons**	**Mon 11/30/15**	**Fri 3/15/19**
136		**Update distribution design and construction standards to reflect best practice**	**10 mons**	**Mon 10/6/14**	**Fri 7/10/15**
141		**LV network improvements (Bifurcation)**	**58 mons**	**Mon 6/15/1**	**Fri 11/22/19**
156		**Capacitor banks for reactive power compensation**	**41 mons**	**Mon 5/16/1**	**Fri 7/5/19**
171		**Install Bulk Supply Points with 33kV links**	**30.5 mons**	**Mon 5/16/1**	**Fri 9/14/18**
189		**Install primary substations with interconnecting 33kV links and 11kV offloading circuits**	**41 mons**	**Mon 7/11/16**	**Fri 8/30/19**
206		**Installation of Outage Management System**	**21 mons**	**Mon 5/16/1**	**Fri 12/22/17**
221		**Sectionalizing study of Accra region, automation of MV networks within ECG's network and SCADA expansion**	**39 mons**	**Mon 5/16/16**	**Fri 5/10/19**
234		Compact 5 year mark	0 mons	Fri 1/17/20	Fri 1/17/20



Project: Activity_Gant_Chart
Date: Thu 5/22/14

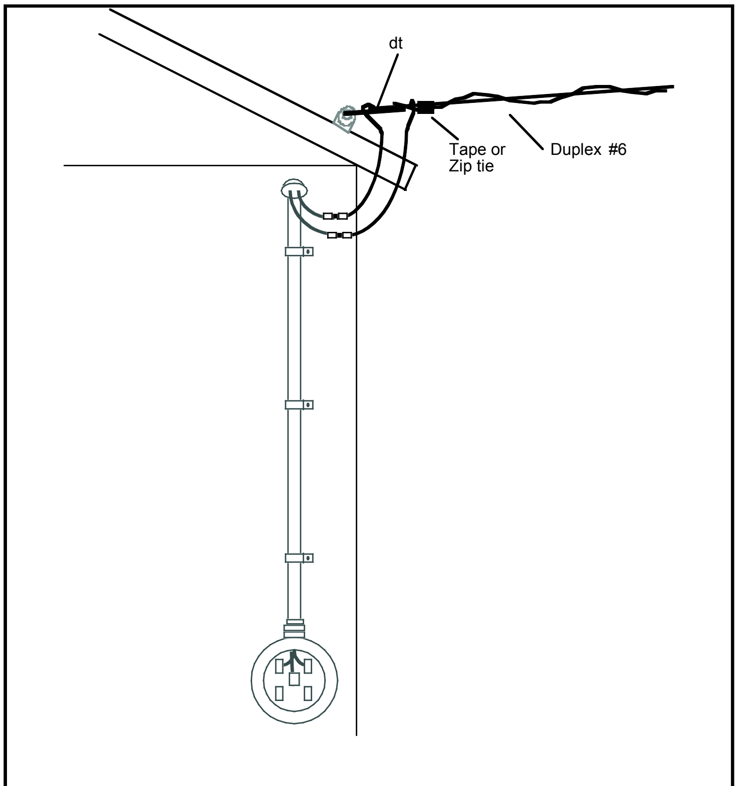
Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

Appendix J
Illustrations and Examples of Proposed Activities

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
1	1.01	14/5/93	NRECA
2	2.0	20/11/94	NRECA
3	2.5	18/5/05	NRECA

Service 50 a. 240 v.

Design: M. Manon
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.

