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Title of Paper

USING AN INNOVATIVELY DEVELOPED METERING SPREADSHEET TO COMPARE EKURHULENI METROPOLITAN MUNICIPALITY, CITY POWER OF JOHANNESBURG, CITY OF TSHWANE METROPOLITAN MUNICIPALITY AND ESKOM LARGE CUSTOMER TARIFFS WITH ONE ANOTHER AND USING THE METERING SPREADSHEET AS A TOOL TO COMPARE ACCOUNT RESULTS

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INTRODUCTION

The purpose of this paper is meant to be informative of nature and is not meant to take a standpoint for or against the different tariff structures used in municipalities. The purpose is rather to point out the structural differences that inherently exist in the various electricity tariffs of Municipalities. It is also important to note that where comparison of tariffs are displayed that the tables were compiled during May 2004 and increases in tariffs or tariff structural changes after this time will not be reflected.

The actual presentation at the technical meeting will deviate slightly from the content of the paper in order to display the features of the innovatively developed metering spreadsheet to the audience.

ELECTRONIC METERS AND PROFILE DATA

Common amongst almost every electronic meter, and higher level billing system, is the ability to save accumulated energy values within the meter at regular intervals, the so-called "metering interval", over which energy values are integrated. The most common interval used is 30 minutes.

Each type of electronic meter is provided with some form of meter specific software. This software, and some hardware typically a notebook type of computer, are used to programme the meter, retrieve data, and to a limited extend process data.

Some packages that can read a variety of meters do exist, but in some instances at a price that only larger utilities can afford. There are also annual costs involved to update these packages as tariffs are increased and structures change.

What is common to most of the meter software packages is the ability to output the profile data to a compatible format that can be imported by commonly available spreadsheets.

This enables the (experienced) spreadsheet user to analyze data and produce meaningful output.

In an article published in the Elektron Journal of the Institute of Electrical Engineers , March 1997, page 29, Profile Data: "The window into Electricity usage and costing", the following two statements are quoted:-

1.) “The use of spreadsheets is however not all that effective where large amounts of data are involved, or advanced analysis is required e.g. Time-Of Use analysis”

2.) “Those experts who are able to use the programming languages built into the modern generation spreadsheets, quickly run in to bottlenecks and timing issues- an early attempt to run a spreadsheet based time of use analysis on one year’s data, **ran for 13 hours on a 100 Mhz Pentium based computer”**

The author developed an innovative set of spreadsheets to simultaneously calculate 3 different electricity tariff accounts for Ekurhuleni, City Power, Tshwane and Eskom and will demonstrate its application and speed to compile and compare different tariff structures accounts from a month’s profile data.

With the aid of a modern spreadsheet the author has extensively made use of the so called “AND”, “OR”,”IF” mathematical statements to developed an effective tool whereby various bills are generated directly from imported monthly profile data from a variety of commercially available electricity meters.

The spreadsheets also have the capability to provide for public holidays that should either be treated as a Saturday or Sunday and automatically change the profile data to the applicable Standard or Off-peak energy or demand values, which means that meters in the field do not have to be updated annually with new holidays.

The notebook computer used for processing data runs on an Intel µPGA2 Mobile Pentium III microprocessor, featured with SpeedStep technology, with integrated 256 KB L2 Cache. Memory 144-pin SODIMM 256 MB. PCI Local Bus Architecture- 32-bit PCI Enhanced IDE optimizes data transfer between CPU and hard disc drives. 32-bit PCMIA CardBus PCI Technology that is also backwards compatible with 16-bit PC cards (it is certainly not the latest and fastest computer technology now available, however the time taken to obtain results were reasonably satisfactorily).

The accuracy of the input data is of prime importance. Experience and knowledge (skills) of problems that may be encountered is required as the profile data is financially related and used to create bills, and therefore require that extensive checks need to be applied.

