



The Economics of Electricity Pricing and Costing in SAARC countries

By *Mohammad Iqbal Ghori, FCMA, Chairman Research & Publications Committee; Muhammad Kamran Jamil, Director, Research & Publications and Shahid Anwar, Joint Director, Research & Publications*

Preamble

Electricity is recognized as a basic human need and an essential constituent of infrastructure on which depends the socio-economic development of any country. In fact, electricity can be termed as one of the key drivers for rapid economic growth, poverty alleviation and peoples' welfare. In any typical economy, electricity is produced from six main sources viz. coal, oil, gas, hydro, nuclear and renewable energy sources e.g. wind, solar, biomass, geothermal etc.

Electricity supply industry is a '**natural monopoly**' and a regulated sector in most of the countries in view of its three distinct features which requires policy makers, regulators, producers and consumers to treat it in a different way. **Firstly**, there is a continuous network requirement as all three activities viz. generation, transmission and distribution are connected with each other. **Secondly**, electricity is a non-storable output and it is not possible to store it at large scale. The suppliers are required to match supply with demand at every point of time. **Thirdly**, the demand for electricity keep changing on a continuous basis which requires adjustments on supply side to match with the varying demand. All these factors provide a strong basis to treat the electricity supply industry as a natural monopoly.

Being a regulated sector, the price of electricity is subject to regulation by a public authority as opposed to price determination of a product by market demand and supply mechanism. The regulated price can take different forms

such as setting of prices, price caps or combination of both. Electricity pricing, which is sometimes referred to as 'electricity tariff' varies from country to country and even city to city within a country. This is due mainly to the fact that cost of electricity generation depends much on type of fuel used (thermal, hydro etc) and market price of fuel, subsidies by government etc.

In this research paper, we would attempt to briefly look into the costing and pricing of electricity in the SAARC region, constituting Pakistan, India, Bangladesh, Sri Lanka, Nepal and Bhutan. This would cover the public regulatory authorities in these countries which are involved in electricity tariff setting as well as methodology of calculating cost of electricity supply as well as tariff determination.

Electricity Regulating Agencies in SAARC

Before we proceed, let's have a look at the electricity regulating agencies in SAARC countries.

Nepal was the first country in SAARC region which established an electricity regulatory authority in August 1985 through merger of Department of Electricity of Ministry of Water Resources; Nepal Electricity Corporation and related Development Boards. Pakistan followed by establishing NEPRA in 1997 and next year in 1998, India also formed a Central Electricity Regulatory Commission. Sri Lanka and Bangladesh realized importance of electricity regulatory agency in 2002 and 2003, respectively.

Supply Chain of Electricity



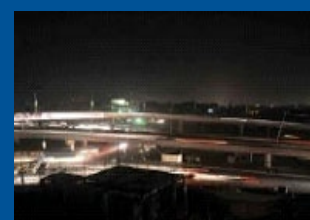
Generation



Transmission



Distribution



Consumption

Electricity Pricing or Tariff Setting by Regulators

Electricity pricing or tariff setting is a key regulatory instrument which determines the volume and nature of demand and supply. There are costs involved in supply of electricity which need to be recovered from the consumers in order to sustain the supply in future. Tariff determination refers to the process of determining price of electricity to the consumers. Tariff is, therefore, a schedule of prices for various consumer categories and signifies the amount of money paid by consumers in lieu of making electricity available at their homes.

Table 1: Electricity Regulatory Authorities in SAARC countries

Country	Name of Authority	Year of Establishment
Pakistan	National Electric Power Regulatory Authority (NEPRA)	1997
India	Central Electricity Regulatory Commission (CERC)	1998
Bangladesh	Bangladesh Energy Regulatory Commission (BERC)	2003
Sri Lanka	Public Utilities Commission of Sri Lanka (PUCSL)	2002
Nepal	Nepal Electricity Authority (NEA)	1985
Bhutan	Bhutan Electricity Authority (BEA)	2001

Source: Websites of Regulatory Authorities

Sri Lanka has highest Electricity Tariff rate for 'Residential consumers' amongst SAARC countries

The electricity tariff rate for domestic/ residential consumers in Sri Lanka is much higher than in other SAARC countries.

Table-2 indicates that average electricity tariff in Sri Lanka is USD 0.21 for Category 2 (b/w. 101 to 200 units); USD 0.28 for Category 3 (b/w. 201 to 300 units) and USD 0.32 for Category 4 (above 300 units) which are much higher than tariff rates for these categories in India, Bangladesh, Nepal and Sri Lanka. Only for Category 1 (upto 100 units) for domestic consumers, Pakistan leads with highest tariff rate of USD 0.07 as compared to USD 0.06 in each of the SAARC country. Similar trend of high electricity tariff for domestic users in Sri Lanka can be witnessed if we convert the local currencies of SAARC countries to Pakistani Rupee. Except for Category 1 in which Pakistan has highest electricity price, for the other Categories 2, 3 and 4, the tariff rates in Sri Lanka comes to Pak Rs. 22.16, 33.39 and 33.39 respectively.

