Tariff Principles and Design with a focus on ToD tariff and market based dynamic ToD

12th Capacity Building Workshop for officers of ERCs at IIT Kanpur

February 2019
### Tariff Principles and their applicability

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sufficiency</strong></td>
<td>- Network tariffs should allow the full recovery of efficient network costs</td>
</tr>
<tr>
<td></td>
<td>and a reasonable return on capita</td>
</tr>
<tr>
<td><strong>Achievability and adequacy of</strong></td>
<td>- Regulated rate of return should guarantee a return in line with the</td>
</tr>
<tr>
<td><strong>RoE</strong></td>
<td>relative risk of the investments and financing conditions</td>
</tr>
<tr>
<td><strong>Achievability of the incentive</strong></td>
<td>- The incentive mechanism should pose achievable target</td>
</tr>
<tr>
<td><strong>components</strong></td>
<td><strong>Additivity of components</strong></td>
</tr>
<tr>
<td></td>
<td>- Various tariff components must add up to give the total revenue</td>
</tr>
<tr>
<td></td>
<td>requirement to be recovered</td>
</tr>
<tr>
<td><strong>Productive Efficiency</strong></td>
<td>- Infrastructure cost efficiency: tariff regulation should aim to incentivise</td>
</tr>
<tr>
<td></td>
<td>efficient investment</td>
</tr>
<tr>
<td></td>
<td>- Operational cost efficiency: tariffs regulation should aim to reduce</td>
</tr>
<tr>
<td></td>
<td>operational (including administrative) costs</td>
</tr>
<tr>
<td><strong>Allocative Efficiency</strong></td>
<td>- Peak reduction: Network tariffs should promote peak demand management; aim</td>
</tr>
<tr>
<td></td>
<td>to reduce infrastructure cost for peak demand</td>
</tr>
<tr>
<td></td>
<td>- Flexibility - Tariffs should encourage system flexibility, e.g. distributed</td>
</tr>
<tr>
<td></td>
<td>generation, demand response and energy efficiency</td>
</tr>
<tr>
<td><strong>Cost Reflectiveness</strong></td>
<td>- Consumers should be charged in accordance with the costs of the services</td>
</tr>
<tr>
<td><strong>Transparency</strong></td>
<td>- Methodology and results of tariff allocations should be published and</td>
</tr>
<tr>
<td></td>
<td>available to network participants</td>
</tr>
<tr>
<td><strong>Non-discrimination</strong></td>
<td>- All users that belong to a certain category and demand the same network</td>
</tr>
<tr>
<td></td>
<td>services should be charged the same</td>
</tr>
<tr>
<td><strong>Equity</strong></td>
<td>- Certain categories of users, like low income users, are charged a tariff</td>
</tr>
<tr>
<td></td>
<td>which is lower than the cost of the services received</td>
</tr>
<tr>
<td><strong>Simplicity</strong></td>
<td>- Methodology and results of the tariff allocations should be easy to</td>
</tr>
<tr>
<td></td>
<td>understand and implement</td>
</tr>
</tbody>
</table>

The multiple objectives belonging to the three sets described above are not always compatible with one another and in many cases present clear trade-offs that one should take into account while designing tariff.
Distribution Tariff
Evolution of tariff determination in India

- **Indian Electricity Act 1910**
  - Stipulation that Tariff should be non-discriminatory and allow a reasonable return to licensee

- **Electricity Supply Act, 1948**
  - Cost plus methodology for tariff determination with a cap on the rate of return (Standard Rate) of licensee under IE Act, 1910 and a floor of 3% surplus for SEBs

- **ERC Act, 1998**
  - Establishment of CERC and SERCs, Tariff determination comes under the purview of ERC

- **Indian Electricity Act 2003**
  - Concept of controllables and uncontrollable in a multi year framework introduced
Approach for tariff determination – MYT Framework

**Guiding Forces**
- National level laws/Policies
  - Electricity Act, 2003
  - National Tariff Policy
- Regulatory Provisions
  - CERC regulations
  - FOR/ ERC Regulations
- Regulatory Precedence
  - ARR/ Tariff Orders
  - Discussion Papers
  - APTEL Orders
- Utility Performance
  - Financial
  - Operational efficiencies

