Estimated Power Tariff Model of Rayalaseema Thermal Power Plant 2x210 MW

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Abstract: From times immemorial it is a conversant rudimentary fact that the State Electricity Boards of India were cash strapped with no exception of bifurcated Andhra Pradesh. To avert from such precarious and deteriorating economic situations of widening gap between increasing trend of cost of supply of electricity and meagre power tariffs, the restructuring of Andhra Pradesh State Electricity Board became quite inevitable according to the Electricity Reform Act of 1998 to ensure its commercial viability and efficiency. To usher gainful insights regarding rapid emergence of competitive markets in Thermal Electric Energy Industry, this research paper computes power tariff in Generation segment for Rayalaseema Thermal Power Plant with installed capacity of 2x210 MW both during Pro-Privatization Period and during Privatization Period with strict adherence to Central Electricity Regulation Commission (CERC) Guidelines. The estimated price per Kilo Watt Hour of electricity generated during pro privatization and during privatization was Rs.1.29 Paise per Kilo Watt Hour and Rs.2.55 Paise per Kilowatt Hour.

These calculations were based on the price opinionated and discriminatory techniques of pricing policies in partially monopolistically structure of Thermal Electricity Generation Industry. It comprises of recuperation of twelve-monthly static concerns and fixed expenditures that constitutes Interest on Principal amount rented, downgrading of assets, maneuvering operations and conservation measures of overwhelming expenditures, (eliminating energy feedstock), chargeable rate on income figured , interest on operational wealth at standard norm of production of electrical energy or voltage , productivity and lucrativeness of electric business in relation with equivalence or parity and energy inconstant duties and charges including feedstock fee with recouping for each unit or kilowatt of electric energy multifarious delivered. Value added to this, further estimations were carried out for projected power tariff for the tenure period ranging from 2019-2020 to 2031-2032 using statistical time series trend analysis. During all these future years similar trend is likely to be exhibited with estimated power tariff at Rs. 1.95 Paise per Kilo Watt Hour.

Key words: Power Tariff, Fixed and Variable Charges, Cost of Generation

I. INTRODUCTION

The Electric Energy as a part of derived demand has been possessed with the inherent characteristic feature of sole authority that can be betokened as natural monopoly. With the advent of New Economic Policy Reforms of 1991, the importance of Liberalization, Globalization and Privatization has attained greatest strides in the Electricity Supply Industry.

Slowly the Electric Energy has got transformed from incompetent machinery and equipment to more advanced and sophisticated technological breakthroughs, but it had entailed escalated generation costs.

II. METHODOLOGICAL MATERIALS

It is customarily well-known fact that every generating electric energy power project undergoes thorough overhauling in terms of techno cost-effective economic authorizations. For this purpose it is mandatorily imperative to follow the edged rubrics of Ministry of Power, through a regulatory body of Central Electricity Authority. In accord to this, the research paper selected Rayalaseema Thermal Power plants that adhered to the strict protocol of thermal engineering concepts along with follow up of the Central Electricity Regulatory Commission laid down stipulated canons apropos for the procedure of Thermal power generating stations.

Based on the aforementioned concept, the research study have commendably estimated the Electric Energy charge for the selected Power station during denationalization Period. This have been computed with six percent feed stock coal worth acceleration in terms of price, six percent repairs costs escalation, seven percent total credit interest with overseas foreign currency rate escalation, seven percent credit reimbursement with foreign exchange increase in prices, and power tariff projections are made over the 30-year life period of this particular thermal plant.

For the past one decade the Electric Generation Industries had enormous scope for prevalence of economies of scale due to which it allowed for lowering the production costs. The major transitional shift from non-renewable resources such as coal, oil and natural gas to renewable resources such as solar, wind energy for electricity generation has necessitated a tremendous leeway for relentless constant costs with respect to huge preliminary investment in plant and machinery. In synchronization with this, the other financial parameters costs such as wear and tear of tangible assets, diminution of intangible assets, millage rate, insurance, return of capital are all constant. Based on this perspective also, the concept of power tariff is calculated in selected Rayalaseema Thermal Power Plant and power tariff forecasts are primed.

III. DATA ANALYSIS AND EMPIRICAL RESULTS

The Computation of Price Per Kilo Watt Hour In Rtpp 2x 210 Mw

The micro-economic reform in production (generation) side of electricity supply industry with respect to in selected thermal power plant of Andhra Pradesh is based on the following empirical calculations.