Table 2: Average Electricity Tariff Rate for Domestic consumers in SAARC countries (up to 5 Kwh)

	Country Category 1 (0 to 100 Average Unit)			Category 2 (101 to 200 Average Unit)			Category 3 (201 to 300 Average Unit)			Category 4 (> 300 Average Unit)		
	Local Currency of SAARC Country	Converted to US Dollars	Converted to Pak Rs.	Local Currency of SAARC Country	Converted to US Dollars	Converted to Pak Rs.	Local Currency of SAARC Country	Converted to US Dollars	Converted to Pak Rs.	Local Currency of SAARC Country	Converted to US Dollars	Converted to Pak Rs.
Pakistan	7.45	0.07	7.45	9.35	0.09	9.35	10.87	0.10	10.87	15.60	0.15	15.60
India	4.00	0.06	6.38	4.00	0.06	6.38	5.95	0.09	9.49	8.58	0.12	12.84
Bangladesh	4.47	0.06	6.03	5.14	0.07	6.94	5.36	0.07	7.23	8.10	0.10	10.93
Nepal	6.63	0.06	6.60	9.05	0.09	9.01	10.25	0.10	10.21	11.00	0.10	10.95
Sri Lanka	8.92	0.06	6.62	29.87	0.21	22.16	45.00	0.28	33.39	45.00	0.32	33.39

Source: ICMAP R&P Dept. Analysis

Industrial consumers are charged more electricity tariff in Pakistan than in other SAARC countries

According to ICMA Pakistan's research, the industrial consumers in Pakistan are charged highest electricity tariff rate than in other SAARC countries. Table-3 indicates that industrial tariff rate in Pakistan is USD 0.14 followed by India with USD 0.13, Bangladesh USD 0.10, Nepal USD 0.08 and Sri Lanka USD 0.09. It is quite interesting to note that Sri Lanka where electricity tariff is much higher for domestic consumers, the industrial tariff rate is the lowest in SAARC region, which reflects the Sri Lanka lucrative policy towards the growth and development of industrial sector.

Note:

- For Pakistan, the average of per unit electricity tariffs of LESCO, IESCO, FESCO and K-electric have been taken, whereas for India, the actual per unit tariff of Delhi electricity has been considered. For Bangladesh, Nepal and Sri Lanka, the average of different tariff categories have been calculated to arrive at a uniform category for all countries.
- US Dollar parity to local currencies in SAARC countries: Pakistani Rupee 105.42; Indian Rupee 65.94; Bangladeshi Takka 78.56; Nepalese Rupee 105.54; and Sri Lanka Rupee 142.92
- Conversion rate from local currencies in SAARC to Pak Rupee: Indian Rupee = Pk. Rs. 1.597; Bangladeshi Takka = Pk. Rs. 1.34; Nepalese Rupee = Pk. Rs. 1; Sri Lanka Rupee = Pk. Rs. 0.7376

Table 3: Average Electricity Tariff Rate for Industry consumers in SAARC countries

Country	Industry Tariff Rate (upto 5 Kwh Average Units)		
	Local currency of SAARC country	Converted to US Dollars	Converted to Pak Rupee
Pakistan	14.36	0.14	14.36
India	8.45	0.13	13.49
Bangladesh	7.93	0.10	12.64
Nepal	8.00	0.08	7.90
Sri Lanka	12.78	0.09	9.48

Source: ICMAP R&P Dept. Analysis

Table 4: Fixed and Variable Cost Components of a Electricity Generation Plant

Fixed Cost (Capacity Cost)	Variable Cost (Fuel/Energy Cost)
1. Fixed Operations & Maintenance cost (O&M)	Fuel cost (major cost)
2. Return on Equity (ROE)	Variable Operations & Maintenance cost (O&M)
3. Return on Equity during Construction (ROEDC)	
4. Insurance	
5. Cost of Working Capital	
6. Withholding tax	
7. Debt Repayment	
Note:	
o Fixed O&M covers cost of maintenance, financial cost, employee cost, rents and cost of other utilities	
o ROEDC is the amount incurred during construction & testing time and finalized after commissioning of plant	
o Debt repayment includes principal amount plus interest	

The tariff decision is a complex issue and the regulator must keep a balance among various interests. For instance, the end-users wants a 'lower tariff' and if the regulator sets high tariff it would cause loss of consumer welfare. Similarly, if the electricity tariff is unreasonably lower, it would bring loss to the supplier and result in inefficient service. The electricity regulatory authorities have, therefore, to keep in consideration some principles while determining tariff for end-users such as 'principle of economic efficiency' which means that cost of supply should be minimum given the level of technology. The 'principle of adequacy' means that the approved tariff should be adequate to recover all reasonable cost of production. The 'principle of economy' indicates that electricity should be utilized efficiently and higher tariff should be set for higher amount of consumption of electricity. Lastly, the 'principle of affordability' should be considered which means tariff should not be a barrier to fulfilling human need.

Besides considering above principles, the regulators must also ensure that the process of determining electricity prices or tariff should be transparent, accountable and participatory to serve public interest. As electricity tariffs affect different sections of society e.g. residential consumers, businesses and industries, the tariff determination process should have a clear mechanism of participation, allowing written complaints, public hearings, etc to redress the grievances against the regulators.