**Regulatory Approach**
- Review of Costs (True-Up, APR):
  - Recovery of Costs in prudent manner
  - Signals for efficiency improvements
  - Review against performance benchmarks
- Review of Tariff Proposals:
  - Tariffs in accordance with tariff philosophy
  - Rationalization and elimination of cross-subsidy
  - Accuracy of demand forecast
- Directives for efficiency improvement
  - Directives on key efficiency norms
  - Financial viability of utilities
  - Comparative assessment with other States
  - Customer orientation of utilities
- Directives for guidelines for issuing orders
  - Consistent with existing legal provisions
  - Facilitate public participation (public hearings)
  - Facilitate transparency

**Approval Process**
- Proposed ARR
- Proposed Tariff
- Preliminary analysis
  - Adequacy check
  - Further information requirement
  - Acceptance
- Consultation Process
  - Written objections
  - Public Hearings
  - Other stakeholders
- Drafting of Order
  - Analysis and documentation
  - Iterative consultation within Commission
  - Drafting of Order
### Methods for tariff determination

<table>
<thead>
<tr>
<th>Model</th>
<th>Methodology</th>
<th>Limitations</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Service/ Rate of Return Regulation</td>
<td>Fixed return on rate base (capital) plus variable cost as pass through</td>
<td>• No incentive to reduce cost</td>
<td>• Predictable returns to utility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fair as cost of service related to asset base</td>
<td>• Fair as cost of service related to asset base</td>
</tr>
<tr>
<td>Performance Based Regulation</td>
<td>Performance benchmark set for both financial and operational criteria</td>
<td>• Extensive database required for benchmarking</td>
<td>• Provides maximum incentive to utility for performance improvement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Challenge in setting base year cost</td>
<td>• Allows flexibility to utility to incur costs and take actions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lack of continuity of inflation indices</td>
<td></td>
</tr>
<tr>
<td>RPI-X</td>
<td>Sets a price cap over tariff period which can be crossed only by Retail Price Inflation and discounted by efficiency factor</td>
<td></td>
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</tr>
</tbody>
</table>

India moved from a cost plus regime to a hybrid tariff determination regime where targets are set for operational elements (Controllables) and other cost elements (Uncontrollable) are on cost plus basis.
Controllable and Uncontrollable Parameters

Concept of Multi-Year tariff advocated by Electricity Act to introduce certainty in tariff; Bifurcation of expenditure into controllables and uncontrolables

<table>
<thead>
<tr>
<th>Uncontrollables</th>
<th>Controllables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Power Purchase, Sales, Taxes &amp; Duties, Change in Law, Force Majeure</td>
<td>AT&amp;C Loss, Financing Charges, O&amp;M, Capex</td>
</tr>
</tbody>
</table>

- Any gain/loss is passed on to the consumer
- Gain/Loss is shared with the consumers in a prescribed percentage

In addition, the ERC may stipulate trajectories for certain variables like distribution loss, collection efficiency, O&M Expense norms etc.
## Controllable and Uncontrollable Parameters

<table>
<thead>
<tr>
<th>Sales (Metered)</th>
<th>Sales (Un-metered)</th>
<th>Distribution Loss</th>
<th>Power Purchase Cost</th>
<th>Employee Cost</th>
<th>Repair and Maintenance</th>
<th>Admin &amp; General</th>
<th>Financing Cost</th>
<th>Depreciation</th>
<th>IOWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CAGR of sales for last 3, 5 years</td>
<td>• An independent year long month-wise study by Licensee to assess unmetered consumption based on stratified sampling</td>
<td>• Establish ment of baseline loss by the Commission and loss reduction targets determined</td>
<td>• Comprehensive Power Purchase plan to be submitted in MYT Petition</td>
<td>• Base norm escalated by inflation and adjusted by provision for expenses beyond control of Licensee</td>
<td>• Base norm escalated by inflation and adjusted by provision for expenses beyond control of Licensee</td>
<td>• Normative Debt Equity Ratio of 70:30</td>
<td>• Return on equity capped by Regulator</td>
<td>• Depreciation on 90% of original cost with residual value of 10%</td>
<td>• Allowed on normative basis including O&amp;M expense, receivables, maintenance spares and security deposit from consumers</td>
</tr>
</tbody>
</table>
Tariff Rationalization

