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In Collaboration with:  
**THE PUBLIC UTILITIES REGULATORY COMMISSION, GHANA**

**GHANA TARIFF REVIEW**

**TARIFF FORECAST MODEL**

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## **SECTION 1 - EXECUTIVE SUMMARY**

### **1.1 Introduction**

PricewaterhouseCoopers (PwC) together with RMI (Navigant Consulting) and Bechtel Technology & Consulting, who together made up the project team, were contracted by USAID as a part of an overall tariff review study to assist Public Utilities Regulatory (PURC) of Ghana in developing a forecast of tariff prices. This was to be done using a simple spreadsheet forecast model that will be used in calculated system average electric price levels based on the new rate setting process. The designing of this model is an integral part of the impact assessment phase II of the Ghana Tariff Review Project carried out by the project team. Data used for the design of the model were made available to project team by PURC and the model presently runs from 1999 to 2001, which is the limit of the available information.

### **1.2 Summary of Results**

The forecasted bulk supply tariff as depicted by the model for the years 1999, 2000 and 2001 are respectively 133, 144 and 158 Cedis/KWh. These showed increases of 8.3% and 9.7% from the period 1999 to 2000 and 2000 and 2001 respectively.

The forecasted end-user tariff averages 242 Cedis/Kwh in year 2000 and 261 Cedis/Kwh in 2001. Measured from the average price of 194 Cedis/Kwh calculated when the rates were last adjusted in 1999, the increase necessary to adopt the new pricing methods through 2001 will be an additional 35%.

## SECTION 2 - ASSUMPTIONS

### 2.1 Introduction

During the preparation of the model, a number of assumptions were taken into consideration. Some of the assumptions have been highlighted on all the five sheets that make up the model. The sheet named 'Assume\_input' has all the other assumptions required for the model. These are linked to the calculation worksheet so that new results will be computed as these are changed.

### 2.2 Detail of Assumptions

The main assumptions considered in the 'Assume\_input' sheet are as follows:

- a. A consumer price index of 10% was considered from the years 1999 to 2001.
- b. A productivity factor of 4% was assumed for Ghana based on the US estimate of 2%, reflecting the greater potential for saving in the present Ghana operations.
- c. Asset life of 35 and 30 years for transmission and distribution equipment respectively were assumed throughout the period (i.e. 1999-2001)
- d. Working capital (cash) days of operating & maintenance (O&M) was assumed to be 45 for VRA and 60 days for ECG based on the US normal allowance of 45 days.
- e. A rate of return of 12% was considered based on the project team's review of practices in other countries as reflected in its 'issues' report.
- f. The exchange rate for the Cedis to 1 US Dollar was assumed to be ₵2601, ₵2758 and ₵2895 for the years 1999, 2000 and 2001 respectively.
- g. System losses for VRA and the distribution companies (i.e. ECG & NED) were assumed to be 3% and 15% respectively.
- h. No conclusion has yet been fixed for the rate class cost allocation factors in respect of the asset costs and O&M costs. However, provision has been made for them should actual figures be made available in due course.
- i. Energy sales for VRA and the distribution companies (ECG & NED) in the period were based on the figures in their current corporate plan documents.
- j. O&M expense factor to reflect expense growth in relationship to incremental investment of 0.5 was used for both transmission and distribution.

These assumptions and others used have been clearly noted in the column named 'reference' on each of the model's work sheets.

## **SECTION 3-MODEL DESCRIPTION**

### **3.1 Introduction**

The model is made up of six different sheets namely: Assume\_input, Gen\_cost, Trans\_cost, Dist\_cost, CAPEX and summary. The format and the methods used for each of the above-mentioned sheets are summarised below:

### **3.2 The 'Assume\_input' Sheet**

This sheet is made up of all the assumptions that were used in the design and construction of the model. The sheet is structured as follows: The economic assumption, followed by the system losses, the cost allocation factors to detail costs of tariff rate class (data not available yet) and the energy sales as predicted by VRA, ECG and NED in their respective corporate plans / budgets.

### **3.3 The 'Gen\_Cost' Sheet**

This is structured into two parts namely; the total energy supplied in GWh by VRA and the cost of supply (in million Cedis). The energy-supplied section is made up of hydro and thermal less the transmission losses and the total supply from Independent Power Purchasers (IPP), and expected imports are added together to get the total available supply in GWh for VRA.

