Guide to Electric Power in Ghana

First Edition

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RESOURCE CENTER FOR ENERGY ECONOMICS AND REGULATION

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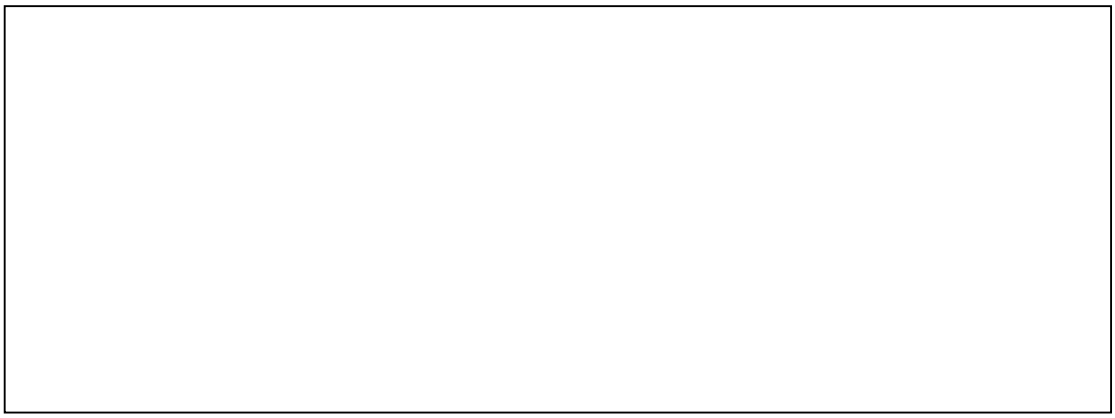


Outline

Preface

Prof. Ernest Aryeetey

1. Facts on Ghana's Electric Power

1.1 Who uses electricity in Ghana

Table 1.1: **ECG and NED Customer population and energy consumption, 2004**

Customer	Number of Customers	Energy Consumption (GWh)

1.2 Electricity and population growth

The Energy Commission:

1.3 Organisations

The Private Generators:

The Ministry of Energy:

The Energy Foundation:

The Volta River Authority (VRA):

The Electricity Company of Ghana (ECG):

1.4 Electric power system

The Northern Electrification Department (NED):

Generation

The Public Utilities Regulatory Commission (PURC):

Electricity Storage Technologies

Transmission System

Capacity vs. Actual Generation

Local Distribution Systems

Storing Electricity

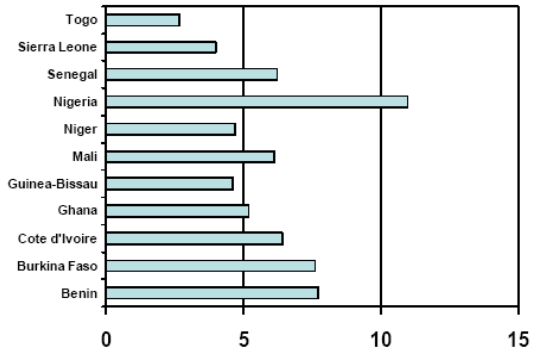
Table 1.2: **Ghana electricity system capacity supply and demand balance**

Generation Source	Effective Capacity (MW)	Percent of Total Available Effective Capacity	Installed Capacity (MW)	percent of Installed Capacity
Hydro:				
Akosombo	850		1020	
Kpong	120		160	
Total Hydro	970	56	1180	55
Thermal:				
TAPCO	320		330	
TICO	220		220	
TDS	15		35	
OECF Barge	0		125	
Total Thermal	555	32	710	33
Imports	200		250	
Total Installed Capacity Including Imports			2140	100
Total Available Effective Capacity	1725	100		81
System Coincident Peak Demand*	1200	70		56
Reserve Margin	525	30		25

1.5 How much does it cost and how much do we pay?

1.6 Electric power and Ghana's neighbours

Figure 1.1: **Average annual growth in electricity demand, 2003-2012**



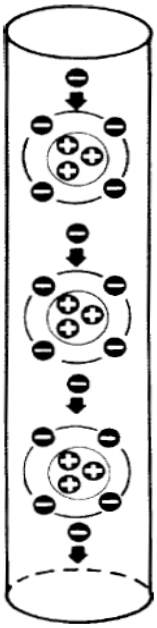
2. The Basics of Electric Power

2.1 Introduction

2.2 Defining and Measuring

Diagram 1
Electric Current

When a metal wire, such as copper, is passed through a magnetic field, electrons are exchanged from atom to atom. This forms a moving stream or *current* of electricity.