• **kVAh based tariff** – to motivate industrial and non-domestic consumers to maintain power factor. Consumers billed at kVAh (apparent energy) and not at kWh (active energy) whereby the reduction of reactive energy becomes the prerogative of the consumer

  **Advantages:** Complete recovery of costs of utility, Improvement of supply voltage, Periodic revision of penalty is not required

• **TOD Tariff** – Consumers charged dynamic price for electricity consumed during peak and off-peak period to reduce the negative slope in the load curve

  **Advantage:** Incentivizes consumers to shift demand to off peak period thereby reducing peak demand

• **Voltage wise tariff** – Allows a more accurate mapping of distribution losses to different voltage levels

  **Advantage:** Network losses of lower voltages are not passed on to higher voltages
Time of Day Tariff
Legal and Policy framework for ToD Tariff

The section 62 (3) of the Electricity Act 2003 says that:

“The Appropriate Commission shall not, while determining the tariff under this Act, show undue reference to any consumer of electricity but may differentiate according to the consumer's load factor, power factor, voltage, total consumption of electricity during any specified period or the time at which the supply is required or the geographical position of any area, the nature of supply and the purpose for which the supply is required”

The provision no 5.4.9 of the National Electricity Policy also advocates the ToD tariff which says that

“The Act requires all consumers to be metered within two years. The SERCs may obtain from the Distribution Licensees their metering plans, approve these, and monitor the same. The SERCs should encourage use of pre-paid meters. In the first instance, TOD meters for large consumers with a minimum load of one MVA are also to be encouraged. The SERCs should also put in place independent third-party meter testing arrangements”

NTP (8.4 Definition of tariff components and their applicability) envisages explicitly the emphasis on the ToD Tariff.

“Two-part tariffs featuring separate fixed and variable charges and Time differentiated tariff shall be introduced on priority for large consumers (say, consumers with demand exceeding 1 MW) within one year. This would also help in flattening the peak and implementing various energy conservation measures”
Determination of TOD tariff for a Utility

Pre-requisites for implementation of TOD tariffs

- Loading Pattern of the utility
- Category wise loading pattern
- Power Purchase Data
- TOD enabled meters
- Dynamic Billing System
- MRIs

Key decision areas

- **Duration of peak/off-peak slot**
  Larger the duration of peak slot, greater the shift in demand to off-peak

- **Incentive/penalty for time slots**
  Incentive/penalty needs to be determined based on the cost of power whose purchase is foregone in the peak period and the that of additional power purchase in the off peak period
  Incentive/penalty will determine the proportion of shift in demand which will in turn determine the commercial benefit to the utility.

Graphs showing:
- **Additional Revenue in Rs. crores** vs. **Percentage shift in demand due to Tod tariffs**
- **Benefit in Rs. crores** vs. **Percentage benefit given in tariff**
Methodology to be followed

**Collation of demand data of Utility**
- Average demand for each of the 96 time blocks in a day recorded for the entire year
- Monthly average calculated each month
- Seasonal variation in demand curve estimated and analyzed

**Identification of Peak/Off-Peak Hours**
- Year segregated into two periods: Summer months and winter months
- Based on monthly average demand curves prepared, peak and off peak periods identified for each period

**Assessment of HT demand (absence of meter data)**
- Sanitization of feeders’ data to identify evaluable feeders
- Average demand of all the identified industrial feeders calculated
- Average demand of feeders scaled up for entire HT industrial category

**Cost benefit analysis of ToD implementation**
- Estimation of costs and benefits on the basis of specific assumptions
Methodology for cost benefit analysis

1. Estimation of reduction in peak demand due to introduction of ToD tariffs
2. Grossing up the estimated reduction in demand by T&D loss to arrive at the total reduction in purchase requirement
3. Assessment of loss of revenue due to reduction of sale in peak hours. The sale in peak hours is assumed to be done at a rate 5% higher than normal rate
4. Assessment of benefit due to increase in revenue due to additional sale in off peak hours at a rate of 5% less than normal tariff
5. Assessment of additional power purchase in off peak hours and reduced purchase in peak hours and their financial implication
6. Assessment of net benefit after adding up the costs and benefits calculated in previous steps
Assumptions used for an illustrative analysis

