

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 Kilowatt 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.

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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 Rtpm 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



PRO-PRIVATIZATION PERIOD:

Experiential Calculation of Coal Based Electric Energy
Tariff: Rayalaseema Electric Energy Industry Stage -I
(2x210 MW)

1.Fixed Capacity of the project:	420 MW
2.Venture cost of industrial power as per TEC:	Rs.503.71 Crores (Nov.1987)
3.Absolute cost of the project: (April 1997)	Rs.860.30 Crores
4. Installed cost : (Item 3 / 1)	Rs.2.048 Crores
5. Interest on capital during: Construction	Rs.198.00 Crores
6. Total sum at charge: (Item 3 + 5)	Rs.1058.30 Crores
7. Cost / megawatt including Interest during: Construction (Item 6 / 1)	Rs.3 Crores
8. Annual Generation :	2730 M.U.
9. Supplementary Consumption at nine percent :	245.7 MU
10. Components of electric energy absorption (Item 8-9)	
11. Weighted heat rate (Assumed) :	2484.3 MU 2300 K.cal/Kwh
12.Coal intake with presumptuous net high energy: value of coal of 3275 K.cal/ kg (2300/ 3275)	0.702 kg / kwh
13. Coal consumption / year/ Kilowatt installed : (Item .702 x2730 / 503.71)	5 M.T
14. Twelve-monthly coal cost @ Rs.440/MT/kw : installed (Item 13x14)	Rs.2007.72
15. Static Charges @ 7 % on item (4) : and 11.5 % on item 7	Rs.4178.0
16. Total fixed and variable charges/year/kw : installed (Item 14 + 15)	Rs.6185.72
17. Accumulation of the cost of fuel oil at : Rs.3000/Kl (Item 14 + Rs.180)	
18. Total fixed plus variable charges	
19. Cost at 220 kv busbar (Item18/5460)	Rs. 2188
20. Profit on capital @ 3.5 % of cost /kw : on Item 7	
21. Profit per unit of Electric Energy :	Rs.117 paise Rs.882.0 12.31 paise per kilowatt hour
The ultimate power tariff calculated can be emphasized as follows	
22. Price/ kwh generated for sale (Item 19 + 21) :	129 paise per kwhr

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
Disposable Generation (MU)	
Power Unit -1 (MU)	:1225
2 (MU)	:1103
Total Mesh Generation at Plant	
Load Factor 80%	:2328
Estimated fairness of equity	: Rs. 313 Crores
STATIC EXPENDITURES:	
Yield on equity	
Wear and Tear Charges at 2.5 %	: Rs.50 Crores
Decrease at 7.84 % (as per project cost TEC)	: Rs. 40 Crores
Interest on credits	: Rs. 123.69 Crores
Interest on operational capital	: Rs. 94.54 Crores
Bulk cost	: Rs. 20.48 Crores
: Rs. 327.83 Crores	
Capacity cost per kwh	: 328/2328.19 = 141 paise/ kwhr
CAPRICIOUS CHARGES:	
Aggregate thermal energy requirement	
Worth of coal	: 1578396 metric ton
Charge of coal	: Rs.1668 /metric ton
Total oil prerequisite	:263 Crores
Price of oil	:6159 Kilo litres
Cost of oil	:Rs.7960/Kilo litre
Whole cost of fuel	: Rs. 5 Crores
Feed cost per kwh	:263.2 + 4.9 = Rs. 268 Crores
Fixed Expenses + Variable Charges = 140.81 + 115 = Rs.3	:268.1/2328.19 = 115.16 Paise per kwh

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 = $1224.13/23 = \text{Rs}53$ Crores.
 As the time of credit repayment is not correctly known typical of loan repayment is taken as $53.22/2 = \text{Rs}.27$ Crores.
 Here Loan = 1224.13 less $26.61 = \text{Rs}.1198$ Crores.
 Interest aggregate = $1198 \times 3.68\% = \text{Rs}.44$ Crores.
 (a) Therefore, total interest on Foreign loan for first installment = $45.05+44.07= \text{Rs}.89$ 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 $40.78/2 = 2.04$ crores.
 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 $1.02 = \text{Rs}.40.76$ Crores
 Interest amount = $39.76 \times 7\% = \text{Rs}. 3$ Crores

