DOMESTIC TIME OF USE TARIFF DETERMINATION

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Contents.

ABSTRACT

- TOU tariffs have to be implemented with the Smart meters for customers using more than 1000 kWh/m according to government regulation.
- Many municipalities have implemented domestic TOU tariffs which do not comply with the EPP and other generic price objectives.
- This paper provides guidelines on how to develop a cost reflective TOU tariff without impacting the municipality negatively.
- It also provides insight into a range of issues which need careful consideration to ensure the loopholes associated with the tariff is avoided.

1 INTRODUCTION

The Government Gazzet 31250 requires that smart meters be installed for all customers consuming more than 1000 kWh/m by 1 January 2012. Many municipalities have installed such meters and implemented TOU tariffs. Many of these tariffs leave much to be desired for. This paper will illustrate the requirements and features of a quality domestic / small commercial TOU tariff.

The tariffs that are being applied by some municipalities do not qualify in terms of the stipulations in the South African Electricity pricing Policy (EPP). Various requests have also been made for a paper to provide guidance on the determination of TOU tariffs for domestic customers.

This paper provides insight into some of the dynamics of applying a TOU tariff for domestic customers and give guidance on how such tariffs should be set.

2 OBJECTIVES

It is important to understand the objectives of implementing smart meters with load management features on TOU tariffs:

- To electricity tariffs which reflect the cost of supply as accurately as possible in respect of the all various type of costs.
- To encourage and support load shifting by customers in an economically efficient way.

This paper will show that it is important that load shifting must not be ensured at all cost but be in response to the economically efficient price signals. A lot of money will be spent on installing the meters and management systems. It is therefore essential to ensure that the price signals will provide the critical drivers to ensure optimal load shifting.

3 EPP STIPULATIONS

Before any tariffs can be set it is essential that the stipulations in the EPP be studied and applied. An extract of the ones critical for determining domestic TOU tariffs are given below:

Efficient electricity prices would lead to:

a. the optimum allocation of scarce resources including financial, human and natural resources;
b. the optimum usage of electricity;
c. the optimum usage of the different energy forms (e.g. electricity, gas, oil and coal); and
d. a financially viable industry.

Policy Position: 27

a) NERSA must see within five years that cost reflective tariffs shall reflect all the following cost components as far as possible:

- Energy costs in c/kWh: The energy cost from the bulk supplier or other sources differentiated by:
    - the bulk supplier TOU periods;
    - or, with non-TOU metering, the relevant portion of the various TOU costs; and
    - plus the losses on the relevant transmission and distribution networks.
- Network demand charges in R/kVA/period covering:
    - the contribution to the transmission network costs by the relevant loads; and
    - plus the variable (shared component) of the DUOS costs.
- Network capacity charges in R/kVA/month or R/Amp/month based on annual capacity: (the fixed or dedicated component) of the DUOS costs;
- Customer service charges in R/cust/month: covering the costs of providing the services to serve the customer including, billing, revenue collection, marketing and customer claims;
- Point of supply costs R/POS/month: covering the costs associated providing each connection customer from the point of common coupling and metering; and
- Cost of poor power factor: Charges may be levied to reflect the avoided costs for the distributor if it had to restore the power factor to the optimum level.

Policy Position: 29

a) Tariff structure and levels shall be aligned with the results from the COS studies in which the resultant income will equal the revenue requirement.

Policy Position: 30

a) Cost reflective tariffs are considered the most effective pricing signal to be provided to customers. Any additional pricing signals over and above the costs must be motivated specifically and be approved by NERSA.

Policy Position: 32

a) TOU tariff energy charges must be differentiated by:

- All the components as reflected by the WEPS.
- In addition a super peak rate to reflect the short terms costs could be applied during emergencies in which case customers need to be informed in advance.