- **HT loading pattern**: Load graph of sample HT feeders extrapolated to entire HTR category based on certain assumptions
- **Utilization factor of HT category**: Considered on the basis of actual data as recorded by Utility
- **Reduction/Shift in demand**: Scenario analysis for estimation of benefits depending on quantum of demand shift
- **Shift in consumption**: It has been assumed that due to ToD implementation there will only be a shift in demand from peak hours to off peak hours to reap maximum benefit
- **Peak and off peak hours**: For simplicity, as a starting point it may be assumed that duration of peak and off-peak hours is the same
- **Costs and benefits involved**:
  - Cost of additional power to be purchased during off peak hours due to shifting of load during off peak periods
  - Cost incurred due to reduction in sale (and consequent reduction in revenue) during peak hours
  - Benefits accrued as a result of reduction in the power purchase requirement during peak hours
  - Benefits accrued due to additional sale during off peak hours
- **Benefit of ToD**: After ToD implementation peak energy charges to be 5% higher than normal rates and off peak charges to be 5% lower than normal rates
Benefits and Cost associated with TOD implementation in the long run

### Additional revenue/ Cost Reduction for Utility

- Additional revenue on account of TOD surcharge during peak hours
- Reduction in cost of power purchase due to reduction in peak consumption
- Revenue gain due to increase in sales during off-peak hours (shifting of load from peak hours to peak)

### Additional cost/ Revenue Loss for Utility

- Revenue loss due to reduction in sales during peak hours (after introduction of TOD Tariff)
- Revenue loss due to discount on existing sale during off-peak hours
- Additional power purchase cost due to increase in demand during off-peak hours

### Illustration

<table>
<thead>
<tr>
<th>Particular</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load during Peak (LDP) – a</td>
<td>1,500</td>
<td>MW</td>
</tr>
<tr>
<td>Load relief during peak (LRDP) – b</td>
<td>150</td>
<td>MW</td>
</tr>
<tr>
<td>Energy Surcharge (ES) – c</td>
<td>0.25</td>
<td>INR/kWh</td>
</tr>
<tr>
<td>Discounted Tariff (DT) – d</td>
<td>4.75</td>
<td>INR/kWh</td>
</tr>
<tr>
<td>Additional Revenue due to TOD (RA) – e={(a-b)<em>c</em>NPH)}</td>
<td>49,27,50,000</td>
<td>INR</td>
</tr>
<tr>
<td>Revenue Loss - reduced sales due to TOD (RL) – f={EC<em>NPH</em>b}</td>
<td>1,09,50,00,000</td>
<td>INR</td>
</tr>
<tr>
<td>Revenue Gain increased sales during off peak hours (RG) – g={b<em>d</em>NOPH}</td>
<td>1,04,02,50,000</td>
<td>INR</td>
</tr>
<tr>
<td>Existing Load during off peak (LDO) – h={(LFO*TCL)}</td>
<td>1,000</td>
<td>MW</td>
</tr>
<tr>
<td>Revenue loss due to discount on existing sale in off peak (RL) – i={h*(EC-d)*NOPH)}</td>
<td>36,50,00,000</td>
<td>INR</td>
</tr>
<tr>
<td>Effective Power Purchase Rate (PPEP) (Peak Hours) – j={PAPP/(1-T&amp;D Loss)}</td>
<td>5.08</td>
<td>INR/kWh</td>
</tr>
<tr>
<td>Savings in PP Cost (SP) – k={(Pb*NPH)}</td>
<td>1,11,30,87,675</td>
<td>INR</td>
</tr>
<tr>
<td>Effective Power Purchase Rate (PPEN) (Normal Hours) – L={(PAPP/(1-T&amp;D Loss))}</td>
<td>4.45</td>
<td>INR/kWh</td>
</tr>
<tr>
<td>Additional PP Cost (AP) in off-peak period – m={(L+b*NOPH)}</td>
<td>97,39,51,715</td>
<td>INR</td>
</tr>
<tr>
<td>Net Gain/Loss (NG) – n={e-f+g+k-n-i}</td>
<td>21,21,35,959</td>
<td>INR</td>
</tr>
</tbody>
</table>