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### Pro-privatization period:

| Description | Details |
|-------------|---------|
| Fixed Capacity of the project | 420 MW |
| Venture cost of industrial power as per TEC | Rs.503.71 Crores (Nov,1987) |
| Absolute cost of the project | Rs.860.30 Crores |
| (April 1997) | |
| Installed cost | Rs.2.048 Crores |
| (Item 3 / 1) | Rs.198.00 Crores |
| Interest on capital during Construction | Rs.1058.30 Crores |
| Total sum at charge | |
| (Item 3 + 5) | |
| Cost / megawatt including Interest during Construction | Rs.3 Crores |
| Annual Generation | 2730 M.U. |
| Supplementary Consumption at nine percent | 245.7 MU |
| Components of electric energy absorption | 2484.3 MU |
| (Item 8-9) | 2300 K.cal/Kwh |
| Weighted heat rate (Assumed) | 0.702 kg / kwh |
| Coal intake with presumptuous net high energy: | |
| value of coal of 3275 K.cal/ kg | 5 M.T |
| (2300/ 3275) | Rs.2007.72 |
| Coal consumption / year/ Kilowatt installed | Rs.4178.0 |
| (Item .702 x2730 / 503.71 ) | Rs.6185.72 |
| Twelve-monthly coal cost @ Rs.440/MT/kw | |
| installed (Item 13x14) | |
| Static Charges @ 7 % on item (4) | Rs.2188 |
| and 11.5 % on item 7 | Rs.117 paise |
| Total fixed and variable charges/year/kw | Rs.882.0 |
| installed (Item 14 + 15) | 12.31 paise per kilowatt hour |
| Accumulation of the cost of fuel oil at | 129 paise per kwhr |
| : Rs.3000/Kl | |
| (Item 14 + Rs.180) | |
| Total fixed plus variable charges | |
| 18 | |
| Cost at 220 kv busbar | Rs.1.17 |
| (Rs18/5460) | |
| Profit on capital @ 3.5 % of cost /kw | Rs.882.0 |
| on Item 7 | |
| 21. Profit per unit of Electric Energy | |
| : | |

### Background of privatization period:

The massive scale of privatization in every sector of economy had its impact tremendously on electric energy generation and distribution industries of Andhra Pradesh State Electricity Board. In this particular set up, many private generating stations face the perfectly competitive market structure where in few of them were in direct contract with APSEB or function as an independent entity. In the process, multiple generating companies have assigning arrangements with varied distribution companies with esteem to magnitude of electric energy abundantly provided and their tariff for sale and other matters subsidiary thereto.

### Experiential Estimation of Electric Energy Tariff – Rayalaseema Thermal Power Station Stage-II (2x210 MW):

To quote a live illustration related to this, a Multi-National Company M/s ZMEC a Chinese administration corporation have come frontward to build RTPP- II project at a very pecuniary price of Rs.4 Crore/ MW with a inimitable 100 % obligation of loan finance, on build and transfer basis. The mission graft has initiated on April 2001 and the first unit was custom-built by November 2003 and the second unit by February 2004. The twelve-monthly coal prerequisite for the two supplementary units is predictable to be about 1.5 million tons.
The rate of producing one kilo watt hour of electrical energy by the RTPP stage-II with a fixed installed capacity of 2x210 MW has been premeditated as per CEA procedures.

| Charge of power venture | Rs.1578 Crores |
|-------------------------|----------------|
| Total capital cost      | Rs.1564 Crores |
| Life cycle              | Thirty years   |
| Disposible Generation (MU) | :1225         |
| Power Unit –1 (MU)      | :1103          |
| 2 (MU)                  |                |
| Total Mesh Generation at Plant | :2328        |
| Load Factor 80%         |                |
| Estimated fairness of equity | : Rs. 313 Crores |

**STATIC EXPENDITURES:**

Charge of power venture Total capital cost Life cycle

Wear and Tear Charges at 2.5 % : Rs.30 Crores
Decrease at 7.84 % : Rs. 40 Crores
(as per project cost TEC)

Interest on credits : Rs.123.69 Crores
Interest on operational capital : Rs. 94.54 Crores
Bulk cost : Rs. 327.83 Crores
Capacity cost per kwh : Rs.328/2328.19 = 141 paise/ kwhr

**CAPRICIOUS CHARGES:**

Aggregate thermal energy requirement Worth of coal
Charge of coal : 1578396 metric ton
Total oil prerequisite : Rs.1668 /metric ton
Price of oil : Rs.7960/Kilo litre
Cost of oil : Rs.7.96Kilo litre
Whole cost of fuel : Rs. 5 Crores

Feed cost per kwh
Fixed Expenses + Variable Charges = 140.81 + 115
= Rs.3

For the purpose of having a huge impact on the Electric Energy Tariff for successive years, the economic parameters Fixed and Variable charges and Power Plant competence was taken in to consideration. For a longer duration of time period of around thirty years, electric energy forecast has been generated by this research paper by employing constant economies techniques.