Policy Position: 36

a) Domestic tariffs to become more cost-reflective, offering a suite of supply options with progressive capacity-differentiated tariffs and connection fees:

- At the one end a single energy rate tariff with no basic charge, limited to 20 Amps and nominal connection charge (details under section on cross-subsidies);
- At the next level a tariff with a basic charge, customer service charge, capacity charge and energy charge with cost-reflective connection charges; and
- At the final level TOU tariffs must be instituted on the same basis as above, but with TOU energy rates.

4 TARIFF STRUCTURE

In view of the EPP stipulations and the practicalities in the Southern African EDI the following tariff structure is proposed:

- Basic charge (Rand/customer/month). This to be set as close as possible to the fixed / customer services costs associated with a domestic TOU customer. This should be differentiated for 1 and 3 phase customers and Bulk Domestic.
- Capacity Charge (Rand / Amps / month). This is to be based on the installed capacity per customer (set per 10 Amps) and be set as close as possible to the network costs which must include capital provision and maintenance.
- Energy charges (c/kWh) This to be as close as possible to the WEPS (Eskom Megaflex).
    - Peak, Standard & Off-peak.
    - High demand / Low demand seasons.
    - All periods to be the same as the Eskom TOU periods.
    - Reactive energy charge.

There are some controversies in this respect which will be discussed later in the paper:

5 TARIFF LEVEL

The setting of the tariff levels presents a bigger challenge than the tariff structure. The following should be considered in this respect:

- Each utility currently has a certain level of cross subsidation between various tariff categories and between different customers within a particular tariff category.
- The introduction of domestic TOU tariff should not just change the cross-subsidisation dispensation between different tariff categories.
- This means that the revenue received from the target domestic TOU customers should remain the same when converted to the TOU tariff from the existing tariff.
- Cross subsidisation between tariffs can change but then it must be a clear, deliberate phased approach.
- This does however mean that within the domestic TOU customers the intra-tariff cross subsidisation will be removed: In respect of Load factor and Relative usage in different periods.

The following process is thus proposed in respect of setting the tariff level:

- Determine the revenue from these customers on the current tariffs.

- Determine the various per unit costs: basic costs, network costs and energy costs for domestic TOU customers. (this to include the municipal surplus).
- Determine the various usage quantities for these customers: Number of 1 phase and 3 phase, bulk, capacities of these, and energy per usage period.
- Simulate the revenue using per unit costs and the usage quantities.
- Now adjust the per unit costs to achieve revenue neutrality with the existing revenue as follows:
    - Increase the TOU energy rates by the same c/kWh surcharge for all periods.
    - Retain all other charges as per cost calculations.
- This will imply that the cross subsidisation to other customers (big reason for any increases) will be covered in the energy charges.

6 CONVERTION STRATEGY

One of the key aspects which influence the setting of the tariff level relates to how customers will be converted to the TOU tariff. The following options exist:

- Give customers the choice to convert. This is not in line with the EPP and other government stipulations and also causes only those customers who will save to convert.
- Give no choice. This is the preferred route. Obviously not all domestic customers using more than 1000 kWh/m have Smart meters installed and therefore not all can be converted to TOU at once.
- It is suggested that all customers for whom Smart meters have been installed be converted as from the start of the new financial year. If customers are converted during the year, the municipality will almost always lose revenue.

What is important to consider is that once customers are converted, their load factor and TOU consumption ratio's will change. The after conversion consumption ratio's cannot be used for future revenue neutrality calculations.

7 COST ANALYSIS

The EPP is clear that the basis for all tariffs should be cost. That requires that a COS study be undertaken but this is problematic in that most municipalities have not done these yet. A simplified COS study should however be done focussing on the Domestic TOU customers. This process is explained below in a very simplified way:

Basic costs:

- Analyse the detailed budget and extract all fixed / customer services type costs such as:
    - Metering reading.
    - Vending.
    - Revenue collection.
    - Billing.
    - Customer services.
- Now obtain details of all customers per category 1 or 3 phase. Allocate a cost weight factor to each and calculate the equivalent domestic 1 phase and 3 phase customer per unit cost.
- Now determine the Smart meter capital cost, expected life and cost of capital and calculate the cost per month per smart meter for 1 and 3 phase.
- Add the customer services costs to the meter capital provision to obtain the proposed fixed charge.