Methodology of Electricity Pricing / Tariff Determination

In a regulated market, various methods are being used to regulate electricity prices, depending upon the socio-economic factors such as scale of electricity sector; use of technology, degree of competition, market responsiveness etc. These methods have their own advantages and disadvantages.

a) **Cost Plus approach** - It balances the costs incurred by the utility with future estimated revenues

b) **Performance-based approach** - It is an extension of cost-plus approach that provides incentives for improving efficiency and reducing costs.

c) **Price Cap approach** - A ceiling price fixed by the regulator on basis of historical cost and future efficiency gains and taking account of general inflation in the economy.

The electricity pricing process should specifically identify the method used for tariff determination and the reasons for its selection so as to enable stakeholders to assess the appropriateness of this method. For instance, the selection of performance-based approach may provide more flexibility to the electricity utilities to improve their performance.

Cost Components of Electricity Tariff/Pricing

The cost calculation of electricity generation, supply and distribution is an important exercise that helps in assessing the financial performance of utilities. The regulatory authority determines the electricity price or tariff on the basis of total cost of supply or annual revenue requirement, calculated after examining the various cost components. Other socio-economic factors such as paying capacity of end-users is also considered by the regulatory authority.

The cost elements in generating, transmitting and distributing electricity are normally classified as '**fixed cost**' and '**variable cost**'. The 'fixed cost' do not change with the amount of electricity used, whereas 'variable cost' changes in proportion to the amount produced and consumed. These costs are recovered from the consumers through tariff.

Table-4 shows the fixed costs and variable costs of an electricity generation plant, whereas **Table-5** shows major cost components of electricity generation, transmission and distribution companies.

Table 5: Major Cost Components of Electricity Generation, Transmission and Distribution Companies

Type of Electricity Utility	Major Cost Components
Generation Company	Fuel Cost; Transportation cost; Employee cost; Repairs & maintenance cost; Depreciation; pollution control expenses; taxes; Return on capital etc.
Transmission company	Employee cost; Repairs & maintenance cost; depreciation; metering etc.
Distribution company	Power Purchase cost; Transmission cost or Wheeling charges; Employee cost, Repairs & maintenance cost; Depreciation; Energy losses; Taxes; Return on Capital
Note:	
o Fuel cost' is a major cost item in thermal and nuclear power plants, whereas in hydro power plants it is almost negligible	
o 'Transmission losses' means electricity lost during transmission process	
o 'Power Purchase Cost' means cost on purchase of electricity from all sources viz. thermal, hydel, nuclear or imported	
o For a distribution company, generation cost and transmission cost become 'power purchase cost'	
o 'Energy losses' means losses due to electricity theft, under-estimation of consumption, technical losses etc	
o 'Wheeling charges' are the distribution commission paid to the Transmission company	

In calculating the electricity cost, some indexation factors are also used to nullify the effect of inflation and exchange rate variation (USD/Rupee). It may be mentioned here that the fixed or capital cost of hydel or wind plants is much higher than their variable cost in view of less production in a year.

Electricity Tariff Structure and Subsidies

The electricity tariff structure or rate design signify a set of rules and procedures that determines the different categories charged to the consumers of electricity. The tariff structure should be simple and must ensure accountability for use of electricity, in addition to improving performance and efficiency of the utilities. The most common tariff structure used is a 'two-part tariff; in which the consumers of electricity are required to pay some fix charges (i.e. minimum consumption charge, load charge or connection fee) per billing period and additional charges based on actual consumption. The other tariff structure include single-part tariffs, block tariffs and Time-of-Day tariffs (TOD, peak load) and seasonal tariffs. In single-part tariff, a single price per unit of electricity is charged for the entire amount of electricity consumed. In blocked-tariff, the tariff are either increased or decreased with the corresponding increase or decrease in electricity consumption.

Many governments provide subsidies for energy, either explicitly or implicitly, to producers and consumers. Through electricity tariff subsidies, the government reduces electricity prices by making 'unrequited value transfers' to the consumers or utilities. The financing of subsidies can be done in innumerable ways such as 'explicit subsidies' that are voluntary transfers by government to consumers and are reflected in the national budget; 'implicit subsidies' are where there is no immediate transfer from the government whereas 'cross-subsidies' are policies that reduces costs to particular types of customers or regions by increasing charges to other customers or regions. In this context, it may be mentioned that energy subsidies normally have a direct impact over the national exchequer as it leads to a worsened fiscal balance due to larger government expenditures, smaller revenues, or net current transfers. Subsidies also affect the long-term growth potential of any economy.



The National Electric Power Regulatory Authority (NEPRA) which was established in 1997 under the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997, is empowered to determine, specify or approve tariffs for power generation, transmission and distribution companies. NEPRA is authorized to issue licenses to power companies and approve investment and power acquisition

programs of utility companies. Under the law, NEPRA is mandated to safeguard the interests of investors and consumers by taking judicious decisions based on transparent commercial principles and provide competitive environment for operation of power sector. The NEPRA (Tariff Standards and Procedure) Rules, 1998 provides for tariff setting process and broad parameters of tariff setting.

Tariff determination for electric power services is one of the primary responsibilities of NEPRA. NEPRA fixes electricity tariffs based on principles of economic efficiency and service of quality and keeping in consideration prescribed Tariff Standards and Procedure Rules, 1998. The tariff of power generation and transmission companies are determined on **cost plus basis**, whereas distribution companies are given a **multi-year performance tariff**. Though NEPRA determines the tariff for all the generation, transmission and distribution companies; yet the sum of costs of all the three kinds of tariffs is recovered from the consumers through the retail tariffs of distribution companies. The bills generated by distribution companies include not only its distribution margin but also the generation cost and wheeling charges.