The author has through the application of the spreadsheet discovered some minor discrepancies in bills generated from the same set of profile data within different programme applications, and were able to ensure that customers are billed correctly as far as practically possible.

It is important to note that the discrepancies found were in no way related to any meters correctly wired, but were rather due to programmable and/or tariff structural features misinterpreted. (Gaps in data, incorrect alignment of data, public holidays, duplicated data, **garbage in garbage out principle, etc.)**

TARIFF COMPARISONS:

Due to the time constraints for the presentation, only the following main categories of tariffs will be briefly compared and discussed in this paper:

EKURHULENI METROPOLITAN MUNICIPALITY

1.) **Tariff C**: (kWh and kVA - demand tariff) and
2.) **Tariff D:** (TOU- tariff > 500kVA)

CITY POWER OF JOHANNESBURG

1.) **Large Customer Demand Tariff (Medium Voltage):** (kWh and kVA - demand tariff) and
2.) **Large Customer Time Of Use Tariff (Medium Voltage)**: (TOU- tariff > 100kVA)

CITY OF TSHWANE METROPOLITAN MUNICIPALITY

1.) **11kV Supply Scale Tariff:** (kWh and kVA - demand tariff) and
2.) **11kV Supply Scale Time Of Use Tariff** (TOU Tariff > 750 kVA)

ESKOM

1.) **NightSave Urban:** Supply voltage >500 V and <66kV, Voltage surcharge 10,07% and Transmission surcharge 0% (kWh and kVA - demand tariff) and
2.) **MegaFlex** Supply voltage >500 V and <66kV, Voltage surcharge 10,07% and Transmission surcharge 0% (TOU- tariff)(> 1000kVA)

However, the spreadsheet applications developed will also generate bills for the following tariffs:-

EKURHULENI METROPOLITAN MUNICIPALITY

3.) **Tariff C1.2 Off–Peak 21:00 to 07:00 on weekdays etc.**:(kWh and kVA - demand tariff) and

CITY POWER OF JOHANNESBURG

3.) **Large Customer Demand Tariff (Low voltage and High voltage):** (kWh and kVA - demand tariff) and

CITY OF TSHWANE METROPOLITAN MUNICIPALITY

3.) **11 kV Supply Scale: Time of Use** (>750kVA, 11kV Supply Scale)

ESKOM MEGAFLEX AND NIGHTSAVE TARIFFS ON ALL VOLTAGE LEVELS AND DIFFERENT TRANSMISSION SURHARGE LEVELS AS WELL AS

3.) **MiniFlex** Supply voltage All levels, Voltage surcharge ALL and Transmission surcharge All% (TOU- tariff)

LOAD FACTOR

It is important to understand how the Load Factor will be calculated when it is used in any tariff structure to determine a customer electricity bill.

NRS 057-1:2001: Electricity Metering defines **Load Factor** as follows: -

A factor that allows for the average period in which an appliance uses maximum load, derived by average load divided by the maximum demand.(NRS-034-0)

NRS 034-0:2001: Electricity distribution – Guidelines for the provision of Electrical Distribution networks in residential areas defines **Load Factor** as follows:-A factor to allow for the average period in which an appliance uses the maximum load.

Generally **Load Factor** is calculated as follows:-

$$= \frac{\text{kWh} \qquad\qquad x1}{\text{(max. demand kVA) x hours in month.}}$$

Ekurhuleni Metropolitan municipality defines **Load Factor** in their tariffs as follows:

Load factor is the average demand of a load divided by the maximum demand of the load over the billing period

$$\text{Load factor} = \frac{\text{Average Load}}{\text{Peak Demand}}$$

Ekurhuleni Metropolitan Municipality has coupled a rebate depending on a certain Load Factor to their tariff structures. It has therefore now become important to clearly define the way in which the Load Factor will be calculated to customers.

The above definitions do not seems to clearly define how Load Factor is to be calculated and therefore the methods used to calculate Load Factor may give varying results.