Interest for second 6 months
 RTL 40.78 less $2.04 = \text{Rs}.38.74$ Crores
 Repayment volume = $\text{Rs}.2.04$ Crores
 But for interest estimation it should be taken as 1.02 as mentioned earlier.
 Hence RTL for Interest purpose = 39 less $1.02 = \text{Rs}.38$ Crores.
 Interest volume = $37.72 \times 7\% = \text{Rs}.3$ Crores.
 (b) Entire Interest on RTL Credit for second part of instalment = $2.78+2.64 = \text{Rs}.5.42$ Crores.
 Therefore, the whole advance interest yearly is (a) +(b) = $89.12+5.42 = \text{Rs}.95$ Crores.
 For the residual years it is deliberated in the analogous method and the outcomes are:
 Credit interest for Stabilization period, $47.83+46.71 = \text{Rs}.95$ Crores
 Year Credit interest for 2002-2003, $44.61+42.51 = \text{Rs}.87$ Crores
 Year Advance interest for 2003-2004, $40.41+38.30 = \text{Rs}.79$ Crores

Year Mortgage interest for 2004-2005, $36.2+34.1 = \text{Rs}.70$ Crores

Year Finance Interest for 2005-2006, $32+29.9 = \text{Rs}.62$ 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 – $\text{Rs}.146.20$ Crores.

For the Equilibrium Period
 Thermal Coal charges—21.47
 Coal store – 21
 Energy feed stock of oil cost—0.67
 Spares – 11
 O & M—3
 Receivables – 96.01
 (Excluding enticements & Income tax)
 Total functioning capital – $\text{Rs}154$ 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 $146.29 \times 14\% = \text{Rs}.20.48$ Crores.

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 losses and their inherent inability to reverse this trend. 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 (2x210mw) AT EIGHTY PERCENT PLANT LOAD FACTOR FOR A LIFE CYCLE OF THIRTY YEARS.

	17th Year 2018-2019	18th Year 2019-2020	19th Year 2020-2021	20th Year 2021-2022	21st Year 2022-2023
Installed Capacity (MW)					
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	50.04	50.04	50.04	50.04	50.04
Operation and maintenance expenses	39.09	39.09	39.09	39.09	39.09
Depreciation	-	-	-	-	-
Interest rate on Working capital	17.34	17.34	17.34	17.34	17.34
Incentives	2.18	2.18	2.18	2.18	2.18
Taxation	26.94	26.94	26.94	26.94	26.94
Total Fixed Charge (Rs. In Crores)	135.59	135.59	135.59	135.59	135.59
Cost Per KWH (in Paise)	50.35	50.35	50.35	50.35	50.35
VARIABLE CHARGES					
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 Tariffmodel 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
1804744	1804744	1804744	1804744

1667.52	1667.52	1667.52	1667.52
300.94	300.94	300.94	300.94
5886.72	5886.72	5886.72	5886.72
7960	7960	7960	7960
4.69	4.69	4.69	4.69
305.63	305.63	305.63	305.63
137.73	137.73	137.73	137.73
188.08	188.08	188.08	188.08

A) POWER TARIFF PROJECTIONS FOR RTPP STAGE II FOR A LIFE PERIOD OF 30 YEARS WITH CONSTANT ECONOMICS BASED ON TECHNO-ECONOMIC CLEARANCE.