The cost of supply is categorised as follows: It is made up of adding up the cost associated with system generation and supplementary power operating expenses (theses were all obtained from VRA's corporate plan) plus a capacity value which is the estimated benchmark value to be allowed for fixed investments. This value was set at the US \$ equivalent amount of US\$0.0125/KWh. Against these system costs, credit for VALCO sales and exports were deducted to get the net cost. This is subsequently divided by the above-mentioned total energy supplied to get the cost per KWh. In order to get the cost per KWh at distribution, the value is further divide the answer by (1-15%) where 15% is the distribution loss rate.

### **3.4 The 'Trans\_Cost' Sheet**

The main components of the transmission cost are the investments / expense in fixed assets and operating & maintenance costs. The sheet is made up of the current value on fixed assets, which is revalued annually by a factor of 15% (based on historical figures). Forecasted additions to fixed assets, capital works-in-progress, working capital (inventory and cash) are annually added to the revalued asset figure, based on VRA's corporate plan.

An annuity rate of 12.23% is calculated based on a rate of return of 12% and asset life of 35years. The calculated annuity rate is then multiplied by the total revalued assets figure to get the asset cost for the year.

The O&M cost allowed by the PURC in determining the rates for 1999 is the base O&M cost. This is then inflated annually and reduced by the productivity factor, as

outlined by the PURC in its Rate Setting Guidelines. The O&M and asset costs are added together to get the total transmission cost. As the O&M and investment costs taken to be 'transmission' related include all activities of the VRA other than those directly specified as generation or distribution before the final transmission cost is calculated, other income is deducted.

The total transmission cost is then divided by the energy transmitted in GWh as indicated by the total energy supplied on the 'Gen\_Cost' sheet. This gives the cost per KWh. To get the cost per KWh at distribution, we divided the cost per KWh by (1-15%), where 15% is the distribution loss rate.

### **3.5 The 'CAPEX' Sheet**

This sheet has the capital expenditure projections for VRA, ECG and NED. The figures here were taken from their respective corporate plans / budgets. Comprehensive projected figures were not available at the time of designing the model.

### **3.6 The 'Dist\_Cost' Sheet**

This sheet is divided into two sections namely the ECG and NED total costs. Within the ECG section, the cost analysis is designed just as was done for the transmission cost sheet. The total annual cost is made up of the asset cost and the O&M cost accruing to the rate setting approach outlined by the PURC. Similarly, for the NED section, the total cost is a combination of the asset and O&M costs. The total costs for both ECG and NED are added together and this is divided by the total energy distributed by ECG and NED to get the total cost per KWh.

### **3.7 The 'Summary' Sheet**

This sheet summarises the tariffs calculated for both the bulk supply tariff and the end user tariff. The bulk supply tariff takes into consideration the generation and transmission costs while the end user tariff considers the distribution in addition to the generation and transmission costs.

## **SECTION 4 – MODEL INPUT/OUTPUT SCHEDULES**

### **4.1 Introduction**

The schedules in this section are copies of the model's worksheets discussed in the preceding sections. These worksheets detail the results summarised in Section 1.2.

### **4.2 Schedules**

The schedules, which follow, are arranged in the order discussed in Section 3.

# ELECTRICITY TARIFF FORECAST MODEL - SUMMARY OF KEY ASSUMPTIONS

## KEY ASSUMPTIONS

Unless otherwise stated, all figures are in millions (GH CEDIS)

1998      1999      2000      2001

ECONOMIC						REFERENCE
Consumer Price Index (CPI)	15%	10%	10%	10%		Estimate from Statistical Service
Foreign Inflation Rate						
Productivity Factor	4%	4%	4%	4%		2 x US estimate(2%)
Country (Ghana) Factor						PURC Estimates
Asset Life - Distribution	30	30	30	30		PURC Estimates
Asset Life - Transmission	35	35	35	35		PURC Estimates
Working Capital (Cash) days of O&M	45	45	45	45		Estimate-US practice
Rate of Return	12%	12%	12%	12%		Per" Issues" Report
Exchange Rate (Cedi to US\$)	2,350	2,601	2,758	2,895		Estimate
Depreciation Rate		11%	6%	5%		Estimate
<b>SYSTEM LOSSES</b>						
Transmission Losses (VRA)	3%	3%	3%	3%		VRA Corporate Plan - '99 target
Distribution Losses (ECG & NED)	15%	15%	15%	15%		ECG Corporate Plan - Target
<b>COST ALLOCATION FACTORS</b>						
Assets Cost - HV (%)						DATA NOT AVAILABLE
Assets Cost - MV (%)						
Assets Cost - LV (%)						
O&M Cost - HV (%)						
O&M Cost - MV (%)						
O&M Cost - LV (%)						