Watt-hour (Wh):

Megawatt-hour (MWh):

Gigawatt-hour (GWh):

Terawatt-hour (TWh):

watt (W)

Kilowatt (kW):

Megawatt (MW):

Gigawatt (GW):

Terawatt (TW):

kilowatt-hour (kWh)

2.3 Generating Electricity

Types of Generators

Steam Turbine
Uses either fossil fuel or nuclear fuel to generate heat to produce steam that passes through a turbine to drive the generator; primarily for base load but some gas-fired plants are also used for peak loads; range in size from 1 to 1,250 megawatts.

Combustion Turbine
Hot gases are produced by combustion of natural gas or fuel oil in a high pressure combustion chamber; gases pass directly through a turbine which spins the generator; used primarily for peak loads but combined cycle plants are used for base load; generator is generally less than 100 megawatts; quick startup suitable for peaking, emergency, and reserve power.

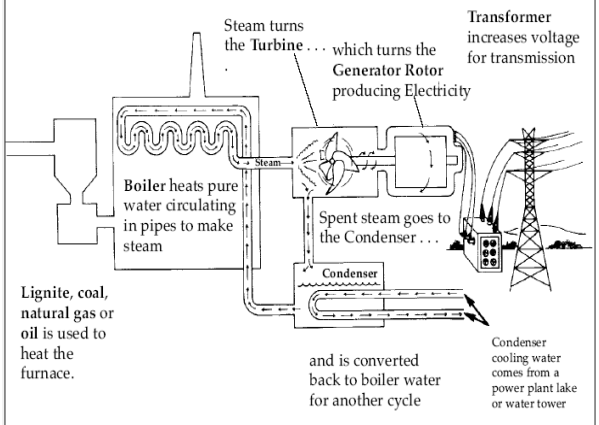
Hydroelectric Generating Units
Flowing water used to spin a turbine connected to a generator; range in size from 1 to 700 megawatts; can start quickly and respond to rapid changes in power output; used for peak loads and spinning reserve, as well as baseload.

Internal Combustion Engines
Usually diesel engines connected to the shaft of a generator; usually 5 megawatts or less; no startup time; operated for periods of high demand.

Others
Geothermal, solar, wind, and biomass; many different technologies; range widely in size and capabilities.

Diagram 2

Steam Turbine Electric Power Plant



2.4 Transmission and Distribution

2.5 Transmission Constraints

Thermal/Current Limits

Voltage Limits

System Operation Constraints

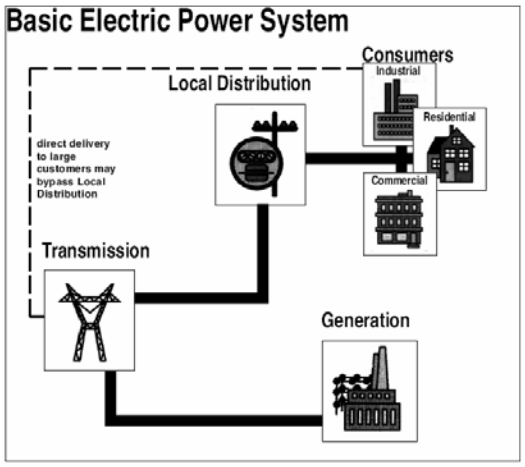
Power Flows:

2.6 Distribution

Preventive Operations:

System Stability:

Customers at the End of the Line



Industrial

Commercial

Residential

2.7 The Electric Power Industry

(public) utilities

3. History of Electric Power in Ghana

3.1 Introduction

3.2 Before Akosombo (1914 to 1966)

Before Akosombo

the Hydro Years

Thermal Complementation

3.3 The Hydro Years (1966 – Mid 1980's)

Akosombo Hydroelectric Project

Kpong Hydroelectric Project

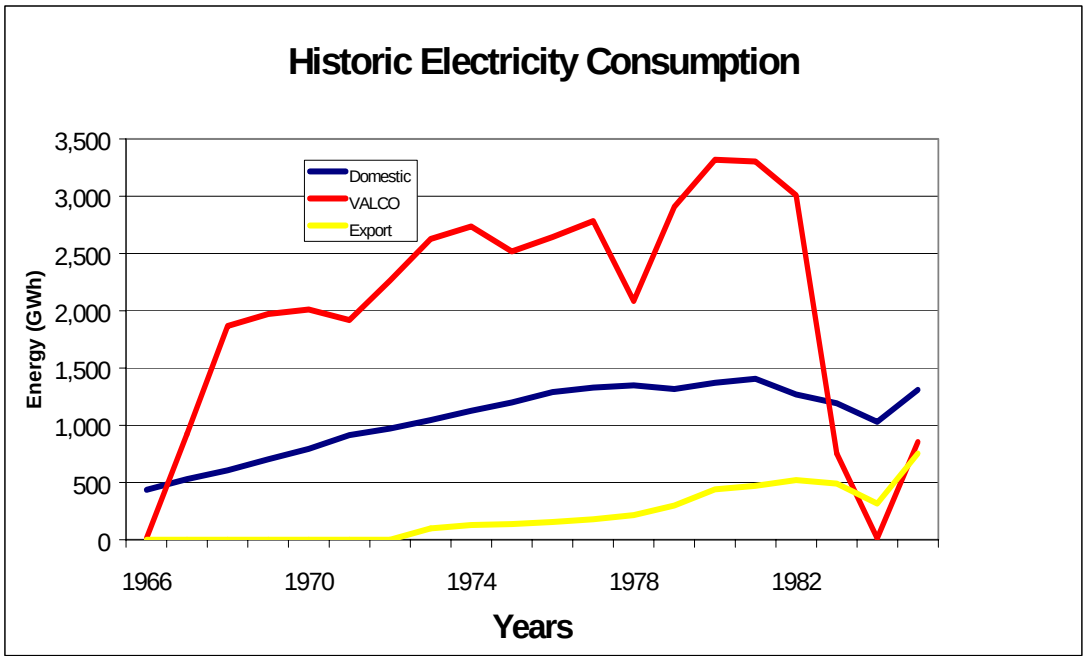
the Ghana Power Study: Engineering and Economic Evaluation of Alternative Means of Meeting VRA Electricity Demands to 1985",