NEPRA chooses a base year to determine the revenue requirement of a distribution company under multi-year tariff regime or annual electricity end-user tariff regime. The tariff so provided provides an opportunity to the distribution company to fully recover NEPRA approved revenue requirement. NEPRA determines the consumer-end-tariff of a Distribution Licensee by assessing the following components of its Revenue Requirement and also inviting comments from the public, prior to tariff determination to ensure transparency and accountability:

- Power Purchase Price (PPP)
- Distribution Margin (DM)
- Prior Year Adjustment (PYA)

Formula for determining 'Revenue Requirement'

'Revenue Requirement' refers to the 'minimum amount of revenue required by a distribution company to run its operations smoothly' and comprises, inter alia, of cost of power purchase; cost of transmitting power and the distribution margin. The formula used by NEPRA for determining the Revenue Requirement (RR) of the distribution company is as under:

$$RR_d = PPP_d + DM_d \pm PYA_d$$

In the above Formula:

RR_d = Revenue Requirement of Distribution company

PPP_d = Power Purchase Price (cost) of Distribution company

DM_d = Distribution Margin of Distribution company

PYA_d = Prior Year Adjustment of Distribution company

Let's analyze the two main cost components of the Revenue Requirement (RR) viz. Power Purchase Price (PPP) and Distribution Margin (DM).

a) Power Purchase Price (PPP)

PPP refers to 'generation cost' and 'transmission cost' allocated to distribution companies from the pool of Centre Power

Purchasing Agency (CPPA) and National Transmission and Distribution Company (NTDC) in accordance with NEPRA-approved transfer price mechanism plus power purchase by distribution companies through NEPRA-approved bilateral contracts.

The Power Purchase Price (PPP) consists of following three cost components:

- (1) **Energy Charges (EC)** - It consists of fuel cost and Variable Operations & Maintenance cost (O&M)
- (2) **Capacity charges(CC)** - It consists of Fixed O&M cost; working capital cost; insurance cost; ROE; ROE during construction; debt servicing; agency fee etc
- (3) **Transmission charges (TC)** - It refers to charges related to transmission of electricity

The following formula is used to determine PPP:

$$PPP = PP_{(EC)} * Q_{(p)} + PP_{(CC)} + TC$$

In the above Formula:

PPP = Power Purchase Price (cost)

PP_(EC) = Energy Charge part of PPP

Q_(p) = Quantity or power purchased

PP_(CC) = Capacity Charge part of PPP

TC = Transmission Charges

b) **Distribution Margin (DM)**

The major cost components in 'Distribution Margin' of a Distributing company comprises of operations & maintenance cost; return on rate base; depreciation; repairs and maintenance; salary and wages; taxes, travels and vehicles; other regulatory costs including other income determined or approved by NEPRA for running the distribution business.

The following formula is used to determine the Distribution Margin (DM):

$$DM_d = RB_d * RORB_d + D_d + E_d + t_d \pm ORC_d$$

In the above Formula:

DM_d = Distribution Margin of Distribution company

RB_d = Rate Base of Distribution company

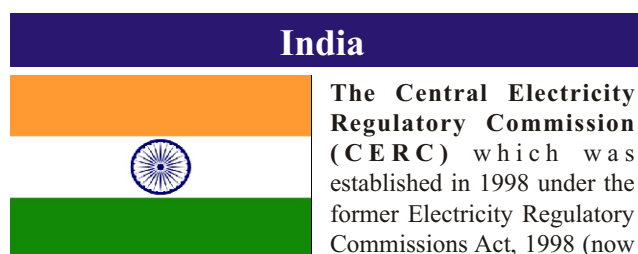
RORB_d = Return on Rate Base (capital cost) of Distribution company

D_d = Depreciation expense of Distribution company

E_d = Employee cost of Distribution company

t_d = Taxes pass through by Distribution company

ORC_d = Other Regulatory Costs of Distribution company



Electricity Act, 2003) is mandated to regulate the tariff of generating companies owned or controlled by the Central Government as well as those companies which are engaged in sale of electricity in more than one State. The Commission is also responsible to regulate and determine tariff of inter-State electricity transmission as well as issue licenses to persons to function as transmission licensee and electricity trader.

CERC, under the Electricity Act, 2003, has issued the Power Market Regulations, 2010 which govern transactions related to "Energy trading" by companies like Indian Energy Exchange (IEX), Power Exchange India (PXI), National Power Exchange (NPX) in various contracts related to electricity. These regulations are aimed at taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and enhancing supply of electricity.

Before 1992, India had a 'single-part tariff system' in which both fixed cost and variable cost was calculated at a certain generation level. However, in 1992, a two-part tariff formula was adopted for all electricity generation plants under the National Thermal Power Corporation Ltd. (NTPC) a Central public sector undertaking, founded in 1975 and functioning under the Ministry of Power of India. Presently, 17 coal-based and 7 gas-based stations are operating throughout India under NTPC.