Credit Refund Agenda and Interest on credits calculation:

| Total credit endowment for RTPP stage-II – Rs.1265 Crores |
|----------------------------------------------------------|
| Out of this Rs.1265Crores --                               |
| 97 % is Foreign Loan                                      |
| -- 3 % is Home Loan                                       |
| Therefore, Foreign Credit – Rs.1224.13Crores              |
| Household Loan – Rs.40.78Crores                           |
| Interest on Overseas Credit – 7.36% PA                    |
| Interest on Rupee Term Loan – 14% PA                      |
Interest on Overseas Loan:

Interest for first 6 months:
Extraneous credit – Rs.1224 Crores
Interest rate 7.36/2 = 4 %
Therefore, interest aggregate for six months is 45. The amount 1224 Crores have to recompense in 11.5 years. No reimbursement in first 6 months.

Interest for second 6 months:
External Loan—1224
Reimbursement in 23 repayments = 1224.13/23 = Rs53 Crores.
As the time of credit repayment is not correctly known typical of loan repayment is taken as 53.22/2 = Rs.27 Crores.
Here Loan = 1224.13 less 26.61 = Rs.1198 Crores.
Interest aggregate = 1198 x 3.68% = Rs.44 Crores.
(a) Therefore, total interest on Foreign loan for first installment = 45.05+44.07= Rs.89 Crores.

Interest on RTL Loan:

Interest for first six months
RTL Credit: 41
Interest rate: 14/2 = 7%
The amount Rs.40.78Crores have to be recompensed in 10 years in 20 portions.
Loan Settlement 40.78/2 = 2.04crores.
In this case also as the accurate time of credit payment repayment is not correctly known typical of loan instalment is reserved for interest calculation.
i.e. 2.04/2 = 1.02
Hence loan = 40.78 less 1.02 = Rs.40.76Crores
Interest amount = 39.76x7% = Rs. 3 Crores

Interest for second 6 months
RTL 40.78 less 2.04 = Rs.38.74Crores
Repayment volume = Rs.2.04crores
But for interest estimation it should be taken as 1.02 as mentioned earlier.
Hence RTL for Interest purpose = 39 less1.02 = Rs.38 Crores.
Interest volume = 37.72x7% = Rs.3 Crores.
(b) Entire Interest on RTL Credit for second part of instalment =2.78+2.64 = Rs.5.42Crores.
Therefore, the whole advance interest yearly is (a) +(b) = Rs.95.42 Crores.
For the residual years it is deliberated in the analogous method and the outcomes are:
Credit interest for Stabilization period, 47.83+46.71 = Rs.94.54 Crores
Year Credit interest for 2002-2003, 44.61+42.51 = Rs.87 Crores
Year Advance interest for 2003-2004, 40.41+38.30 = Rs.79 Crores

Year Mortgage interest for 2004-2005, 36.2+34.1=Rs.70 Crores
Year Finance Interest for 2005-2006, 32+29.9 =Rs.62 Crores

Calculation of Interest on Operational Capital:

The working capital standards are:
Coal expenditures – 19
Coal stock – 18.779
Feed Stock oil price – 0.700
Replacements – 10.79
Operation and Maintenance – 4.34
Disbursements
Receivables – 92.90

For the year total working capital requirement – Rs.146.20Crores.

For the Equilibrium Period
Thermal Coal charges—21.47
Coal store – 21
Energy feed stock of oil cost—0.67
Spare s – 11
O & M—3
Receivables – 96.01
(Excluding enticements & Income tax)
Total functioning capital – Rs154 Crores.
For the continuing years also, the over-all functioning capital is considered. The total working capital prerequisite is declining as the receivables are plummeting from the year 2002-2003 to the lasting years. The working capital interest rate is 14%. Consequently, for the Stabilization period the entire working capital requirement is 146.29x14% = Rs.20.48Crores.

Twelve-monthly interest
Maintenance period –Rs.21Crores
2002-2003—Rs.22Crores
2003-2004 – Rs.21.48Crores

Hence, established on the above two bounds that is Interest on credits and Interest on operational principal capital constriction in the static duties and constant economics of adjustable overheads, Electric Energy tariff prognoses are prepared for 30 years. The power sector will have to accept the fact of financial and operational inefficiency of SEBs and their incapacity to put their house in order. The serious weakness of APSEB is their continued inefficiency of SEBs and their incapacity to put their house in order.