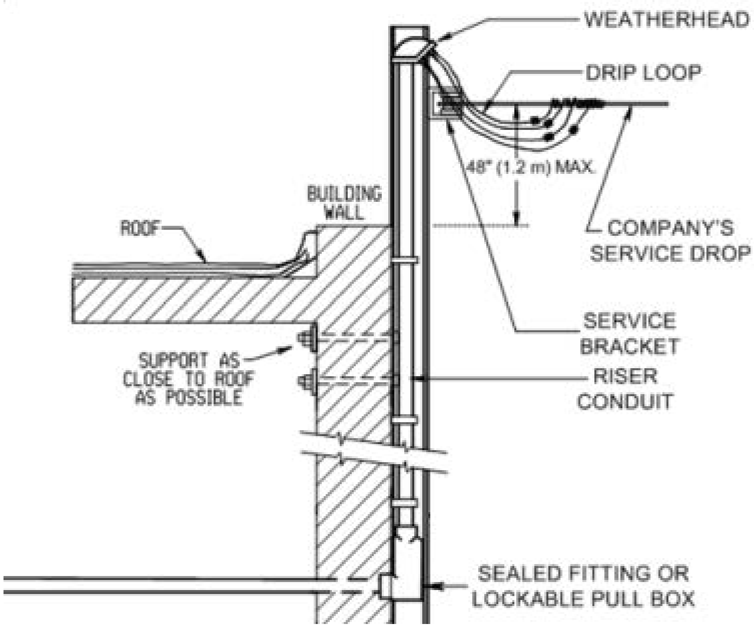
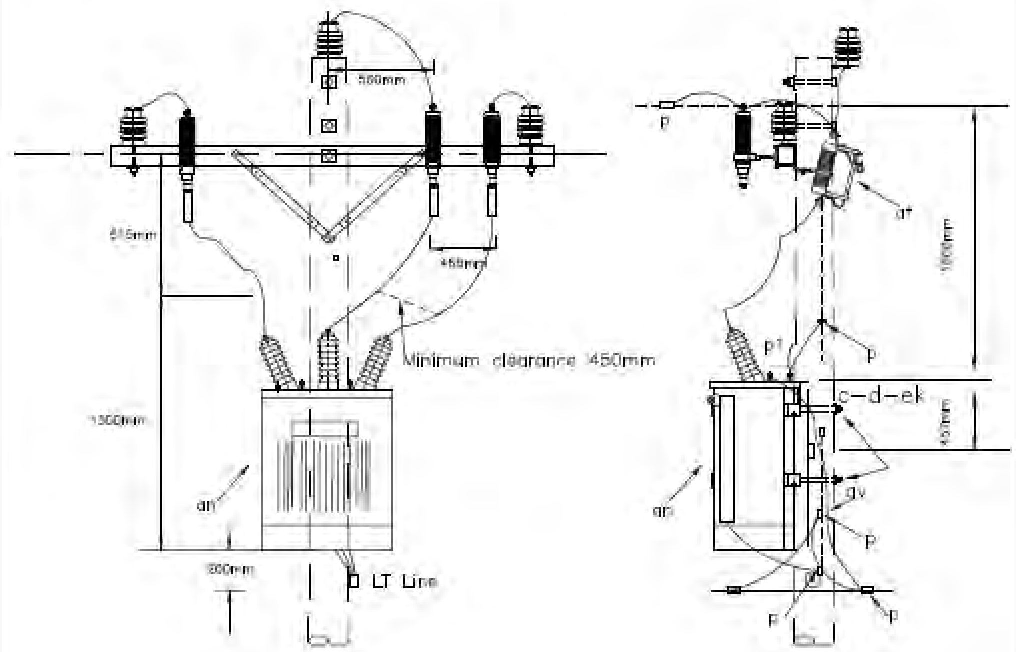