### Assumptions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Connected Load (TCL)</td>
<td>5000</td>
<td>MW</td>
</tr>
<tr>
<td>Load Factor (LFP)</td>
<td>30%</td>
<td>%</td>
</tr>
<tr>
<td>Load Factor (LFO)</td>
<td>20%</td>
<td>%</td>
</tr>
<tr>
<td>Load Relief Factor (LRF)</td>
<td>10%</td>
<td>%</td>
</tr>
<tr>
<td>Nominal Energy Charge (EC)</td>
<td>5</td>
<td>INR/kWh</td>
</tr>
<tr>
<td>Rate of TOD Surcharge (ROTS)</td>
<td>5.00%</td>
<td>%</td>
</tr>
<tr>
<td>Rate of TOD Rebate (ROTR)</td>
<td>5.00%</td>
<td>%</td>
</tr>
<tr>
<td>Number of Off Peak Hours (NOPH)</td>
<td>4</td>
<td>hrs</td>
</tr>
<tr>
<td>Number of Peak hours (NPH)</td>
<td>4</td>
<td>hrs</td>
</tr>
<tr>
<td>Normal Average Power Purchase Cost (NAPP)</td>
<td>3.5</td>
<td>INR/kWh</td>
</tr>
<tr>
<td>Peak Average Power Purchase Cost (PAPP)</td>
<td>4</td>
<td>INR/kWh</td>
</tr>
<tr>
<td>T&amp;D Loss</td>
<td>21.3%</td>
<td>%</td>
</tr>
<tr>
<td>No. of Consumers Served (CS)</td>
<td>10,000</td>
<td>No.</td>
</tr>
</tbody>
</table>
## Status of implementation of TOD tariff

### Time of Day tariff in select states

<table>
<thead>
<tr>
<th>State</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bihar</td>
<td>TOD tariff charges applicable to all HT consumers. Surcharge of 20% rebate of 15% applicable at peak and off peak periods on energy charges</td>
</tr>
<tr>
<td>Chhattisgarh</td>
<td>TOD tariff applicable to select HT consumers. Surcharge of 20% rebate of 25% applicable at peak and off peak periods on energy charges</td>
</tr>
<tr>
<td>Delhi</td>
<td>ToD tariff applicable on all consumers (other than Domestic) whose sanctioned load/MDI (whichever is higher) is 10kW/11kVA and above. Additionally, TOD optional for Domestic consumers. Surcharge Rebate applicable at 20% on Energy Charges</td>
</tr>
<tr>
<td>Gujarat</td>
<td>TOD tariff applicable to select HT consumers. Surcharge of 10% - 20% during peak hours on energy charge. Night time concession available to consumers opting to use electricity exclusively during night time</td>
</tr>
<tr>
<td>Haryana</td>
<td>Optional TOD tariff applicable to HT Industrial customers from October to March. 19% surcharge and 15% rebate applicable on energy charges.</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>TOD tariff applicable on HT consumers. 20% surcharge and 15% rebate applicable on energy charges.</td>
</tr>
<tr>
<td>Punjab</td>
<td>Additional charge of Rs. 2.00/kVAh during peak hours and rebate of Rs. 1.25/kVAh applicable during off peak hours for Medium and Large Industries, Non residential and bulk supply customers. Peak tariff is applicable only for months of June to September; off peak tariff is applicable for the rest of the year</td>
</tr>
<tr>
<td>Kerala</td>
<td>ToD Tariff applicable to EHT, HT and LT industrial consumers (with connected load of and above 20KW) Consumers. Surcharge of 50% and rebate of 25% applicable on energy charges during peak and off peak hours</td>
</tr>
</tbody>
</table>
Dynamic Time of Use (TOU) tariff – Market driven tariff

**Real time pricing** - Prices change on an hourly or sub-hourly, with price signals provided to the user shortly in advance, reflecting the utility's cost of generating and/or purchasing electricity at the wholesale level.

*High risk and high reward for consumers*

**The UK Experience**

While TOD tariff structures like Economy 7 and Economy 10 have been offered by suppliers in the UK since a long time, in 2018, Octopus Energy launched ToU tariff ‘Octopus Agile’ in February 2018 for their smart meter customers, providing them with ‘dynamic’ half-hourly price updates that reflect actual wholesale energy costs.