Capacity costs:

- Analyse the detailed budget and extract all network related costs such as:
    - Network staff costs.
    - Network maintenance costs.
    - Network operations costs.
    - Vehicles and contracts relating to networks.
    - Fault centre and control room costs.
    - Interest and depreciation on networks.
- Determine the total installed capacity as the sum of individual customer capacities.
- Now divide the total network costs by the installed capacity and 12 to obtain Rand/ kVA/month and then convert to R/Amp/month.

The issue of Eskom basic charge, maximum demand and access charges can be interpreted as follows:

- It can be considered a capacity / demand cost and thus be treated as a R/kVA/m charge. If so: Calculate the basic charge, access charge, maximum demand charges for the previous year escalated to the new period and divide by the total installed capacity to obtain a R/Amp/month and ad to the capacity charges.
- It can be treated as an energy cost and thus be converted to an energy charge. If so: Calculate the basic charge, access charge, maximum demand charges for the previous year escalated to the new period and divide by the total energy purchased for that period and ad to the energy charges.

Adding it to the capacity charge is the preferred option because:

- It is a more fixed/kVA cost. In other words if customers increase their maximum demand / capacity, most of these costs would increase.
- If the energy consumption increases but the maximum demand remains the same, these costs would remain the same.

Energy costs:

- Obtain the Eskom tariff charges applicable (Megaflex):
- Determine the energy charges applicable at your location (Include Eskom losses).
- Add to the all 6 energy charges per period the following:
    - Electrification and Rural Subsidy.
    - Environmental levy.

- Now estimate / calculate the local network energy loss factors for each of the 6 TOU periods. This could be done as follows:
  - Determine / estimate the total technical losses for the utility.
  - Determine / estimate the total losses at LV level.
  - Differentiate the losses by time period based on simple engineering principles (losses equal to "I" square). In other words losses are equivalent to the square of the average current in each period.
- Now multiply the 6 energy rates by the respective energy loss factors.
- Finally: Adjust the various energy rates by the same fixed c/kWh surcharge to obtain revenue neutrality for the target customers.

8 EXAMPLE

The example below gives some insight into how these calculations should be done.

Basic costs.

The table below shows an analysis of customer numbers and calculation of equivalent costs per customer.

Customer Cost analysis		Number	Rel weight	Total equav.	Per customer
		Customers	Ratio	Customers	R/kIVA/m
Small	1 phase	34246	1	34246	47.85
	3 phase	1431	1.2	1717.2	57.41
Medium	1 phase	1091	2	2182	95.69
	3 phase	1780	2.2	3916	105.26
Agric		1041	3	3123	143.54
Large	LV	348	10	3480	478.45
	MV	121	30	3630	1 435.36
		Total equavelanmt 1 phase		52294.2	
Total fixed / custiomers servuices costs			50%	30 024 500	
Total cost per 1 phase customer				47.85	

Demand / Capacity costs.

The calculations of the capacity costs starts with the analysis of the Eskom Fixed charges. This is shown in the table below.

ESKOM NETWORK CHARGES		Total access	Total access and demand	Convert to Installed	
Transmission Access	R 4.41	14.26	30.66	Maximum demand	157000
Distribution Access	R 9.85			Installed capacity	944000
Distribution Demand	R 16.40			R/kVA/m installed	5.86405
R/kVA/m	Escalated to 2012/13	R/kVA/m	35.259	R/Amp/m	1.303122

The next step is to calculate the Utility own network costs.