Refurbishment of monetary situation of the State Electricity Boards and enhancement in their working presentation are the decisive concerns currently in the electric energy sector.

From the above case studies, it is clear that the electricity tariff using coal as feedstock in RTPP Stage II in Table B is more than 258.92 Paise per Kilo Watt Hour in 2002-2003 to 795.55 Paise per Kilo Watt Hour in 2030-2031 compared to Table A which are 233.78 Paise per Kilo Watt Hour in 2002-2003 to 163.83 in 2030-2031. This is because the parameters of fixed costs and variable costs in coal-based power projects are high compared to natural gas electric energy projects. The electricity tariffs of thermal power plants are considered as competitive tariffs and they can ensure financial sustainability in Andhra Pradesh State Electricity Board.

IV. CONCLUSION

During privatization period the Profit on equity, Devaluation and Maneuver and maintenance expenses are maintained as per CEA guide lines and the tariffs in each case study are considered as competitive as they are able to recover fixed charges and variable charges. Owing to the declining trend of plant load factor from the level of 60 % to further deteriorating level from 2017-2018 and with a prediction of continuing trend for the future years also in almost all thermal power plants, have initiated the Central Electricity Regulatory Commission, of India to take a leap forward to implement Three-part Tariff structure

Electric energy tariff forecasts for rayalaseema thermal electric energy industry stage-ii (2×210mw) at eighty percent plant load factor for a life cycle of thirty years.

| Installed Capacity (MW) | 17th Year 2018-2019 | 18th Year 2019-2020 | 19th Year 2020-2021 | 20th Year 2021-2022 | 21st Year 2022-2023 |
|------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Unit-1                 | 210                 | 210                 | 210                 | 210                 | 210                 |
| Unit-2                 | 210                 | 210                 | 210                 | 210                 | 210                 |
| Plant load Factor      |                     |                     |                     |                     |                     |
| Unit-1 (Hrs/Year)     | 7008                | 7008                | 7008                | 7008                | 7008                |
| Unit-2 (Hrs/Year)     | 7008                | 7008                | 7008                | 7008                | 7008                |
| Total Net Generation (MU) | 2693.1744          | 2693.1744           | 2693.1744           | 2693.1744           | 2693.1744           |

FIXED CHARGES:Rs.Crores
Return on equity
Operation and maintenance expenses
Depreciation
Interest rate on Working capital
Incentives
Taxation
Total Fixed Charge (Rs. In Crores)
Cost Per KWH (in Paise)

| VARIABLE CHARGES | 1804744 | 1804744 | 1804744 | 1804744 | 1804744 |
|----------------|--------|--------|--------|--------|--------|
| Total Coal Requirement in (Tonnes) | 1804744 | 1804744 | 1804744 | 1804744 | 1804744 |
| Price of Coal Per Metric Ton | 1667.52 | 1667.52 | 1667.52 | 1667.52 | 1667.52 |
| Cost of Coal (Rs. In Crores) | 300.94 | 300.94 | 300.94 | 300.94 | 300.94 |
| Total Oil Requirement (KL) | 5886.72 | 5886.72 | 5886.72 | 5886.72 | 5886.72 |
| Price of Oil per Kilo Litre | 7960 | 7960 | 7960 | 7960 | 7960 |
| Cost of Oil (Rs in Crores) | 4.69 | 4.69 | 4.69 | 4.69 | 4.69 |
| Total Cost of Fuel (Rs. In Crores) | 305.63 | 305.63 | 305.63 | 305.63 | 305.63 |
| Cost per Unit of Fuel Cost (Paise Per KWH) | 137.73 | 137.73 | 137.73 | 137.73 | 137.73 |
| Power Tariff | 188.08 | 188.08 | 188.08 | 188.08 | 188.08 |
## Estimated Power Tariff model of Rayalaseema Thermal Power Plant 2x210 MW