# ELECTRICITY TARIFF FORECAST MODEL - SUMMARY OF KEY ASSUMPTIONS

<b>KEY ASSUMPTIONS</b>		Unless otherwise stated, all figures are in millions (GH CEDIS)			
	1998	1999	2000	2001	
<b>Energy Sales - VRA</b>					
VALCO	927	1,890	2,500	2,500	VRA ANNUAL REPORT - 1998 VRA CORPORATE REPORT
Exports (CEB)	460	300	300	300	
Export (SONABEL)	-	-	-	60	
ECG	3,024	3,790	4,437	4,858	
NED	254	325	380	417	
MINES	713	860	1,007	1,102	
ALUWORKS	11	13	15	17	
AKOTEX	26	28	33	36	
TOWNSHIPS	22	24	28	31	
<b>TOTAL SALES (VRA) - GWh</b>	<b>5,437</b>	<b>7,230</b>	<b>8,700</b>	<b>9,321</b>	
<b>SALES (ECG) - GWh</b>					
Residential	1,076	1,624	1,806		ECG BUDGET
Non-Residential	349	543	600		
SLT-LV	982	1,120	1,241		
SLT-MV					
SLT-HV					
<b>TOTAL - ECG</b>	<b>2,407</b>	<b>3,287</b>	<b>3,647</b>	-	
<b>SALES (NED) - GWh</b>					
Residential					NOT AVAILABLE
Non-Residential					
SLT-LV					
SLT-MV					
SLT-HV					
<b>TOTAL - NED</b>	-	-	-	-	

# ELECTRICITY TARIFF FORECAST MODEL - TRANSMISSION SYSTEM COST

(Unless otherwise stated, all figures are in millions of Cedis)

TRANSMISSION COST	1998	1999	2000	2001	REFERENCES
Fixed Assets-Current Value	1,321,313	1,321,313	1,638,080	2,082,094	VRA 1998, excl. Dam, Gen. & NED;+adds/yr
Disposals	-	0	0	0	
Sub total	1,321,313	1,321,313	1,638,080	2,082,094	
Revalue Factor	100%	115%	115%	115%	VRA 3 year average (1996-98)
Revalued Assets	1,321,313	1,519,510	1,883,792	2,394,408	
Additions	-	118,570	198,302	173,828	VRA Corporate plan (T&D)
CWIP	174,175	100,000	100,000	100,000	1998 yr.end;'99-'01 est
Working Capital - Inventory	11,231	11,231	13,924	17,698	Est. @0.85%of Fixed Assets (Corp. plan)
Working Capital - Cash	6,599	6,227	6,948	7,633	45 days-U.S. standard
<b>Total Assets</b>	<b>1,513,319</b>	<b>1,755,538</b>	<b>2,202,966</b>	<b>2,693,566</b>	
Annuity Rate	12.23%	12.23%	12.23%	12.23%	Return @12%--Life 35yrs
Asset Cost	185,104	214,732	269,459	329,468	
O&M Cost	53,529	50,510	56,359	61,909	VRA 1998;PURC '99-incl. Services-@ formula
Less: Other Income	8,332	9,582	10,540	11,594	VRA Corp. Plan - Other Revenue
<b>Total Cost</b>	<b>230,301</b>	<b>255,660</b>	<b>315,278</b>	<b>379,783</b>	
Energy Transmitted - GWh	5,481	7,267	8,721	9,353	Gen. Cost - Available Supply
<b>Cost per KWh</b>	<b>42.02</b>	<b>35.18</b>	<b>36.15</b>	<b>40.61</b>	
<b>Cost per KWh at Distribution</b>	<b>49.44</b>	<b>41.39</b>	<b>42.53</b>	<b>47.77</b>	Dist. Losses @ 15%

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**ELECTRICITY TARIFF FORECAST MODEL - CAPITAL IMPROVEMENTS FORECAST**

<b>VRA CAPITAL BUDGET FORECAST (c millions)</b>							
<b>Description</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
Generation		97,105	308,521	450,002			
Transmission & Dist.		118,570	198,302	173,828			
<b>Total</b>	<b>-</b>	<b>215,675</b>	<b>506,823</b>	<b>623,830</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>ECG CAPITAL BUDGET FORECAST (c millions)</b>							
<b>Description</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
Development Jobs	7,145	7,954	8,000				
Rechargeable Jobs							
Projects (T&D)							
Building / Civil							
Operations							
Meters							
Computers / Y2K							
Vehicles							
Admin							
Overheads							
SCADA							
<b>Total</b>	<b>7,145</b>	<b>7,954</b>	<b>8,000</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>NED CAPITAL BUDGET FORECAST (c millions)</b>							
<b>Description</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
	6,548	7,145	7,501				
<b>Total</b>	<b>6,548</b>	<b>7,145</b>	<b>7,501</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