To demonstrate the difference in answers that can be obtained by the various methods, the following two examples are used from the same set of profile data:-

1.) Generally **Load Factor** as follows:-

$$= \frac{kWh}{(\text{max. demand kVA}) \times \text{hours in month.}} \times 100$$

$$= \frac{1\,684\,656 \times 100}{3331 \times 24 \times 30.}$$

$$= 70{,}24\%$$

2.) **Load Factor** as follows:-

$$= \frac{kVAh}{(\text{max. demand kVA}) \times \text{hours in month.}} \times 100$$

$$= \frac{1\,979\,529 \times 100}{3331 \times 24 \times 30.}$$

$$= 82{,}54\%$$

Thus a difference in Load factor of: 82,54 – 70,24 = 12,3 %

To compare apples with apples it is suggested that the second calculation method rather be used to determine the Load Factor of a customer.

It is also to note that in case of a power failure on the supply authority network the actual hours to be taken into consideration for calculating the Load factor may differ from the actual hours in a month.

(NRS 071:2004 in DRAFT: Automated Meter Reading for large power users will probably also address this issue and comments from Ekurhuleni requested that the Load Factor be clearly defined)

Table 1: TARIFF COMPARISONS: (kWh & kVA): IMPACT OF LOAD FACTOR ON EFFECTIVE c/kWh

	ESKOM N/Save kVA	**CP** **>100kVA**	EMM **>100kVA**	**Tshwane** **>200kVA**	**= > 13kWh**	
	10.07%		3.00%	**Energy charge reduced if daily consumption is equal or greater than 13kWh per kVA of the max demand/ month**		
Medium Voltage	1491.45	R552.00	R256.25	R333.31		
Medium Voltage	R 15.60	R48.00	R46.31	**R51.51**		R/kVA
	R 45.92	R48.00	R51.97	**R51.51**		R/kVA
Medium Voltage	10.46	11.67	12.61	**12.01**	***11.15***	c/kWh
Medium Voltage	13.92	17.57	16.32	**12.01**	***11.15***	c/kWh
Medium Voltage	0	3.09	0	**0**	**0**	c/kVArh

Table 1: TARIFFS: EKURHULENI METROPOLITAN MUNICIPALITY, CITY POWER OF JOHANNESBURG, CITY OF TSHWANE METROPOLITAN MUNICIPALITY AND ESKOM MEGAFLEX

For comparison purposes the author has **ignored all fixed charges (basic charges)** in table (1) (considered only kVA and kWh costs) for Ekurhuleni, City Power, Tshwane and Eskom to compare the effective c/kWh rate, Low- and High season and Weighted average, at different Load Factors for with one another to demonstrate the following results in Figures A, B and C:-

