DESIGN OF DYNAMIC TARIFF

(As Proposed for ISGAN paper by ISGTF Secretariat)

Current pricing mechanism for Indian consumers is primarily focusing on recovery of cost of generation and service cost and as it is highly cross subsidized it does not provide appropriate signal to end consumer for judicious use of electricity. If we add some price component to existing tariff that could reflect the real time imbalances, the end consumers may shift their load to get some incentive or to avoid disincentives. This necessitates design of Dynamic tariff that will not always remain same to encourage participation of end consumers in DR/DSM programs.

The components that may be considered for dynamic tariff design include:

i. Cost of generation and transmission
ii. Service cost of discom
iii. Reactive power consumption
iv. Voltage level
v. Sanctioned/contracted load
vi. Subsidy
vii. Unscheduled Interchange charges
viii. ToD or pre-announced prices based on a forecast for peak load hours
ix. ToU/CPP that can be linked to frequency or to an average of daily maximum demand
x. Power supply quality- based on voltage fluctuations, reliability and harmonics.

The ideal case scenario would be to offer a predetermined mix of aforementioned components in order to suit the requirements of different consumer segments, The conventional tariff design (to a certain extent) covers elements i. to vi. as mentioned above. UI charges can be partially recovered through incorporating a frequency-based price component in the consumer tariff as in Real time pricing mechanism (RTP). Some Consumers would prefer some prior notice of price variations in a day which might help them plan consumption for the day as incorporated in ToD pricing wherein higher charges are applicable for peak load times announced by Utility beforehand based on historical data.. It is t proposed by authors that Dynamic pricing mechanism for DSM can be based on including both ToD tariff in the form of peak load surcharge and ToU/RTP (i.e. frequency-based price component) in addition to the tariff determined as per ARR. As per the grid code for transmission sector issued by CERC, SLDC/STU discoms shall initiate restriction of the amount withdrawn from its control area from the grid whenever the system frequency falls to 49.7 Hz. This frequency can be the trigger for upward revision of the ARR tariff by some amount .Same amount of discount can be offered on ARR tariff for consumption at frequency above 49.95Hz. For frequencies between 49.7Hz and 49.95Hz ARR tariff rates can be set.

ToD can be announced by SERC weekly or fortnightly based on the utility's forecasted/projected peak load time periods. Consumers can be informed through portal, SMS, and email about ToD prices in advance.

For effecting DSM for peak load management in this context, the possible Dynamic tariff components could be:

a. **Frequency-based, ToU pricing**, Availability-based tariff (ABT) and UI charges are already deployed for Transmission sector. Indian version of Availability Tariff comprises of three components: (a) capacity charge, towards reimbursement of the fixed cost of the plant, linked to the plant's declared capacity to supply MWs, (b) energy charge, to reimburse the fuel cost for scheduled generation, and (c) a payment (UI charge) for deviations from schedule, at a rate dependent on frequency. ABT could bring discipline in transmission sector in abiding to agreed-upon schedules worked per the Indian Electricity Grid Code (IEGC) by the constituents of Indian Power grid. The same can be tweaked for Distribution sector and accordingly this ToU tariff is proposed to be +/- 20% of tariff calculated on the basis of ARR to be levied in case frequency falls below 49.7Hz and rises above 49.95Hz.

   ToU will aim for near real-time load-supply balancing. As suggested above, three rates can be administered:

   I. ARR rate for frequency in acceptable band (e.g., Rs 4.5 per kWh)
   II. ARR x 1.2 for frequency below lower limit of acceptable band (i.e., Rs 5.4 per kWh)
   III. ARR x 0.8 for frequency above upper limit of acceptable band (i.e. Rs 3.6 per kWh).

   Smart meters can communicate with simple LED based display units that may be provided in multiple rooms to show the above three rates as RED/YELLOW/GREEN colors to the end consumer, and this can also be published on a utility's portal. Consumers can also be notified about a change in rates through a small beep sound from the meter.

b. Pre-determined ToD pricing for the utility-specific peak load time zones, to be announced weekly by the Regulatory Commission based on forecast peak load time/ past data from Regional load dispatch centres RLDCs. This can be 10% of the tariff calculated as per existing ARR petition.

c. A reliability surcharge-Utility may consider levying a surcharge of 10% over total bill amount in the areas that have rugged distribution infrastructure so as to provide reliable power supply based on service level agreement (SLA) with consumers of that area. In case SLA is violated no surcharge will be admissible for that month. Reliability can be maintained by switching to load curtailment (with commitment to supply lifeline supply for that premises) in place of load shedding in those areas. In order to increase available power, installation of roof top solar panels can be promoted by utilities' floating suitable incentive schemes. Smart consumers can also store solar energy during the day time and use it during evening peak times to avoid purchase of costly power during peak load time.

d. Discount of 2% to 5% on pre–paid bills depending on AT&C losses for that area. The higher the losses, the lower the discount for pre-paid bills that may encourage people of that area to identify theft.