FIGURE 3
Service entrance to along with meters located on poles

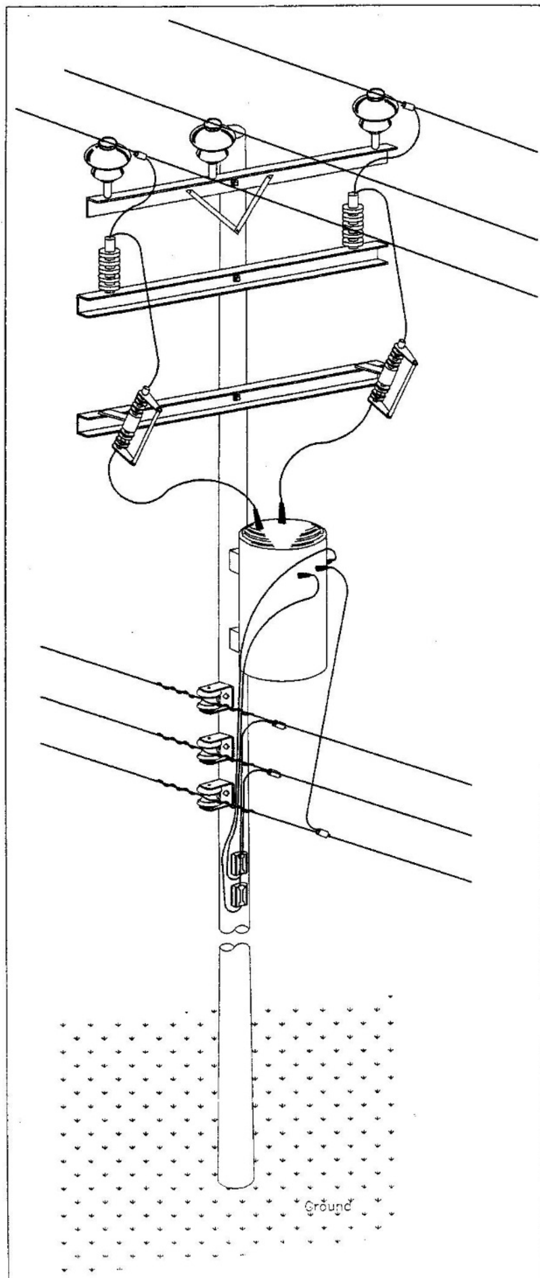
Bifurcation



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, 50x50x5mm,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: 5536N/Insulator Angle: 0 – 5 NRECA International Ltd. Your Touchstone Energy® Partner	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



CHANNEL CROSSARM (HORIZONTAL)	2
CONDUCTOR CLAMPS	5
LIGHTNING ARRESTER	2
DROPOUT FUSE	2
TRANSFORMER	1
TRANSFORMER HOLDING BRACKET	2
BOLT & NUT WITH WASHER	10
M16 FLAT-SQUARE WASHER	10
40x16mm BOLT	4
EARTH GUARD	1
EARTH CONNECTORS	3
EARTH 35mmsq. BARE/16mmsq PVC	30m
EARTH ROD	1
STAPLES FOR EARTH	20
D BRACKET	3
SHACKLE INSULATORS	3
LV AERIAL FUSES	2
70sq.mm PVC PVC COPPER CONDUCTOR	3
BINDING WIRE	4
BANDIT KIT	1
NUMBER PLATE	1
DANGER PLATE	1

Rev.	Date	Revision	Drawn	Checked

ELECTRICITY COMPANY OF GHANA

CONSTRUCTION STANDARD

Title

POLE MOUNTED TRANSFORMER
ARRANGEMENT ON EXISTING
OVERHEAD LINE (TWO PHASE)
(33 & 11kV)

Scale	Designed
Drawn S. AIDOO	Checked
Date SEPTEMBER, 1998	Approved
Drawing No. R0/HV/009/98	Rev

57

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

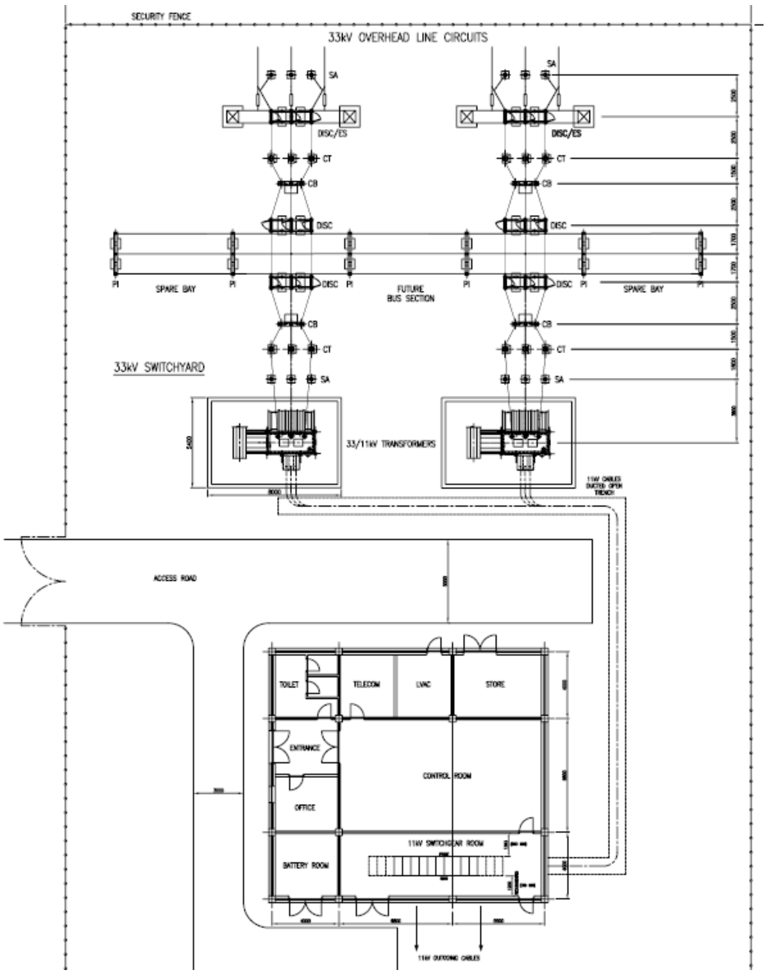


FIGURE 8

Typical indoor primary substation with metal-clad switchgear and OH incoming sub-T