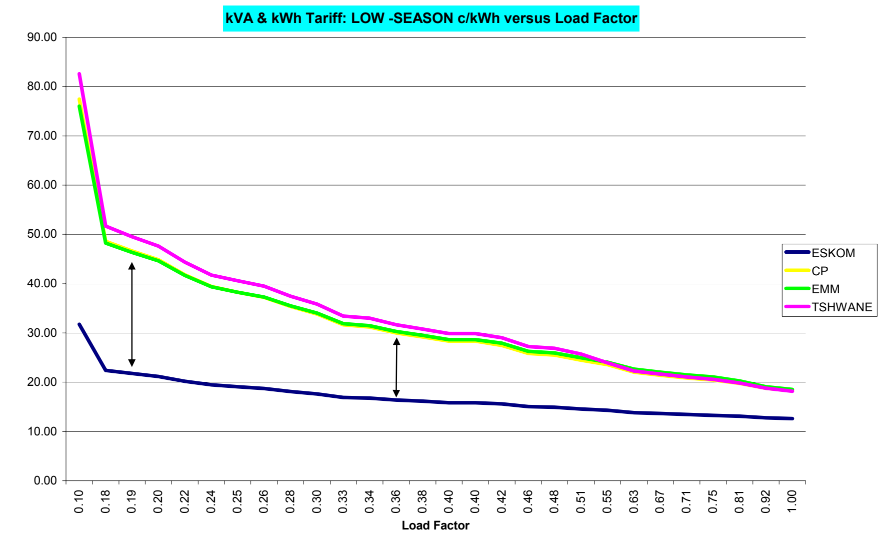


Figure A: Low season months

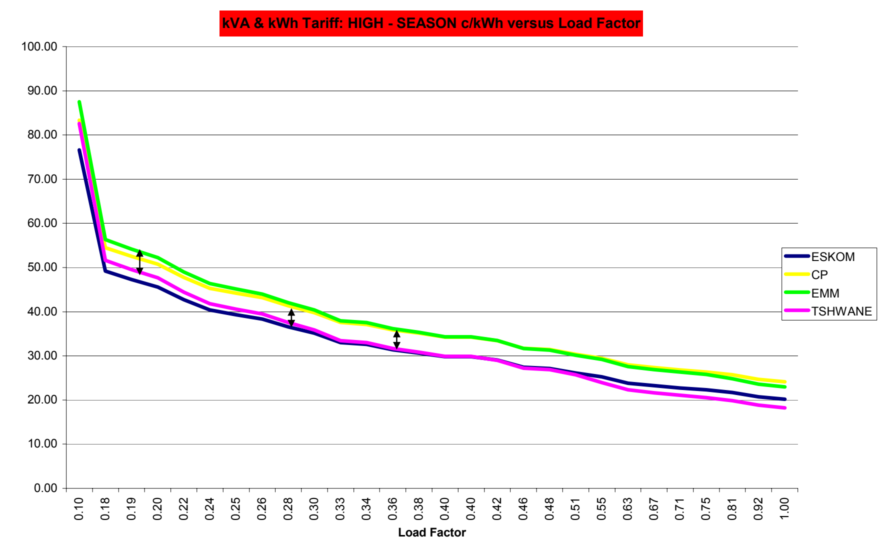


Figure B: High season months

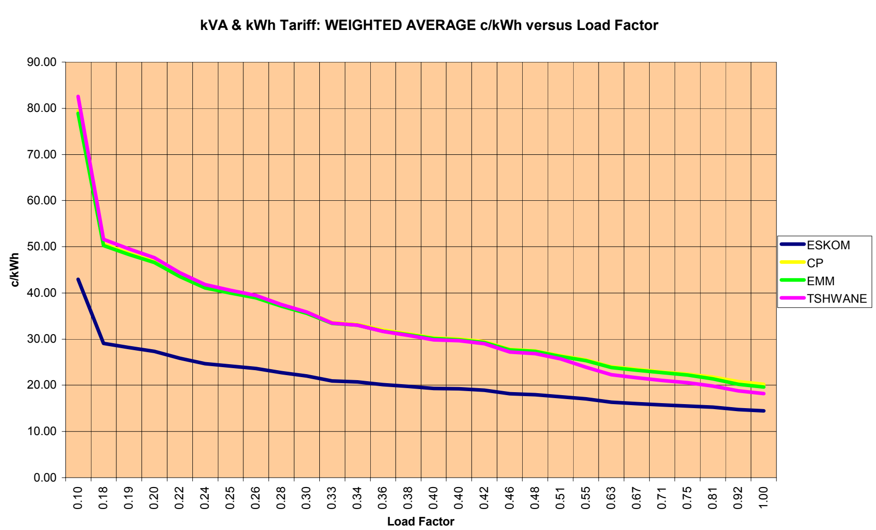


Figure C: Weighted average of Low and High season months

From figure C, the weighted average graph, it can be seen that the so-called three part tariff (basic charge + kVA + kWh costs) of the three metropolitan municipalities under consideration, do not differ much when the c/kWh is compared for load factors from 0 to 0,55.