BUDGET ANALYSIS		
Electricity Purchases from:	Budget	
Eskom	390 112 000	
Salaries & Maintenance		
Salaries, wages and allowances (own staff)	14 004 000	
Repairs and Maintenance (excluding salaries and allowances)	25 778 000	
Total	39 782 000	
Capital Charges	Budget 2012/13	
Interest - External loans	13 765 000	
Total	13 765 000	
Bad debt reserves	7 532 000	
Total	7 532 000	
Other Expenses	Budget 2012/13	
Charges allocated from other Municipal Departments		
Charges allocated to other Municipal Departments	23 404 000	
General Expenses	60 049 000	
Total	83 453 000	
Purchases	390 112 000	
Total cost	534 644 000	
Total exc purchases	144 532 000	
Total network Cost (inc 75% of Gen)	137 000 000	
Depreciation	760 000	Rand
MD	157	MVA
R/kVA/year	R 72 717.62	R/kVA/y
c/kWh	18 026.32	c/kWh
Surplus % of cost	24.0%	%
Net network cost	R 90 142.30	Rand
Network cost	R 47.85	R/kVA/m
Plus Eskom MD charges	R 28.48	R/kVA/m
Total	R 76.33	R/kVA/m
Capacity cost	R 2.82	R/Amp/m

This is then converted to a charge based on installed capacity by dividing that by a ratio of Maximum demand divided by customer installed capacity.

Energy cost.

The objective is to have 1 single energy rate for all time periods. This starts off with the analysis of Eskom charges to the utility. This is shown in the table below.

ESKOM ENERGY CHARGES			
2011/12	**Peak**	**Standard**	**Off Peak**
High demand season [Jun - Aug]	186.05	48.38	25.87
Low demand season [Sep - May]	51.95	31.83	22.28
Levies	4.11	2.00	
Escalation to 2012/13	Increase	15%	
Energy rates including levies	c/kWh	c/kWh	c/kWh
High demand season [Jun - Aug]	213.96	55.64	29.75
Low demand season [Sep - May]	59.74	36.60	25.62
Loss factors	Technical losses at LV		10%
High demand season [Jun - Aug]	15.0%	10.0%	7.0%
Low demand season [Sep - May]	15.0%	10.0%	7.0%
Net Energy costs at LV			
High demand season [Jun - Aug]	246.05	61.20	31.83
Low demand season [Sep - May]	68.70	40.26	27.42

Revenue neutrality.

The final step in tariff design is to establish revenue neutrality. The proposed method is as follows:

Determine the relevant details of the target customers of those with TOU meters which are to be converted and for which data has been obtained. The table below is an example of data required for each custiomer.

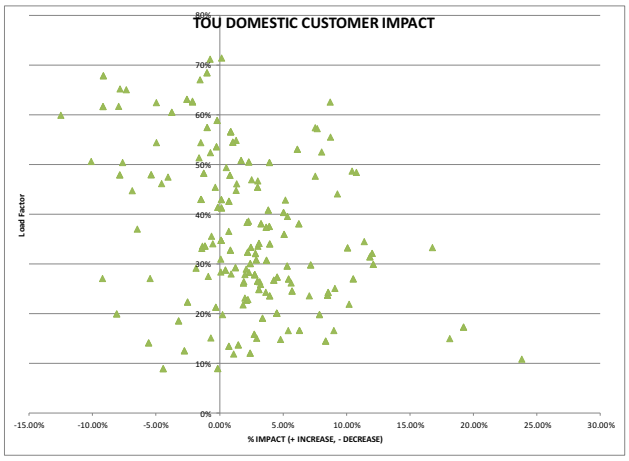
CUSTOMER A		Peak	Standard	Off-Peak	MD - KVA ALL	MD - KW ALL	MD P&St	MD highest	MD highest	kWh TOT
0	Days	kWh	kWh	kWh	KVA	kW	kVA	kVA	kW	kWh
01-Jan-11	31	94	244	379	2.5	2.5	2.4	15.0	14.9	717.1
01-Feb-11	28	173	478	577	15.0	14.9	15.0	15.0	14.9	1 228.0
01-Mar-11	31	79	202	243	2.8	2.8	2.8	15.0	14.9	524.1
01-Apr-11	30	170	417	377	12.0	12.0	12.0	15.0	14.9	963.6
01-May-11	31	98	257	384	2.8	2.8	2.8	15.0	14.9	738.8
01-Jun-11	30	55	254	157	1.7	1.7	1.7	15.0	14.9	466.3
01-Jul-11	31	56	218	195	1.4	1.4	1.4	15.0	14.9	469.2
01-Aug-11	31	65	191	211	1.5	1.4	1.5	15.0	14.9	466.7
01-Sep-11	30	68	180	225	2.3	2.3	2.3	15.0	14.9	472.6
01-Oct-11	31	175	427	416	12.0	12.0	12.0	15.0	14.9	1 018.0
01-Nov-11	30	93	246	346	2.8	2.8	2.8	15.0	14.9	685.1
01-Dec-11	31	97	257	359	3.9	3.9	2.6	15.0	14.9	712.6
01-Jan-12	30	1 222	3 370	3 870	61	60	59	180	179	8 462