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

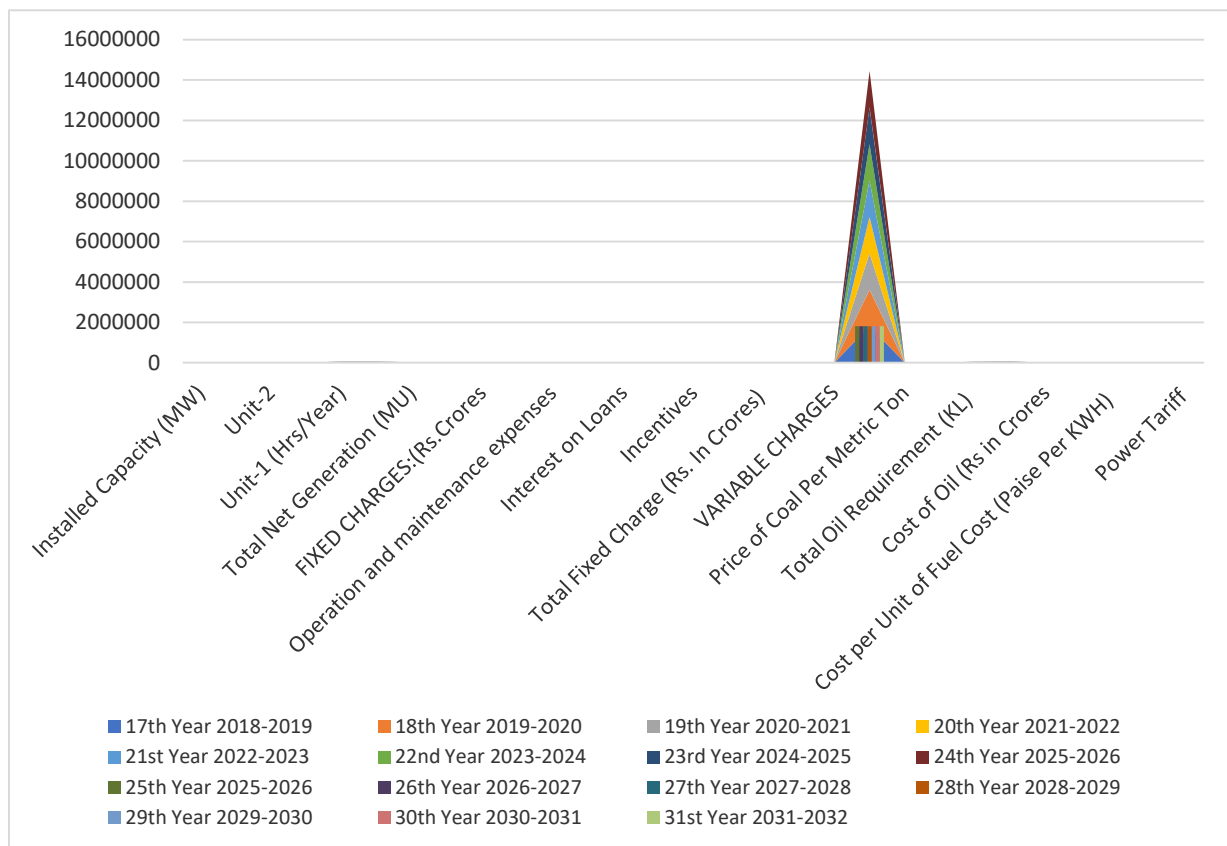
FIXED CHARGE	VARIABLE CHARGE	POWER TARIFF paise/kwh
(2002-2003) 120.3	113.48	233.78
(2031-2032) 50.35	113.48	163.83

C) POWER TARIFF PROJECTIONS FOR THE RTPP STAGE II FOR A LIFE PERIOD OF 30 YEARS --- Assuming 10% Increase in Variable Charge (price of coal)

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

B) POWER TARIFF FORECASTS FOR THE RTPP STAGE II FOR A LIFE PERIOD OF 30 YEARS --- Assuming 5% Increase in Variable Charge (price of coal)

A CLUSTERED GRAPH CHART:



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The author commendably possessed with academic qualification of Doctoral of Philosophy in Energy Economics from Institute of Eminence, University of Hyderabad, and Hyderabad and was also conferred with Post-Doctoral in Energy Economics, from Indira Gandhi Institute of Development Research, Mumbai. Have a store house of many research publications in national and international journals of repute, along with paper presentations at national and international conferences. Work experiences include culmination of 16 years teaching and research at various esteemed universities both in India and Abroad. Achievements encompass recipient of State level First Rank Holder at Post Graduation with Gold Medal, won Scientist Award "Kalpana Chawla" for meticulous contribution to the body of Knowledge research at National Level, Appreciation award from Ministry of Human Resource Development, Central Ministry for stellar performance in teaching. Value added to this have been accredited by United Kingdom British Council, Appreciation Award for Innovative design of Academic Curriculum and floating Research projects Proposals.