Availability-based Tariff (ABT) system

Since January 2000, an "Availability-based Tariff (ABT) system has been adopted for all regional grids in India for improving grid discipline by frequent dependent pricing. Presently, it is limited to short-term energy transactions between the beneficiary states and Central generating stations without the need for negotiations on price or quantum in real time. In the Indian context, 'Availability Tariff' refers to a 'rational tariff structure for power supply from generating stations on a contracted basis.

The electricity generation plants have two kinds of costs viz. fixed costs and variable costs. The fixed cost covers the interest on loan, return on equity (ROE), depreciation, cost of secondary fuel cost (for coal-based & lignite fired generating stations) O&M expenses, insurance, taxes and interest on working capital, whereas variable cost comprises of the fuel cost, i.e., coal and oil in case of thermal plants and nuclear fuel for nuclear plants. In ABT system, fixed cost and variable cost components are treated separately. The fixed or capacity charge is for recovery of annual fixed cost, whereas the variable or energy charge is for recovery of primary fuel cost, wherever applicable.

There are following three main components of Availability-based Tariff (ABT):

a) **Fixed or Capacity Charge**

The fixed cost payment to generating company is linked to the availability of plant which denotes its capability to deliver MWs on day-by-day basis. The total amount payable to generating company over a year towards fixed cost depends on average availability (MW delivering capability) of the plant over the year. In case the average actually achieved over the year is higher than the specified norm for plant availability, the

generating company gets a higher payment. However, if average availability achieved is lower, payment is also lower.

b) Variable or Energy Charge

The energy charge comprises of the variable cost (i.e., fuel cost) of power plant for generating energy as per given schedule for the day. The energy charge (at the specified plant-specific rate) is based on scheduled generation and not on actual generation and plant output.

c) Deviation Charge

In case there are deviations from the schedule (e.g., if a power plant delivers 700 MW while it was scheduled to supply only 600 MW), the energy charge payment would still be for scheduled generation (600 MW), and the excess generation (100 MW) would get paid for at a rate dependent on the system conditions prevailing at the time. If the grid has surplus power at the time and frequency is above 50 cycles, the rate would be lower. If the excess generation takes place at the time of generation shortage in the system (in which condition the frequency would be below 50.0 cycles), the payment for extra generation would be at a higher rate.

d) Tariff determination

The State Electricity Regulatory Commissions (SERCs) fix the electricity tariffs through tariff orders in accordance with the National Tariff Policy 2006 (Ministry of Power, Government of India, 2006) and as per the provisions of the Electricity Act, 2003. The tariff is set based on the estimated Annual Revenue Requirement (ARR) of the electricity distribution licensee(s) (DISCOM) in a financial year.

The Annual Revenue Requirement (ARR) is calculated by combining the following cost components:

- a) Power Purchase Cost or cost of generation in case of licensee owned power station
- b) Cost of capital
- c) Operational and Maintenance (O&M) cost
- d) Depreciation
- e) Interest on working capital
- f) Provision for tax
- g) Adjustment with preceding year's unaccounted expenses or revenue gaps

The ARR is determined ex ante for each financial year of a Control Period (over 5 years as per National Tariff Policy 2006). The initial control period is allowed to be of three years. Tariff for the financial year is fixed and based on estimated ARR (provisional) and expected electricity sales.

Since tariff is estimated ex ante, actual revenue realized may not cover annual revenue requirement. The gap is to be adjusted while estimating the ARR in the ensuing year. Only in exceptional circumstances ("natural causes or force majeure" situations), the SERC may carry forward the deficit with interests to be amortized in future. This revenue deficit is earmarked as regulatory asset.

Average tariff for a consumer is measured from the total tariff-related revenue from the consumer category divided by total

estimated electricity sales to the category. In an ideal case, average tariff for a consumer category should be at par with the cost of electricity supply. The consumer tariff has three main components viz. Power purchase cost (80% of total cost); O&M cost and financial cost.

Bangladesh

The **Bangladesh Energy Regulatory Commission (BERC)** which was established in March 2003 through a legislative Act of the Government of Bangladesh is empowered to determine tariff



of electricity generation and transmission, marketing, supply, storage and distribution of energy. BERC is mandated to determine both the bulk and retail tariff rates of electricity, natural gas, petroleum products, coal and other mineral resources, with reference to the government's overall policies in the sector. Electricity generation in Bangladesh is overwhelmingly natural gas-based.

BERC is also mandated to issue licenses and ensure transparency and accounting in the pricing framework. For this purpose, it arranges public hearings of stakeholders, policy-makers, government officials and civil society where proposals are shared for intended retail and bulk tariff pricing. BERC then determines the tariff rate based on the discussion in the public hearings and other public issues.

The Bangladesh Power Development Board (BPDB), being the sole buyer of electricity from Independent Power producers (IPPs); Small Independent Power Producers (SIPPs); Rental power plants, corporatized generation companies and other publicly-owned power plants, based on negotiated bulk power tariff rates, sells electricity to distribution utilities based on BERC's regulated wholesale tariff rates.

The Power Grid Company of Bangladesh (PGCB) was established in 1996 by the Government of Bangladesh to act as the national grid operator and is allowed to recover its costs through wheeling charges from BPDB power generating companies to distribution companies utilizing transmission network. Wheeling charges are set by the Bangladesh Electricity Regulatory Commission (BERC).