Once this data has been determined the revenue from the existing domestic tariff after application of the average price increase is compared with the revenue from rates calculated above. The TOU energy rates are then all adjusted with a fixed c/kWh to yield the same revenue from the TOU tariff.

In the example the breakeven is achieved at a mark-up of 18.79 c/kWh on the Eskom effective TOU energy rates. The resultant charges are as shown below

DOM TOU TARIFFS		01-Jul-12	0	
		BASIC		ENERGY
		CHARGE		CHARGE
Tariff Name	**Code**	R/C/m		c/kWh
Existing 2 part	1 ph	200.00		89.00
	3 ph	900.00		89.00
Dom TOU 1 ph	1 ph	BASIC	CAPACITY	
		R/C/m	R/A/m	
		47.46	2.82	
		Peak	Standard	Off-Peak
		c/kWh	c/kWh	c/kWh
	Energy: High Demand	264.84	79.99	50.63
	Energy: Low Demand	87.50	59.06	46.21
Dom TOU 3 ph	3 ph	BASIC	CAPACITY	
		R/C/m	R/A/m	
		71.18	2.54	
		Peak	Standard	Off-Peak
		c/kWh	c/kWh	c/kWh
	Energy: High Demand	264.84	79.99	50.63
	Energy: Low Demand	87.50	59.06	46.21
		Markup	18.79	c/kWh

The impact on customers is very important to address when the conversion process is compulsory. The graph below indicates the impact on customers at various load factors.



In my experience less than 5% customers will be subject to an impact of more than 15% due to structure change.

9 ISSUES

There are a few controversial issues that will now be discussed:

2 period vs 3 TOU day periods.

A few utilities have been advocating a 2 day periods (peak and Standard combined into a new peak). The only motivation provided is that no more significant load shifting has been detected going from 2 to 3 periods. It is believed not correct because of the following:

- The EPP clearly stipulates that the tariff structure needs to be as close as possible to the WEPS. Therefore 3 periods should be used.
- When a 2 rate period is applied the very high price signal associated with the Eskom peak periods is negated because the rate for the new peak (peak and Standard) the average of the 2 will be significantly less. This is in contradiction with the EPP in terms of ensuring efficient allocation of resources.
- The biggest issue relates to the ability for customers to move load effectively and avoid the Eskom peak times. This is illustrated by some examples:
    - Customers with solar water heaters usually require that some electrical heating in the late afternoon if the water did not heat up adequately. With the 2 rate period the optimal time would be from 18h00 (exactly on Eskom peak) when the sun is close to setting. With the 3 rate the boost can be done from 17h00-18h00 which is in the Eskom Standard period.
    - Customer with solar panels for their swimming pools can run from 10h00 to 18h00 totally avoiding the Eskom peak period. With the 2 rate there is no incentive not to start at 08h00 in the peak time.
    - The same applies to washing machines and dishwashers especially where domestic