Demand for Electricity during the Volta Development Period

3.4 Thermal Complementation – The Takoradi Thermal Power Plant

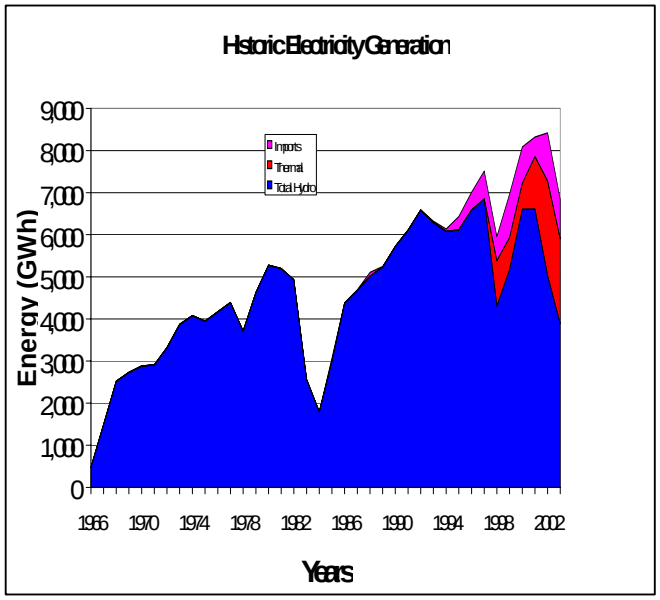
Ghana Generation Planning Study

Figure 3.1: **Consumption of electrical energy from 1967 to 1985**



Takoradi Thermal Plant Feasibility Study

Figure 3.2: **Electricity generation in Ghana, 1966-2003**



3.5 Current Power System Facilities

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3.6 Need for Additional Generation

4. Regulation and Policies

4.1 Introduction

4.2 History of electricity policy and regulation

4.3 Restructuring of electricity sector

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-

4.4 Current regulation of electric power in Ghana

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-
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-

5. Major Electric Power Issues

5.1 Consumer issues

Residential Customers

Non-Residential Customers

Industrial Customer Special Load Tariff Customers (SLT)

5.2 Electric Power and Economic Development

[2] Armah, B. 2002, Economic Analysis of the Energy Sector, Institute of Economic Analysis (IEA) Ghana

5.3 Environment and Energy Policy Issues

Air Pollution

Fuel Choices

Acid Rain:

Transmission Lines and Stations

Urban Ozone:

Global Warming:

Related Energy Policy Issues

Particulates:

Energy Efficiency and Conservation

5.4 Financing and Operations

Electricity Investments and Technology

Table 5.1: **Financial performance of VRA, 1997-2002 (in ¢Billion)**

Year	1997	1998	1999	2000	2001	2002

Source:

Table 5.2**: Financial performance of ECG, 1997-2002 (in ¢Billion)**

Year	1997	1998	1999	2000	2001	2002

Source:

5.5 Performance of Ghana's Electric Power Industry

State of the Ghanaian Economy 2002

Study on Electricity Services Delivery to the Private Sector

[11] *Ghana Mid-Year Micro-economic Review*. Jan-June, Centre for Policy Analysis, Accra, 1998.

6. Future Trends

6.1 Introduction

New Generation Technologies

6.2 Technological changes

Transmission, Distribution and Storage Technologies

Information Technologies

6.3 Financing

World Energy Investment Outlook 2003

Global Development Finance 2004

What International Investors Look for When Investing in Developing Countries: Results from a Survey of International Investors in the Power Sector.

6.4 Industry Re-organisation

before

Key Drivers

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-
-

Investment Shortages:

Technological Developments:

High Electricity Costs:

Key Characteristics

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-
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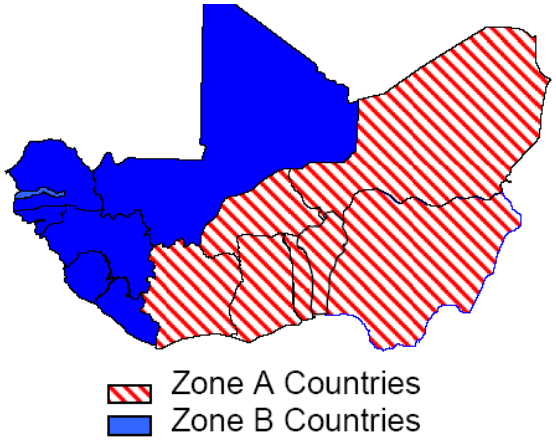
6.5 Electric power and Ghana's neighbours – West African Power Pool

Power for Development: A Review of the World Bank Group's Experience with Private Participation in the Electricity Sector

***Table 6.1*: WAPP international transmission lines**



The West African Power Pool & Optimal Long-Term Planning of International Transmission with a Free-Trade Electricity Policy,

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IEE Introductory Booklet on The Power Station Game,