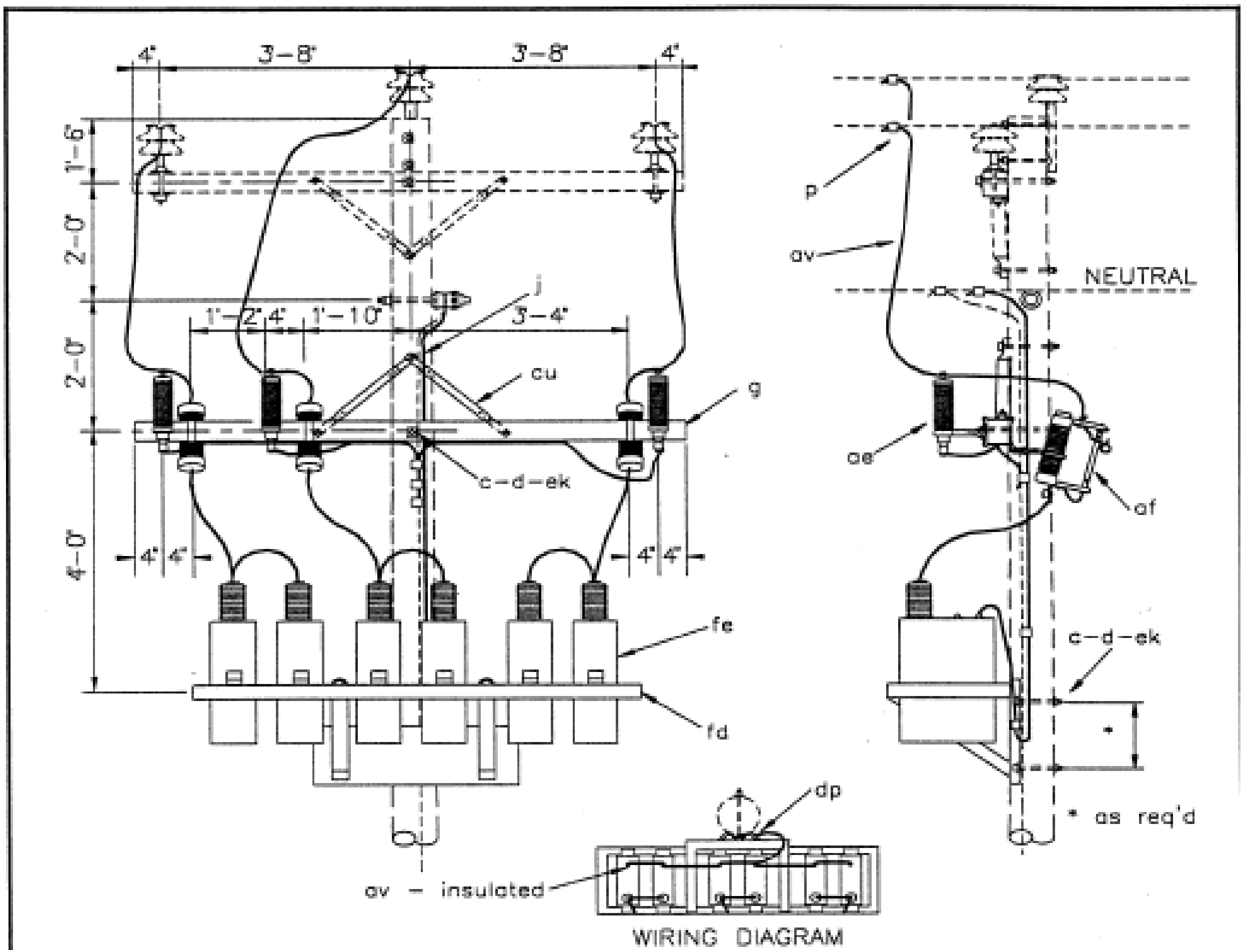
FIGURE 9

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