However for load factors higher than approximately 0,55 the Tshwane tariff specific condition that specifically states as follows:-"provided that in case of a consumer who is not supplied with electricity under the Off-peak Supply Scale, the said energy charge will be reduced, if the average daily consumption in any month is equal to the greater than 13kWh per kVA of the maximum demand in that month, to 11,76c/kWh" have the consequential result that Tshwane will have the lowest overall bill for larger customers with a relative high load factor charged on this tariff.

COMPARISON OF TIME OF USE TARIFFS (TOU): EKURHULENI METROPOLITAN MUNICIPALITY, CITY POWER OF JOHANNESBURG, CITY OF TSHWANE METROPOLITAN MUNICIPALITY AND ESKOM MEGAFLEX

	ESKOM M/Flex kW	City Power kVA	EMM kVA	Tshwane
	10.07% Surcharge added to tariff		Less 3% discount on tariff	
Medium Voltage	R 2,613.86	R2,675.76	R1,025.00	R348.31
	R 11.37	R33.15	R13.65	R53.57
	R 11.37	R33.15	R13.65	R53.57
PEAK kWh	55.52	45.03	80.60	27.62
Standard kWh	16.03	17.49	23.27	9.04
Off-Peak kWh	9.50	12.54	13.79	7.21
PEAK kWh	17.01	19.42	24.69	27.62
Standard kWh	11.26	14.33	16.35	9.04
Off-Peak kWh	8.50	11.87	12.34	7.21
c/kVArh	3.17	0	0	0

Table 2: TIME OF USE TARIFFS (TOU): EKURHULENI METROPOLITAN MUNICIPALITY, CITY POWER OF JOHANNESBURG, CITY OF TSHWANE METROPOLITAN MUNICIPALITY AND ESKOM MEGAFLEX

The following graphs compare a typical 5MVA customer account with an approximate 80% load factor for the high and low season months and indicates the corresponding different pricing signals.

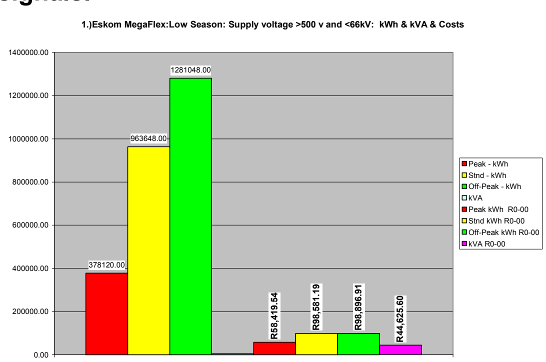


Fig 1 Above: Eskom MegaFlex: Low Season :

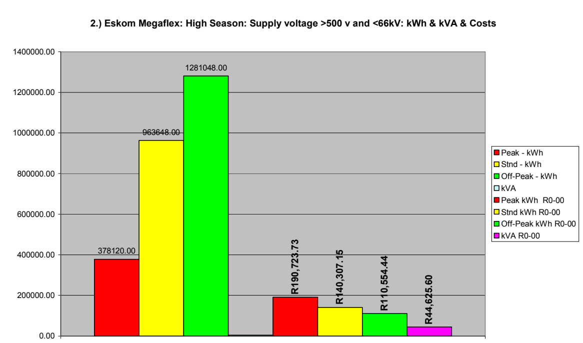


Fig 2 Above: Eskom MegaFlex: High Season :

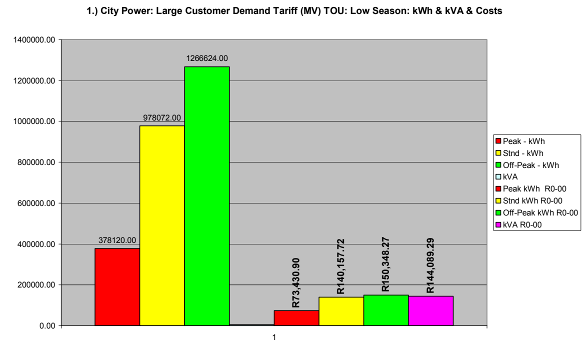


Fig 3 Above: City Power Large Customer TOU Tariff Low Season :