## ELECTRICITY TARIFF FORECAST MODEL - DISTRIBUTION SYSTEM COST

<b>DISTRIBUTION COST (ECG)</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>REFERENCE</b>
Fixed Assets -Current Value	865,751	939,303	1,091,902	1,266,408		1998 ECG Report;+ additions/yr.
Disposals	-	0	0	0		
<b>Sub total</b>	865,751	939,303	1,091,902	1,266,408		
Revalue Factor	100%	108%	108%	108%		ECG Avg. 1996-98
Revalued Assets	865,751	1,014,447	1,179,254	1,367,721		
Additions	73,552	77,455	87,154	96,087		ECG Corp. Plan-'01@+5%
CWIP	129,909	61,027	119,177	103,371		ECG Corp. Plan-'01@3yr.avg.
Working Capital - Inventory	73,941	86,641	100,716	116,813		(1998 Line 9/Line 6) x Line 6/yr.
Working Capital - Cash(60days)	10,243	14,050	15,444	16,946		60 days of O&M expense
<b>Total Assets</b>	949,546	1,105,953	1,281,852	1,480,754		
Annuity Rate	12.41%	12.41%	12.41%	12.41%		Return@12%---Life 30yrs
Asset Cost	117,880	137,297	159,134	183,826		
O&M Cost	62,465	85,688	94,186	103,344		ECG 1998;PURC '99basis---'00-'01-@ formula
<b>Total Cost</b>	<b>180,345</b>	<b>222,985</b>	<b>253,320</b>	<b>287,170</b>		
<b>DISTRIBUTION COST (NED)</b>						
	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>		
Fixed Assets -Current Value	250,265	250,265	270,286	291,909		1998 NED(VRA) Report;+additions/yr.
Disposals	-	0	0	0		
<b>Sub total</b>	250,265	250,265	270,286	291,909		
Revalue Factor	100%	108%	108%	108%		ECG Avg. 1996-98
Revalued Assets	250,265	270,286	291,909	315,262		
Additions	-					Not Separately Avail--Incl .w/Transm.
CWIP	2,197					
Working Capital - Inventory	7,521	8,123	8,772	9,474		(1998 Line25/Line22) x Line 22/yr.
Working Capital - Cash(60days)	1,001	1,061	1,125	1,192		60 days of O&M expense
<b>Total Assets</b>	251,266	271,347	293,034	316,454		
Annuity Rate	12.41%	12.41%	12.41%	12.41%		Return@12%---Life 30yrs
Asset Cost	31,193	33,686	36,378	39,286		
O&M Cost	6,105	6,471	6,860	7,271		NED 1998;PURC'99basis---'00-'01@formula
<b>Total Cost</b>	<b>37,298</b>	<b>40,157</b>	<b>43,238</b>	<b>46,557</b>		
<b>Total Cost (ECG &amp; NED)</b>	<b>217,643</b>	<b>263,142</b>	<b>296,557</b>	<b>333,727</b>		
<b>Total Energy Distributed - GWh (ECG &amp; NED)</b>	<b>3,278</b>	<b>4,115</b>	<b>4,817</b>	<b>5,275</b>		
<b>Total Cost per KWh-Cedis</b>	<b>66.40</b>	<b>63.95</b>	<b>61.56</b>	<b>63.27</b>		
<b>Cost per KWh at Distribution</b>	<b>78.11</b>	<b>75.23</b>	<b>72.43</b>	<b>74.43</b>		Dist.Losses @15%

# ELECTRICITY TARIFF FORECAST MODEL - SUMMARY OF KEY RESULTS

TARIFFS - Cedis/KWh	1998	1999	2000	2001	REFERENCES
<b>Bulk Supply Tariff</b>					
Power Supply	77.53	98.03	107.68	117.86	Gen Cost--Line20
Transmission	42.02	35.18	36.15	40.61	Trans. Cost-- Line 19
<b>Bulk Supply Tariff - (Cedis/KWh)</b>	<b>120</b>	<b>133</b>	<b>144</b>	<b>158</b>	
<b>End User Tariff - Average</b>					
Power Supply	91.21	115.32	126.68	138.65	Gen. Cost--Line 21
Transmission	49.44	41.39	42.53	47.77	Trans. Cost --Line 20
Distribution	78.11	75.23	72.43	74.43	Dtst. Cost--Line 36
<b>End User Tariff-(Cedis/ KWh)</b>	<b>219</b>	<b>232</b>	<b>242</b>	<b>261</b>	