After further discussions with utilities, the proposed dynamic price structure can be implemented for smart grid pilots in parallel to the existing billing mechanism in order to test actual impact on load profile, tariff, and revenue for the utility from that area. In order to avoid resistance to change, consumers may be given an option to opt out of the new price structure and a commitment that the bill as per new tariff structure shall not exceed the bill as per conventional tariff structure except for reliability surcharge that will be payable only if agreed mutually by a group of consumers served by same Distribution transformer. Further improvement of the price mechanism can be based on the outcome of pilots

SIMULATION STUDY

In order to test the monetary impact of ToU price as described at 'a.' above, a simulation study was done to determine monetary impact of actual frequency variation on sample consumption, as given in Table 1 below, for the months of July 2012 and January 2012 (summer and winter seasons)

Table 1 Sample Consumption Profile

a.Electrical Appliance put to use	b.Qty. of appliances (No.)	c.UseStartTimeof Day	d.UseEndTimeOf Day	e.TimePeriod (h) (d-c)	f.PowerRating of each unit appliance (kW)	g.Energy (kWh) b*f*e
Light	3	0600	0800	2	60	360
CFL	3	0600	0900	3	15	135
Stereo	1	0630	0730	1	100	100
Geyser (January 2012)	1	0630	0830	2	1,100	2,200
Air Conditioner (July 2012)	2	2200	0600	5	1,500	15,000
Food Processor	1	0700	0715	0.25	1,100	275
Microwave	1	0730	0745	0.25	1,800	450
Toaster	1	0730	0745	0.25	1,100	275
Iron	1	0730	0745	0.25	1,100	275
Chimney	1	0730	0745	0.25	1,000	250
Exhaust	2	0730	0745	0.25	200	100
Washing machine	1	0830	0930	1	1,500	1,500
Refrigerator	1			24	70	1,680
TV	1	1800	2200	4	200	800
Tubelight	4	1800	2200	4	60	960
CFL	2	1800	2200	4	15	120
Chimney	1	0730	0745	0.25	1,000	250
Microwave	1	2000	2015	0.25	1,800	450
Mobile charging	3	2000	2400	0.5	100	150
Laptop charging	2	1900	2000	2	100	400

For Simulation studies, three rates (i.e., 5.4 for f< 49.7, 4.5(ARR rate); 3.6 for f>49.95; as part of ToU tariff) were applied on 15-minute time blocks based on actual frequency for that time block. The percent distribution of three rates for both the months is as given in Fig 6. It was also estimated how many times a day the proposed ToU rate was changing based on actual frequency and it was found that rate change after only 15 minutes occurs for 3% of time periods out of total 2977 periods (Frequency Data from NRLDC). Also, the same rate is mostly applicable for at least half an hour, which gives the consumer flexibility and some convenience to switch load.

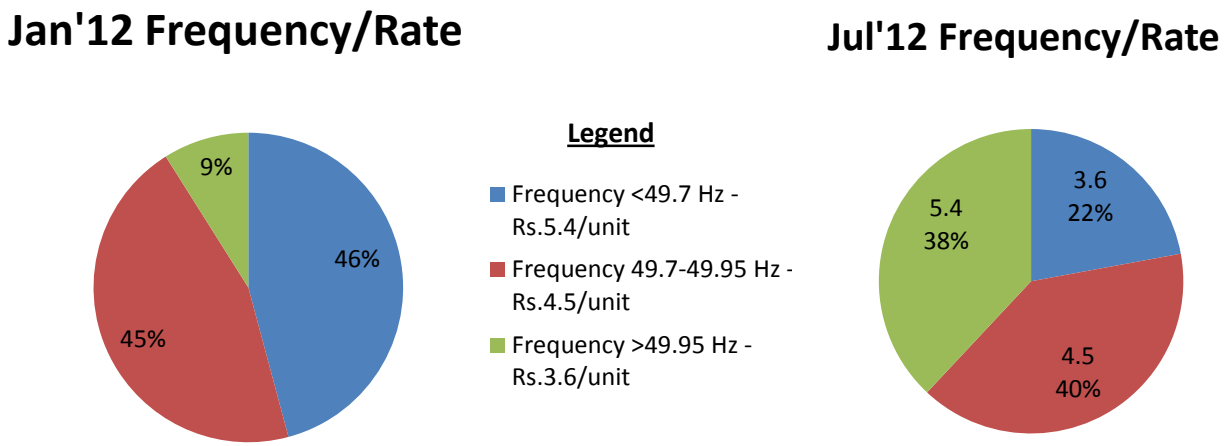

Figure 1 Distribution of frequency in three ranges for the month

In Jan'12 morning Peak hours, frequency is below 49.7 implying higher rates for morning peak hours		
In July'12 night frequency is mostly below 49.7 implying higher rates during night time		
Simulated Bill for Sample consumption profile	**Jan'12**	**Jul'12**
ToU Bill	1555.67025	3250.829
Normal Bill	1581.58125	3177.934

Simulation study for computing the bills based on proposed dynamic tariff vis-à-vis existing tariff indicates that the net impact on consumer bill on account of aforementioned ToU charges will be almost negligible if the consumer does not make any change in consumption pattern.