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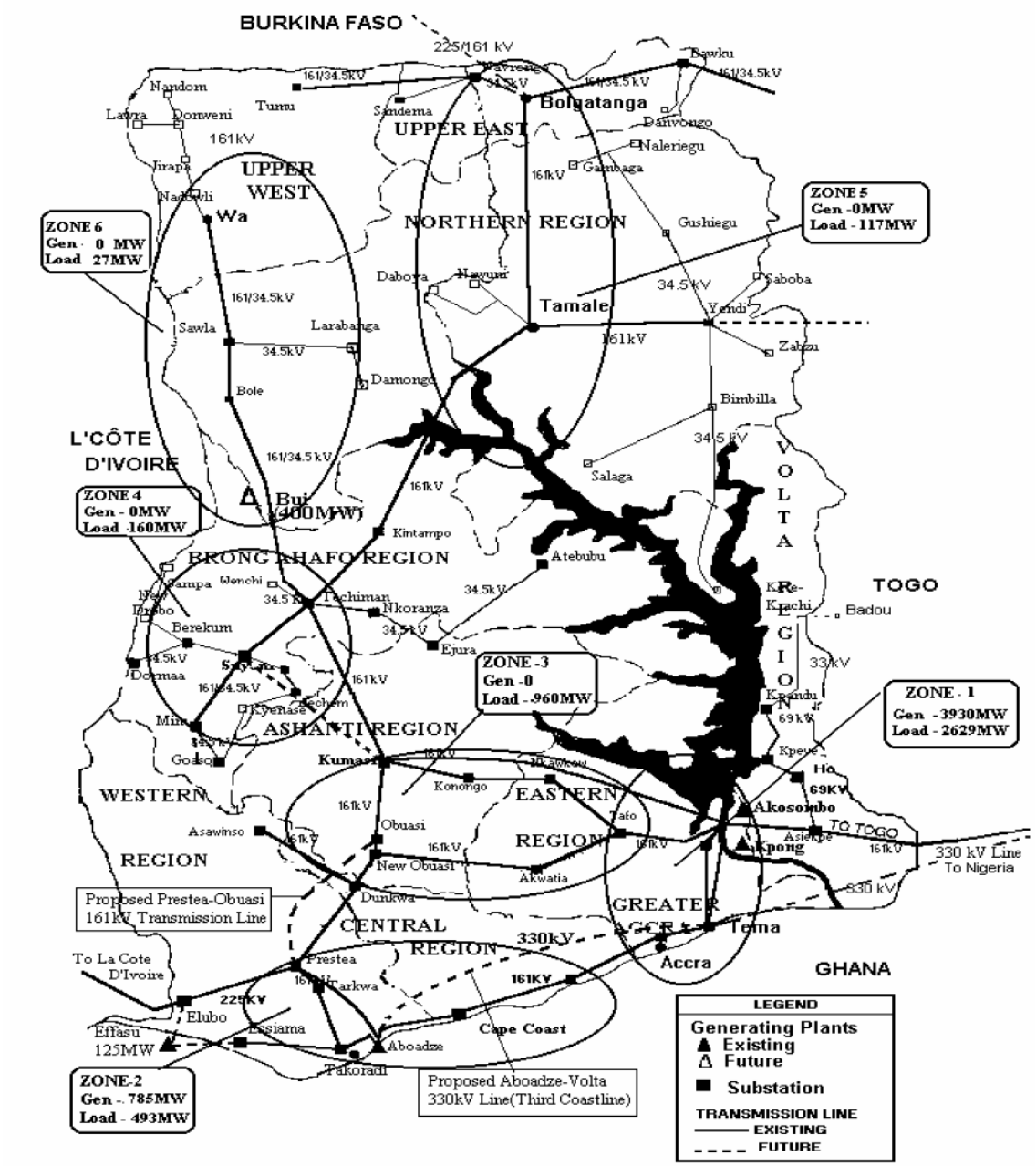
Appendix 1: Ghanaian Electricity Infrastructure



Source:

Appendix 2: Energy Sources for Generating Electricity

Fossil Fuels

Fuel Oil

Coal

Renewables

Hydroelectricity

Natural Gas

Wind Electricity

Nuclear

Solar Electricity

Nuclear Electricity

Biomass and Geothermal