| 22nd Year 2023-2024 | 23rd Year 2024-2025 | 24th Year 2025-2026 | 25th Year 2025-2026 | 26th Year 2026-2027 | 27th Year 2027-2028 |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| 210                 | 210                 | 210                 | 210                 | 210                 | 210                 |
| 210                 | 210                 | 210                 | 210                 | 210                 | 210                 |
| 7008                | 7008                | 7008                | 7008                | 7008                | 7008                |
| 7008                | 7008                | 7008                | 7008                | 7008                | 7008                |
| 2693.1744           | 2693.1744           | 2693.1744           | 2693.1744           | 2693.1744           | 2693.1744           |
|                     |                     |                     |                     |                     |                     |
| 50.04               | 50.04               | 50.04               | 50.04               | 50.04               | 50.04               |
| 39.09               | 39.09               | 39.09               | 39.09               | 39.09               | 39.09               |
| 0                   | 0                   | 0                   | 0                   | 0                   | 0                   |
| 0                   | 0                   | 0                   | 0                   | 0                   | 0                   |
| 17.34               | 17.34               | 17.34               | 17.34               | 17.34               | 17.34               |
| 2.18                | 2.18                | 2.18                | 2.18                | 2.18                | 2.18                |
| 26.94               | 26.94               | 26.94               | 26.94               | 26.94               | 26.94               |
| 135.59              | 135.59              | 135.59              | 135.59              | 135.59              | 135.59              |
| 50.35               | 50.35               | 50.35               | 50.35               | 50.35               | 50.35               |
| 1804744             | 1804744             | 1804744             | 1804744             | 1804744             | 1804744             |
| 1667.52             | 1667.52             | 1667.52             | 1667.52             | 1667.52             | 1667.52             |
| 300.94              | 300.94              | 300.94              | 300.94              | 300.94              | 300.94              |
| 5886.72             | 5886.72             | 5886.72             | 5886.72             | 5886.72             | 5886.72             |
| 7960                | 7960                | 7960                | 7960                | 7960                | 7960                |
| 4.69                | 4.69                | 4.69                | 4.69                | 4.69                | 4.69                |
| 305.63              | 305.63              | 305.63              | 305.63              | 305.63              | 305.63              |
| 137.73              | 137.73              | 137.73              | 137.73              | 137.73              | 137.73              |
| 188.08              | 188.08              | 188.08              | 188.08              | 188.08              | 188.08              |

| 28th Year 2028-2029 | 29th Year 2029-2030 | 30th Year 2030-2031 | 31st Year 2031-2032 |
|---------------------|---------------------|---------------------|---------------------|
| 210                 | 210                 | 210                 | 210                 |
| 210                 | 210                 | 210                 | 210                 |
| 7008                | 7008                | 7008                | 7008                |
| 7008                | 7008                | 7008                | 7008                |
| 2693.1744           | 2693.1744           | 2693.1744           | 2693.1744           |
| 50.04               | 50.04               | 50.04               | 50.04               |
| 39.09               | 39.09               | 39.09               | 39.09               |
| 0                   | 0                   | 0                   | 0                   |
| 0                   | 0                   | 0                   | 0                   |
| 17.34               | 17.34               | 17.34               | 17.34               |
| 2.18                | 2.18                | 2.18                | 2.18                |
| 26.94               | 26.94               | 26.94               | 26.94               |
| 135.59              | 135.59              | 135.59              | 135.59              |
| 50.35               | 50.35               | 50.35               | 50.35               |
A) Power Tariff Projections For Rtp Stage II For A Life Period Of 30 Years With Constant Economics Based On Techno-Economic Clearance.

| YEAR       | FIXED CHARGE | VARIABLE CHARGE | POWER TARIFF PAISE/KWH |
|------------|--------------|-----------------|-------------------------|
| (2002-2003)| 120.3        | 113.48          | 233.78                  |
| (2031-2032)| 50.35        | 113.48          | 163.83                  |

B) Power Tariff Forecasts For The Rtp Stage II For A Life Period Of 30 Years --- Assuming 5% Increase In Variable Charge (Price Of Coal)

| YEAR       | FIXED CHARGE | VARIABLE CHARGE | POWER TARIFF PAISE/KWH |
|------------|--------------|-----------------|-------------------------|
| (2002-2003)| 120.3        | 137.73          | 258.03                  |
| (2031-2032)| 50.35        | 137.73          | 188.03                  |

C) Power Tariff Projections For The Rtp Stage II For A Life Period Of 30 Years --- Assuming 10% Increase In Variable Charge (Price Of Coal)

| YEAR       | FIXED CHARGE | VARIABLE CHARGE | POWER TARIFF PAISE/KWH |
|------------|--------------|-----------------|-------------------------|
| (2002-2003)| 120.3        | 144.29          | 264.59                  |
| (2031-2032)| 50.35        | 144.29          | 194.64                  |

A Clustered Graph Chart:
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