At 4pm every day, unit rates are updated for the next 24 hours. As the customer uses electricity, the charges are calculated based on half-hourly data from your smart meter.

The dynamic tariff includes the passing on of even negative prices (when the wholesale price goes below 0p/kWh), allowing customers to actually be paid to use electricity when demand is low, or when the grid is oversupplied by renewable power. Customers are alerted to this “plunge pricing” by text, email or online notifications.
THANK YOU
Detailed Methodology for cost benefit analysis of TOD implementation

- Compute the MW load during peak hours assuming various probable values of load factor (LF) during peak hours: \( MW \text{ load during peak (MWPL)} = \text{Load Factor (LF)} \times \text{Total Connected Load} \)

- Compute the MW load during off peak hours assuming various probable values of load factor (LF) during off peak hours: \( MW \text{ load during peak (MWOPL)} = \text{Load Factor (LF)} \times \text{Total Connected Load} \)

- Compute actual load relief (in MW) achieved during peak hours by implementing TOD tariff based on various probable values of load relief factor (LRF): \( MW \text{ load relief during peak (MWLR)} = \text{Load Relief Factor (LRF)} \times \text{MWPL} \)

- Calculate peak hour energy surcharge per kWh (TOD surcharge in absolute term): \( \text{Energy surcharge (ES) in paise/kWh} = \text{Rate of TOD surcharge} \times \text{Nominal energy charge (EN) in paise/kWh} \)

- Calculate off peak hour energy rebate per kWh (TOD rebate in absolute term): \( \text{Energy Rebate (ER) in paise/kWh} = \text{Rate of TOD rebate} \times \text{Nominal energy charge (EN) in paise/kWh} \)

- Calculate additional revenue on account of TOD surcharge after implementation of TOD tariff: \( \text{Additional Revenue (RA) (in Rs.)} = \left( \frac{\text{ES}}{100} \right) \times (\text{MWPL} - \text{MWLR}) \times (\text{No of Peak Hours}) \times 365 \times 1000 \)

- Calculate revenue loss due to reduced sales during peak hours on account of TOD tariff: \( \text{Revenue Loss (RL) (in Rs.)} = \left( \frac{\text{EN}}{100} \right) \times (\text{MWLR}) \times (\text{No of Peak Hours}) \times 365 \times 1000 \)

- Calculate revenue gain due to increased sales during off peak hours on account of TOD tariff: \( \text{Revenue Gain (RG) (in Rs.)} = \left( \frac{\text{EN-ER}}{100} \right) \times (\text{MWLR}) \times (\text{No of Off Peak Hours}) \times 365 \times 1000 \)

- Calculate effective power purchase rate of costly power at consumer end considering T&D losses: \( \text{Effective Power Purchase Rate (PPE & PPO)} = \frac{\text{Rate of Power Purchased in Peak or Off Peak Hours}}{[1 - (\text{T&D losses in %})]} \)

- Calculate saving in power purchase cost due to reduction in sales on account of TOD surcharge: \( \text{Saving in power purchase cost (SP) (in Rs.)} = \left( \frac{\text{PPE}}{100} \right) \times (\text{MWLR}) \times (\text{No of Peak Hours}) \times 365 \times 1000 \)

- Calculate additional power purchase cost for off peak hours: \( \text{Additional Power Purchase Cost (AP) (in Rs.)} = (\text{PPO}/100) \times (\text{MWLR}) \times (\text{No of off peak Hours}) \times 365 \times 1000 \)

- Calculate revenue loss due to rebate in off peak hours (RLO): \( \text{MW load during off peak (MWOPL)} \times (\text{ER}) \times \text{No of off peak hours} \times 365 \times 1000 \)

- Calculate net gain/loss: \( \text{Net Gain (+)/Loss(-) (NGL) (in Rs.)} = (\text{RA}) - (\text{RL}) + (\text{RG}) + (\text{SP}) + (\text{AP}) - (\text{RLO}) \)
Generation Tariff Principles
Tariff Setting in India
Tariff Setting methodology has evolved over time

1992
• Single part Tariff Cost plus on actual

2001
• For SEBs- Single part Cost plus on actual
• For CPSUs & IPPs- Two part Cost Plus with performance based rate making (KP Rao Committee)
• For SEBs- Single part Cost plus on actual
• For CPSUs & IPPs- Availability Based Tariff (ABT) Cost Plus with performance based rate making (CERC Regulation)