Components of Electricity Tariff

The Bangladesh Power Development Board (BPDB) fixes the bulk tariff rate for the power distribution companies, whereas retail tariff rates are imposed on final consumers of electricity by the distribution companies. There are separate retail tariff rates for five categories of consumers viz. domestic, agriculture, small industry, non-residential and commercial.

The electricity generation cost is 'passed through' to end-user tariffs. The average end-user electricity tariff for each customer class is so fixed as to fully cover reasonable costs of supplying electricity to that customer class (including generation cost, system services, transmission, and distribution), and generate a surplus to expand coverage and supply, and improve the quality of service. The tariff is adjusted in case there is variation in the

recognized costs in excess of ten percent. Differential rates are maintained for peak and off-peak consumption by consumers.

There are following price components of electricity tariff in Bangladesh:

a) Fixed or Service Charge

The fixed charge, also known as 'service charge' or 'daily supply charge' is applied for supply of electricity to consumers for each day of billing period, regardless of how much electricity is consumed. It is often shown as a 'daily rate' on the electricity bill.

b) Variable or Usage Charge

The variable charge, also known as 'usage charge' or 'consumption charge', is listed as cents per kilowatt hour (c/kWh) for electricity and cents per mega joule (c/MJ) for gas.

Tariff Calculation

Each generation unit consists of two part tariff rate. One part constitutes the “fuel cost” used in the generation of electricity, whereas the other part is intended to recover plant's revenue requirement.

The electricity bill of consumer indicate 'fuel charge' and 'service charge' for the month's consumption. The customer's total charge will be the sum of these two amounts and calculated as follows:

- a) **Fuel Charge** = Fuel Cost Recovery Rate x Customer's Consumption
- b) **Service Rate Charge** = Service Rate x Customer's Consumption

For tariff calculation of Electric power, the following components are calculated:

- 1) **Fuel cost/charge**
 - a) Yearly net generation
 - b) Fuel required
 - c) Fuel cost per unit/kwh
2. **Service charge**
 - a) Operation & Maintenance cost
 - b) Yearly Depreciation
 - c) Regulatory Working Capital
 - d) ECA loan calculation
 - e) Commercial loan calculation
 - f) Return on Equity calculation

Fuel cost calculation :

At first, the yearly net generation is calculated by multiplying net capacity with plant factor and monthly operation hour as follows:.

Yearly Net Generation = capacity × plant factor x hours per year

Thereafter, the total heat required for generation is calculated by multiplying yearly net generation and heat rate as under:

Total Heat Required = Yearly Net Generation x Heat Rate

After these calculations, the total Fuel required for net

generation is calculated by dividing total heat required for generation by calorific value of Fuel (oil).

Total Fuel Required = Total Heat Required / Calorific Value of Fuel

Finally, the total Fuel cost per year by multiplying Fuel Price with total fuel required.

Total Fuel cost = Total Fuel Required x Fuel Price

The Generation cost is the summation of fuel cost and non-fuel cost.

The **Total Annual Revenue Requirement (ARR)**, which represents the licensee's capital and operation costs, is then calculated by adding the 'Total Costs' with the 'Return on Rate Base'.

Sri Lanka

The Public Utilities Commission of Sri Lanka (PUCSL)



which was established in 2002 is empowered to regulate electricity tariff and other charges levied by regulated entities. It exercises licensing, regulatory and inspection functions and enforce provision of licenses, contracts and other instruments. It is also mandated to protect the interests of all consumers and promote competition.

An electricity 'tariff methodology' has been enforced by PUCSL under the Sri Lanka Electricity Act No. 20 of 2009, which classified the tariff components under following heads:

- a) **Bulk Supply Tariffs** - This relates electricity generation and use of Transmission System
- b) **Distribution Tariff** - This relates to use of licensee's Distribution System
- c) **Retail Supply Tariff** - This related to supply of electricity

Under the PUCSL tariff methodology, the transmission customers are required to pay the bulk supply tariff, whereas other customers are required to pay a tariff comprising of all components.

Determination of Bulk Supply Tariffs

The electricity produced by PUCSL-licensed Generating companies are purchased by a single buyer and reflected in Power Purchase Agreements (PPAs). The generation cost is determined by the single buyer based on which the bulk supply tariff is also calculated.

The bulk supply tariff is composed of following three components:

- a) Generation tariff
- b) Transmission tariff
- c) Bulk supply and Operations Business tariff

Generation tariff : The following two-part tariff pricing formula is used in Power Purchase Agreements:

- a) Capacity Price/ Charge to recover fixed costs associated with each generating unit such as debt servicing; efficient

O&M fixed costs and costs of services provided by CEB Generation HQ

- b) Energy Price/Charge to recover the fuel cost; efficient variable O&M costs and start-up costs

Transmission tariff : The Transmission System Allowed Revenue (TSAR) is that revenue that the Transmission Licensee is allowed to collect from the transmission users for use of transmission system, excluding connection charges. TSAR is the sum of following two components:

- a) Transmission Base Allowed Revenue (BAR)
b) Large Infrastructure Development (LID) allowances

A multi-year tariff system is used to calculate the 'Transmission Base Allowed Revenue (TBAR)' with a limitation (Revenue Cap) imposed by PUCSL on overall revenues (TSAR) during tariff period (5 years) regardless of the number of Transmission Users, energy transmitted, etc. Transmission System Allowed Revenue is adjusted yearly on basis of Revenue Control Formula.