workers are only at home during the day. For them there is no advantage to only start at 10h00 avoiding the Eskom peak.
    - There are various other applications with a similar need to run during the day but not all day. Even if fridges are equipped with timers they can be set to avoid the Eskom morning and evening peaks with a 3 rate whereas it is not possible to switch them off for the whole day from 07h00-10h00.
- Other issues relate to the setting of the tariffs. When customers shift load, the revenue impact to the utility will not match the savings in energy cost to Eskom (WEPS for Eskom Distribution). This means that a detailed and complex revenue neutrality calculation will have to be done every year.

Treatment of Public holidays.

The issue of the treatment of public holidays also brings a decision to be made. The following can be said in this respect:

- The different treatment of public holidays as per the Eskom Megaflex is the more cost reflective option.
- It is unlikely that domestic customers would take specific effort to make maximum use of the cheaper power during some public holidays.
- If public holidays are not treated differently the P/S/O-P quantities should be calculated treating public holidays as normal days to ensure fairness.
- If a Smart Meter System without remote ability to load the public holidays as different days is used, it is not advised because of the need to visit the meter and reprogrammed it annually. (This is the case with some large customers on TOU).

Reactive energy charges.

Megaflex contains a reactive energy charge and many utilities have to implement power factor correction due to customer's reactive loads. The following in this respect:

- Historically domestic loads have been very resistive. The loads are however becoming more reactive because of the following:
    - Less resistive loads with solar water heaters being installed, less electricity for cooling and space heating
    - heatpumps used for water heating, more CFL's and LED lights and various electronics generally with poor power factors.
- Customers best way of managing the power factors is:
    - By the equipment they purchase. The problem is that power factor labelling is not generally done in South Africa.
    - By using motor driven appliances such as heat pumps mostly during the off-peak times when power factor is usually not a problem.
- In recent studies done for Domestic customers using more than 1000 kWh/m, it was found that on average the power factor is worse than the excepted 0.85%. Reactive energy exceeding 30% of the active energy during the peak and Standard period only is as much as 7% of the active energy.

Based on this information the case can be made to charge a reactive energy charge. The following in respect of such charge:

- It should cover the Eskom reactive energy charge which is applicable in peak and standard periods during the high demand period only and charged for such quantities in excess of 30% of the active energy during every half hourly period.
- The utility own power factor needs should also be considered. If there are overloading which are worsened by bad power factors during the low demand period, such charge should be set for the whole year.
- The charge should only be levied during peak and standard periods for such reactive energy exceeding 30 of active power.
- Setting the level is a complex issue which need complex assessment of power factor correction equipment cost converted to per kvarh. It is suggested to start with a level close to that of the Eskom Megaflex charge.

Domestic Bulk Supplies.

A few million domestic customers are supplied via a reseller or body corporate within either a complex or flat. Historically these customers were given a bulk supply tariff very close to the domestic tariff. With the NERSA forces introduction of heavily subsidised Inclining Block Rate Tariffs (IBT) for domestic customers, a big problem has been created:

- If a Bulk domestic TOU tariff is developed which break even with the customers using more that 1000 kWh/m as in the rest of the municipality, a big problem will be created:
- Municipal and National Legislation requires that all customers within a municipal boundary be treated fairly. In this respect the EPP also stipulates that customers of resellers should not be charges unfavourable relative to customers supplied directly by the municipality.
- With the IBT tariff available to customers using less than 1000 kWh/m, customers with lower consumption received massive cross-subsidies.
- Studies has clearly shown that if a Domestic TOU tariff calculated for revenue neutrality for domestic customers using more than 1000 kWh/m is applied to reseller, the revenue from the IBT would be significantly less than the price at the Domestic TOU tariff.