2003
• Availability Based Tariff (ABT) Cost Plus with performance based rate making – Competitively Bid Tariff
Recommendations of KP Rao Committee
Regarded as a landmark in history of tariff determination

Need for KP Rao Committee

- Prior to 1992, there were issues of shortage of power and difficulty in performing grid operations due to acute indiscipline shown by the generators as well as the beneficiaries.
- No defining principles were available for tariff setting
- Tariffs for individual stations were decided on the basis of mutual consent between the generator and the consuming SEBs
- Absence of mandatory norms for tariff setting delayed settlement of commercial terms
- Committee was formed to recommend alternative methods for the determination of generation tariffs of central stations

Major recommendations

1. The concept of two-part tariff, comprising fixed and variable charges respectively was accepted, though it was only implemented in part (for CPSUs and IPPs at that stage).
2. Efficiency enhancing changes were effected in the existing incentive structure – from recovery on PLF shifted to plant availability
3. Operational norms were determined for station heat rate, auxiliary power consumption, specific oil consumption. The norms were challenging relative to average performance levels at the time and hence laid the basis for performance based ratemaking.
4. Up to 100% foreign equity was permitted with foreign exchange risk protection.
Methods for Tariff Regulation
Different Methods of calculation of tariff

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
</table>
| Rate of Return + Cost of Service | • Determination of allowable costs, a rate base and the rate of return to be allowed on the rate base.  
• Rate base is the capital amount on which a return is allowed, together with the variable costs incurred in the test year. |
| Performance Based Regulation  | • Provides incentives for the utility to improve efficiency and reduce costs.  
• The return to the utility depends upon performance.  
• A form of PBR is in actual use in India, where tariffs are based on normative parameters. |
| Marginal Cost based Price      | • Emphasizes future economic signals rather than relying on financial signals based on today's performance and historic financial costs.  
• Future cost of power which takes account of additional investments, etc. |
| RPI-X                          | • Imposes a price cap which, over the tariff period, can be crossed only to the extent of the retail price inflation (RPI).  
• This inflation rate is reduced by a pre-determined efficiency gain (X). |
| Competitive Bidding            | • A market based approach  
• Successful adoption of this method presupposes the existence of competitive forces at the bidding stage |
Availability Based Tariff
Cost plus with performance based rate making

- Availability means the **readiness of the generating station to deliver**.
- Defined as the **MW capability** of the generator for supplying to the grid **after accounting for the planned and unplanned outages and deration due to non-availability of auxiliaries, fuel and water**.

1. **Capacity charges (fixed cost):** full recovery at normative availability
   - Fixed cost elements are interest on loan, return on equity, depreciation, O&M expenses, taxes and interest on working capital

2. **Energy charge (variable cost):** up to scheduled energy, at normative tariff
   - Comprises of the variable cost (i.e., fuel cost) of the power plant for generating energy as per the given schedule

3. **Unscheduled Interchange/ DSM: deviation from schedule, rate linked to frequency**

- Payable depending upon what is deviated from the schedule
- Levied for difference in its Actual and Scheduled Generation/ drawl
- UI/ DSM charges linked to average frequency of 15 minutes time block.
- Recent DSM regulation links charges to ACP

<table>
<thead>
<tr>
<th>Generation/Offtake</th>
<th>Payment of UI/ DSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generates more than schedule</td>
<td>Gets UI</td>
</tr>
<tr>
<td>Generates Less than schedule</td>
<td>Pays UI</td>
</tr>
<tr>
<td>Beneficiary overdraws power</td>
<td>Pays UI</td>
</tr>
<tr>
<td>Beneficiary Under draws power</td>
<td>Gets UI</td>
</tr>
</tbody>
</table>
RE Tariff
Regulated tariff to be determined on levellized basis

- As per RE Tariff Regulations-2012, tariff is determined on levellised basis for all RE technologies for the tariff period.
- Levellised tariff is calculated with appropriate discount rate representing weighted average cost of capital on the basis of normative debt-equity ratio.