The revenue related to capital expenditure (CAPEX) classified as **Large Infrastructure Development (LID) Allowances** is collected from the users of transmission system by adding an allowance to the Transmission Base Allowed Revenue (TBAR) from time to time.

Adjustment of Technical Losses in Bulk Supply Tariffs

The technical losses in Transmission System is allowed to be 'passed-through' to Bulk Supply Tariffs. The forecast transmission losses is calculated by System Operator as a part of Annual Operating Plan. The actual transmission losses are, however, measured through the metering system. In case the metering system is not available, the Commission may allow the Transmission Licensee to use forecast transmission losses for determining the Bulk Supply Tariffs.

Determination of Distribution Tariff

The Distribution and Supply Licensee is involved in distribution as well as retail supply of electricity. The Distribution Allowed Revenue (DAR) is that revenue that the D&S Licensee is allowed to collect from the users of distribution system (wire business), excluding Allowed Charges (connection, reconnection, meter testing, etc) that are separately regulated.

A multi-year tariff system is used to calculate the 'Distribution Allowed Revenue (DAR) with cap imposed by PUCSL on overall revenues during the tariff period. This cap is adjusted for changes in the number of distribution users and energy distributed as prescribed by the Revenue Control Formula.

Determination of Retail Supply Tariffs

The Retail supply tariff is classified into following two main components:

- a) **Retail service tariff** - This includes all costs related to commercial cycle (meter reading, invoicing, collection), routine meter testing cost and bad debt allowance etc. The Retail service tariff is calculated on basis of a Multi Year

Tariff System in which a cap on average price is also imposed during tariff period (5 years). The cap is adjusted annually considering SLCPI.

- b) **Bulk Supply "Pass-Through" Tariff** - This tariff is based on the Bulk Supply Tariffs and adapted in order to be applied to retail customers. It consists of two parts viz. capacity charge and energy charge. The energy part is further divided into three time intervals. The Bulk Supply "Pass-through" Tariffs is differentiated by voltage levels defined by the USCSL. The following formula is used to charge bulk supply pass-through tariffs to the retail consumers:

$$PTP_{p,i,v} = BST_p^E (E_i) \times (1 + AL_{p,v})$$

$$CP_{p,v} = BST_p^E (C) \times (1 + CAL_{p,v})$$

In the above Formula:

PTP_{p,i,v} = Allowed energy Pass-through-tariff for a 6-month period 'p' in hourly interval 'i' at voltage 'v'

AL_{p,v} = Allowed (energy) Loss factor (%) at voltage level 'v' for 6-month period 'p'

CP_{p,v} = Allowed capacity Pass-through Tariff for 6-month period 'p'

CAL_{p,v} = Allowed (capacity) Loss factor (%) at voltage level 'v' for 6-month period 'p'

Nepal



The **Nepal Electricity Authority (NEA)** which was established way back in August 1985 under the Nepal Electricity Authority Act, 1984 through the merger of Department of Electricity of Ministry of Water Resources, Nepal Electricity Corporation and related Development Boards, is mandated to recommend, determine and realize tariff structure for electricity consumption. It is also responsible for generate, transmit and distribute power by planning, constructing, operating and maintaining all generation, transmission and distribution facilities in Nepal's power system, both inter-connected and isolated.

The Electricity Tariff Fixation Regulations were promulgated under provision of Electricity Act, 1992. In 1994, an Electricity Tariff Fixation Commission (ETFC) was formed in accordance with Electricity Act, 1993 to oversee the retail tariff structure. However, the generation tariff is looked after by NEA. The Commission is non-functional at present. It followed ROR method to fix tariff rates for consumers.

Determination of Tariff

As per Electricity Act, 1992, the tariff and other charges are required to be determined on the basis of rate of depreciation, reasonable profit, mode of operation of power plant, changes in consumer's price index, royalty and policy adopted by government of Nepal. Any entity distributing electricity in isolation of national grid, is entitled to fix tariff and other charges for distribution of electricity.

Further, the Act mentions that tariff may be so fixed that all investments made on electricity generation, transmission or distribution is paid back in average of 25 years by deducting the depreciation cost and a dividend of 25% on share capital earned. It is also required under the Act that the tariff should be fixed by taking into consideration the types of consumers; social liability; cross subsidies and demand potential. The following components are considered while fixing the tariff:

- a) Marginal cost of electricity generation
- b) Exchange rate of convertible foreign currency
- c) Fuel cost
- d) Loans and debt servicing

Nepal electricity generation system pre-dominantly depends on hydro resources. The hydro-power pricing in Nepal is determined on basis of hydro-power project costs, which can be classified as:

- a) **Associated costs** - This includes all costs incurred during construction and operation phases such as civil works, electrical and mechanical equipment, transmission and sub-station, engineering, management, administration and operation and maintenance costs.
- b) **Induced costs** - All costs that are incurred to mitigate adverse impacts produced by the project during construction phase to the society, nature and environment
- c) **External costs** - The costs incurred on the infrastructure such as roads, rural electrification, transmission lines that may not be directly linked to the project are considered external costs. There are generally no external costs during the operation phase.
- d) **Opportunity costs** - This cost refers to the cost assigned for the forgone opportunity for other users of water as irrigation.