This is a complex issue which seem to be flawed with many challenges. The following options hold a possible solution:

- Do not apply a Domestic TOU tariff to these resellers but charge an IBT where the blocks sizes are multiplied by the number of units supplied in that complex. This is the most simple but fair approach but the TOU message is not getting to customers of the reseller.
- Offer a Bulk domestic TOU tariff where the c/kWh markup is set at a level which would bring the average price to the same level as the IBT tariff within the complex. This is a difficult option as the figure would be very different to each complex.

Demand vs Access charge.

There is the feature available in the smart meters to charge a maximum demand charge or even an access charge based on the highest maximum demand in a year. The following can be said in terns if charging a maximum demand charge vs charging a charge based on installed capacity.

- It is better for the utility to manage its demand and subsequent network capacities if the customers' maximum load is limited rather than to charge by way of demand charges.
- Domestic customers generally do not have the sophistication or time to manage their loads on an hourly basis.
- Experiences in many municipalities is that customers are aware of their capacity limits and do take measures to remain within the contracted capacity.

Based on the above it is proposed to charge a R/Amp/month charge rather than a maximum demand or access charge based on measured demand per month. It is also proposed that steps of 10 Amps be provided for in the selection for customers.

Load control by utility.

The Smart meters must make provision for the management of various loads of the customer remotely by the utility. The controversial issues in this respect are as follows:

- The capacity charge and the TOU energy rates should provide a very strong signal for customers to avoid the Eskom peak times and the local peaks which would mostly co-inside with customers own peaks.
- When utilities now manage some of these loads remotely the following questions arise:
    - Will it not compromise the customer's TOU energy cost? For example if the utility interrupts the solar water geyser load from 16h00 to 18h00, the customer will need to heat the water during the peak time to be able not to have cold water.
    - If an air-conditioning unit is interrupted from 06h00 to 07h00, the customer may usually have pre-heater the house before the peak which he would now need to do during peak time.
    - If any such reductions are part of Eskom's Demand Market Participation (DMP) plan, should the customer not be credited with any such payment to the municipality?

The key message here is that great care would need to be taken in doing the system setup closely with customers.

Time periods / seasons different from Eskom.

Some utilities have opted to apply TOU day periods and Seasonal months different from that of Eskom. The following in this respect;

- The objective is to set tariffs equal to cost.
- The energy charges must thus cover energy cost.
- The capacity charges must cover network costs.

Applying periods different to that of Eskom WEPS is not supported.

Method of mark-up for revenue neutrality.

Various methods can be followed in marking up the basic costs as calculated to obtain revenue neutrality. The following options can be used:

- On all charges or only some.
- The same or different surcharges on different charges.
- The same % or same c/kWh on energy charges.

It is proposed that the mark-up be done as follows:

- on energy costs only
- as a fixed c/kWh on all energy charges.

This is motivated as follows:

- If the surcharge is applied to energy only, the customer can at least save a little bit more when reducing consumption.
- In this time of energy shortages in the country, the need to save energy is important.
- If the surcharge is the same c/kWh on all energy charges, the utility will remain net revenue neutral when customers shift load.
- The Eskom TOU price signal is not distorted. If it is distorted by say applying a much higher surcharge on peak energy, "the efficient allocation of resources" objective will not be obtained.

One of the most common mistakes made by utilities in the design of their TOU tariffs is to mark-up the Eskom energy rates by the same or similar percentages. When customers shift load from an expensive to a cheap period, the utility will lose more revenue than what it saves in Eskom purchase cost. This has lead many utilities, including Eskom, at one stage to discourage any load shifting.

Cross-subsidy, renewable energy levy.

Some utilities are showing many different charges for example: Renewable energy levy, cross-subsidy levy, etc. The following should be noted in this respect:

- Considering the increased complexities of domestic TOU customers do we really want this further complexity?
- If the customers are on pre-payment, they will not even see these separate charges.
- If the various cross-subsidies / levies are worked into the relevant rates, the pricing signal will not be distorted.
- When the rates applied by Eskom are applied at the LV level, it needs to be adjusted because of losses. In other words the charge must be higher than the Eskom charge because of losses to be cost reflective. If a higher charge than that of Eskom is charged, negative customer reaction could be expected.
- Because the renewals energy levy is a charge on generators and thus a cost to customers, even Eskom is considering to not showing it separately in future.
- It is expected that the domestic TOU customers will make a contribution to the cross-subsidies in the utility. To be able to show this levy would require that a detailed cost of supply study be undertaken regularly.