Approaches for Capital Cost Benchmarking

- **Regulatory Approach**: Based on Norms as approved by various SERCs
- **Market Approach**: Project awarded through competitive tender process
- **Actual Cost Approach**: Information furnished by developers as a part of project appraisal requirements

**Project Specific Tariff**: Project specific tariff is determined by the Commission on case to case basis for new RE technologies.

- Municipal Solid Waste and Refuse Derived Fuel based power projects (if a project developer opts for project specific tariff)
- Solar PV and Solar Thermal (if a project developer opts for project specific tariff)
- Hybrid Solar Thermal Power Projects
- Other Hybrid projects including renewable-renewable or renewable-conventional sources
- Biomass project other than that based on Rankine Cycle technology application with water cooled condenser
- Any other new renewable energy technologies approved by MNRE
Feed-in Tariff (FIT)
FIT is a policy tool encouraging deployment of RE technologies

- A renewable energy policy that offers a guarantee of payment to renewable energy developers for the electricity they produce
- It is regulator determined tariff for the price of RE by the cost plus approach
- Feed-In Tariffs are index linked to inflation
- Popular across the world with different names - Advanced Renewable Tariffs, Renewable Energy Payments, Renewable Energy Payments, Fixed Price Policies, Renewable & energy dividends, etc.

Tariff levels are usually guaranteed for a longer period 20 years or more
- Longer contracts = lower initial tariff
- Shorter contracts = higher initial tariffs

Standardized Contract (Model PPA)
In this way FiT provides long-term certainty about receiving financial support, which is considered to be lower investment risks
<table>
<thead>
<tr>
<th>Differentiation by Project Size</th>
<th>Differentiation by Project Location</th>
<th>Differentiation by Resource Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lowest payment level is typically offered to the largest plants</td>
<td>• Varied payments to projects mounted in different physical locations (without regard to resource quality)</td>
<td>• Different payments to projects in areas with a different cost of production</td>
</tr>
<tr>
<td>• Reflecting the gains that result from economies of scale</td>
<td>o To encourage project development in particular applications</td>
<td>o To encourage development in a wider variety of areas, which can bring a number of benefits both to the grid</td>
</tr>
<tr>
<td>• Differentiating FiT payments by project size is another means of offering FiT payments that reflect actual project costs</td>
<td>o To encourage multi-functionality (e.g. solar PV)</td>
<td>o To match the payment levels as closely as possible to RE generation costs</td>
</tr>
<tr>
<td>• E.g.: France, Germany, Switzerland, and Italy provide the highest tariff amounts for the smallest PV installations</td>
<td>o Target particular owner types such as homeowners</td>
<td>o e.g. areas with a high-quality wind resource will produce more electricity from the same capital investment, all else being equal, leading to a lower levelized cost (FIT)</td>
</tr>
<tr>
<td>• Eg. France</td>
<td>o To meet a number of other policy goals</td>
<td>• Eg. Denmark, France, Germany, Portugal, and Switzerland have implemented resource adjusted payment levels</td>
</tr>
</tbody>
</table>
Hydro Tariff Structure

Annual Fixed Cost = Capacity Charge + Energy Charge

**Recovery of tariff**

- 50% of the Annual Fixed Cost is collected in the form of Capacity charge on monthly basis
- 50% of the AFC is divided by the Design energy net off of AUX to find out energy rate per unit
- Energy rate so derived is multiplied with monthly scheduled energy to find out Energy charge per month
- Incentive is inbuilt in the formulae and not provided separately
Transmission Tariff Principles
Transmission Tariff

Cost Components of a transmission tariff

Separate provisions for transmission tariff do not explicitly exist in any the electricity laws

**Transmission Charges**

The transmission charge payable for a calendar month for a transmission system or part thereof:

\[
AFC \times \left( \frac{NDM}{NDY} \right) \times \left( \frac{TAFM}{NATAF} \right)
\]

Where,

- AFC = Annual fixed cost specified for the year
- NATAF = Normative annual transmission availability factor, in %
- NDM = Number of days in the month
- NDY = Number of days in the year
- TAFM = Transmission system availability factor for the month, in %

**Annual Fixed Cost**

The Annual Fixed Cost (AFC) of a transmission system consists of the following components –

- Return on equity
- Interest on loan capital
- Depreciation
- Interest on working capital
- Operation and maintenance expenses