In addition to above costs, there are two kinds of royalties (as defined in Hydro-power Development Policy 2001) namely capacity and energy royalty based on capacity and energy generated respectively.

Cost plus pricing approach is generally used for pricing of electricity in Nepal in which the generator fixes electricity tariff, based on its average generation cost plus a certain net profit margin. However, in cases of power purchase from IPPs by the Nepal Electricity Authority (NEA), a Fixed percentage of retail tariff approach is used in which a certain percentage of retail tariffs is fixed as tariff.

The hydro-power pricing in Nepal is determined on basis of following two price components:

- a) **Capacity Price** - This refers to the annuitized installation cost of hydro-power project, including debt repayment, interest payment; guarantee fee during repayment; interest tax, insurance fee and capacity royalty.
- b) **Energy Price** - This refers to the cost of annual operation of hydro-power plant per unit (kWh) and covers the equity portion of installation cost. The cost of operating hydro-power plant is related with operation and maintenance expenses, energy royalty, return on investment, corporate tax, dividend tax and export premium, if applicable.

Bhutan

The **Bhutan Electricity Authority (BEA)** which was established way back in 2001 is an autonomous regulator for the electricity sector, operating under the Department of Electricity of Ministry of Power of



Bhutan. It is empowered to develop regulations for domestic tariff setting including subsidies in accordance with provisions of Electricity Act, 2001. It is also responsible for economic and technical regulation of power sector entities, including tariff setting and licensing.

The Electricity Act 2001 contains broad principles of tariff setting. Subsequently, a Tariff Determination Regulations, 2007 were enforced which became applicable on all distribution, supply, transmission, generation and system operation Licensees. The Bhutan Power Corporation Ltd. (BPCL) is responsible for electricity transmission, distribution and supply functions including management and operations of embedded generation units consisting of micro/mini/small hydro and diesel generating units. The BPCL provides transmission access for export of surplus power to India.

Determination of Tariff

The electricity tariff sold to industries and household in Nepal is calculated using the cost-plus model. Under the Bhutan Electricity Authority (BEA) Tariff Determination Regulations, 2006, the BEA is authorized to approve a 'Tariff Schedule' for each Licensee that sets the maximum prices to be charged. The Tariff Schedule is applicable for the duration of tariff period with appropriate indexing or other adjustments over the course of tariff period.

For generation Licensees, tariff determination shall provide for an allowance for auxiliary consumption at power stations as well as an allowance for station availability. For transmission, distribution and supply Licensees, the 'costs of supply', to be determined by BEA, shall provide for an allowance for technical losses, commercial losses and non-payment. The scope of costs shall include the following:

- a) Operating and Maintenance (O&M) costs
- b) Depreciation
- c) Return on Fixed Assets, including an allowance for company taxation
- d) Power purchases and Fuel costs for electricity generation
- e) Costs of losses and non-payment of electricity bills
- f) Cost of working capital
- g) Any Regulation fees, duties or levies applicable on Licensee under the law

Formula for determining Average Cost of Supply

The formula for determining the average cost of supply for a Licensee in any year is determined as under:

$$TC = OM + DEP + RoA + RoWC$$

In the above Formula:

TC = Total Cost of supply in million Ngultrum

OM = Allowance for Operating and Maintenance costs in million Ngultrum (including regulatory fee etc)

RoA = Return on Fixed Assets in million Ngultrum, determined as per following formula:

$$RoA = WACC \times NA$$

where

WACC = Weighted Average Cost of Capital

NA = Net Value of all Fixed Assets at start of year in million Ngultrum

RoWC = Return on Working Capital in million Ngultrum determined as per following formula:

$$RoWC = WACC \times [REV \times ARREARS / 365 + INVENTORIES]$$

where

WACC = Weighted Average Cost of Capital

REV = O&M + Depreciation + RoA

ARREARS = Allowed days receivables

INVENTORIES = Allowance for Inventories in million Ngultrum

Formula for determining End-users Prices

The Authority (BEA) determines an 'Average Price' for each 'Customer Group' applicable for tariff period. All customers connected to a common voltage level shall comprise on customer group for the purpose of determining Average Prices. Within each customer group, the Licensee may create different tariff structures for different customer categories. For determining the Average Prices, the Power Purchase Price (PPP) shall comprise of the weighted average of purchases from domestic generators at their 'Additional Price' and purchases from imports, at the average import price.

The cost of supply for a Customer Group in a particular year is determined as per following formula:

Energy purchase cost valued at Power Purchase Price

Add: Network costs allocated to Customer Group

Add: Cost of Working Capital allocated to Customer Group

Less: Any Non-Tariff Revenue from Customer Group

Less: Subsidies allocated to Customer Group

The Average Price for a Customer Group is determined as the ratio of the discounted costs of supply for that Customer Group to the discounted electricity sales to that Customer Group, where sales are adjusted for an allowed collection rate, and where discounting occurs over the Tariff Period at the Weighted Average Cost of Capital (WACC) applicable to the Licensee.

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Websites of relevant Electricity Regulatory Authorities in SAARC countries

The data collection has been facilitated by Shabbir Ahmed Baqai, Research Associate