In view of the above it is proposed to include these charges / levies to the appropriate tariff charges.

Pre-payment vs. conventional payment.

One of the drivers in South Africa has been to convert domestic customers to pre-payment. Applying pre-payment to domestic TOU tariffs with smart meters presents new challenges in this respect.

One of the big challenges associated with pre-payment meters currently being used in South Africa is that the customer pays in Rand but receives a token for kWh. This causes a problem when customers purchase very large quantities at the low price just before any price increase thereby causing the municipality to lose money. This problem would be very prominent with the TOU tariffs associated with much higher rates during the high demand season.

If domestic TOU tariffs with smart meters are applied it is therefore proposed that the customer purchase Rand amounts and that the Rand amounts are transferred to the meter. The meter will contain all the tariff charges and will thus deduct the associated amount from the available credit on the meter.

This is further complicated because of the following:

- When the end of the month comes and the basic charges plus capacity charge is deducted that the customer could go into a negative credit available.
- If the customer does not purchase any electricity, the amount due will increase every month.
- Consideration should thus be given to deducting the fixed charge by way of a debit order and only vending the energy.
- Various payment options are being considered to ensure that these, typically more sophisticated customers, can determine the available credit remotely and make payments remotely.

Load shifting support.

Load shifting by customers does not take place by itself. Even if the tariff contains a capacity charge and TOU energy charges, and the system have load management contacts, customers need support in this respect:

- A consumption / requirement audit should be undertaken per household.
- The customer need to be recommended what the optimal load management regime would be optimal.
- A joint decision be made and the system then be configured to operate in terms of this regime
- Customers need to be informed about the effectiveness of the system on total electricity costs and their bills.

Capacity costs / fixed costs in energy charges.

Various utilities have implemented TOU tariffs with energy charges only. The following problems are experienced when fixed and/ or capacity costs are included in the energy charges:

- This distorts the price signals. Customers will now make inefficient decisions. This could for example signal to customers that it is better to use an electrical heater because the few hours of winter peaks are still much less than the increased capacity costs for the whole year.
- There is no signal for customers to improve their load factor and thus installed capacity which have an impact on utility supply costs.
- This will cause customers to increase network capacity / system peak for a few incidents during the year. It is well known that there are a few days in year, usually associated with very cold or very hot weather which causes big system constraints.
- Customers with irregular consumption will not pay their fair cost of supply. This means that customers, who have a second property and only use the supply for a few months in the year, will be subsidised by those customers with one property only and more consistent usage throughout the year.
- When all costs are loaded onto the energy charges, the utility is more exposed to consumption changes by customers. When customers reduce consumption but not required capacity, the utility costs remain the same but experience big revenue losses.

10 IMPLEMENTATION

The roll out if any new system is associated with teething problems. The following is therefore proposed in this respect:

- That the smart meters be installed and be run as a simple non-TOU tariff on conventional payment mode.
- Because of the big difference in rates between the seasons it is proposed that customers only be converted to the TOU tariff at the start of a new financial year. New customers can be charged at TOU from the beginning.
- When a customer that is currently on pre-payment, converts to the new smart meter in conventional mode, a deposit need to be levied for that customer.

11 CONCLUSIONS

The development of a TOU tariff for domestic customers is a complex subject. This paper highlights some of the key considerations. Municipalities are advised not to just jump in and do their own thing. Thorough analysis and various practical and ideological issues need careful analysis and considering.

It is hoped that this paper has provided useful guidance that can be used by all electricity utilities.

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