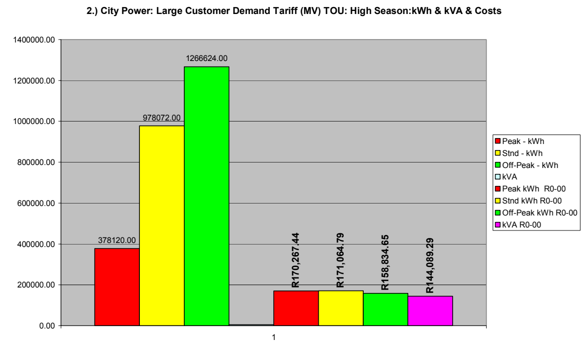


Fig 4 Above: City Power: Large Customer TOU Tariff High Season :

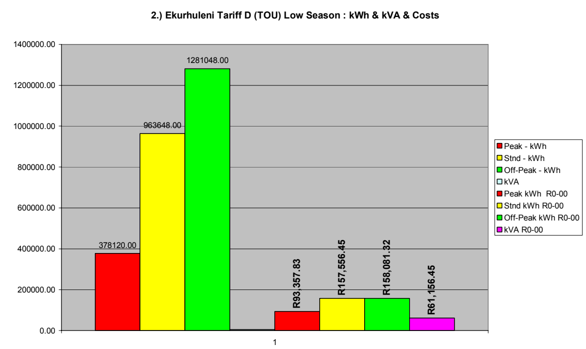


Fig 5 above: Ekurhuleni TOU Tariff: Low Season

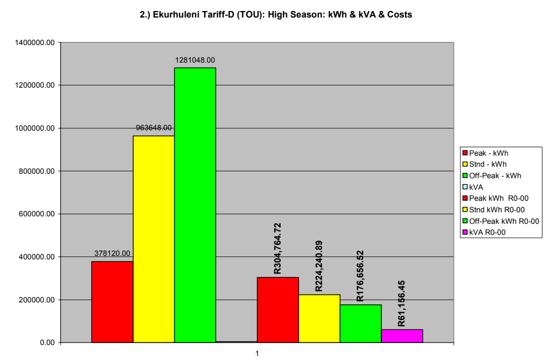


Fig 6 above: Ekurhuleni TOU Tariff: High Season

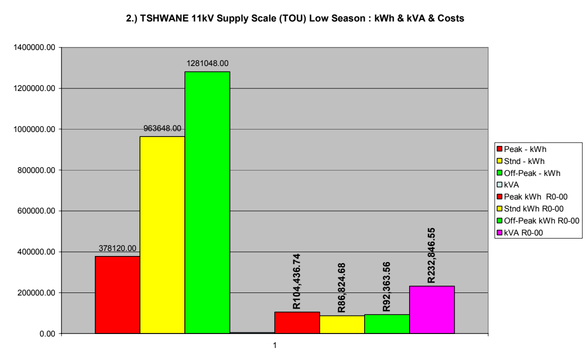


Fig 7 above: Tshwane 11kV Supply TOU Tariff: Low Season

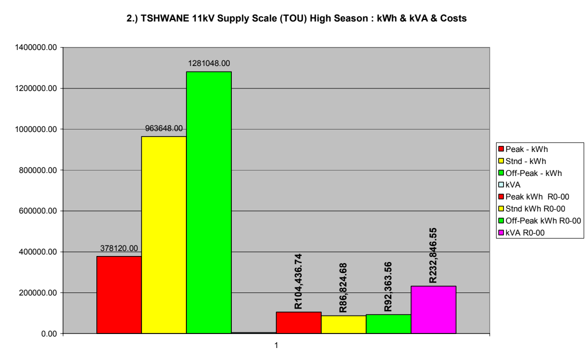
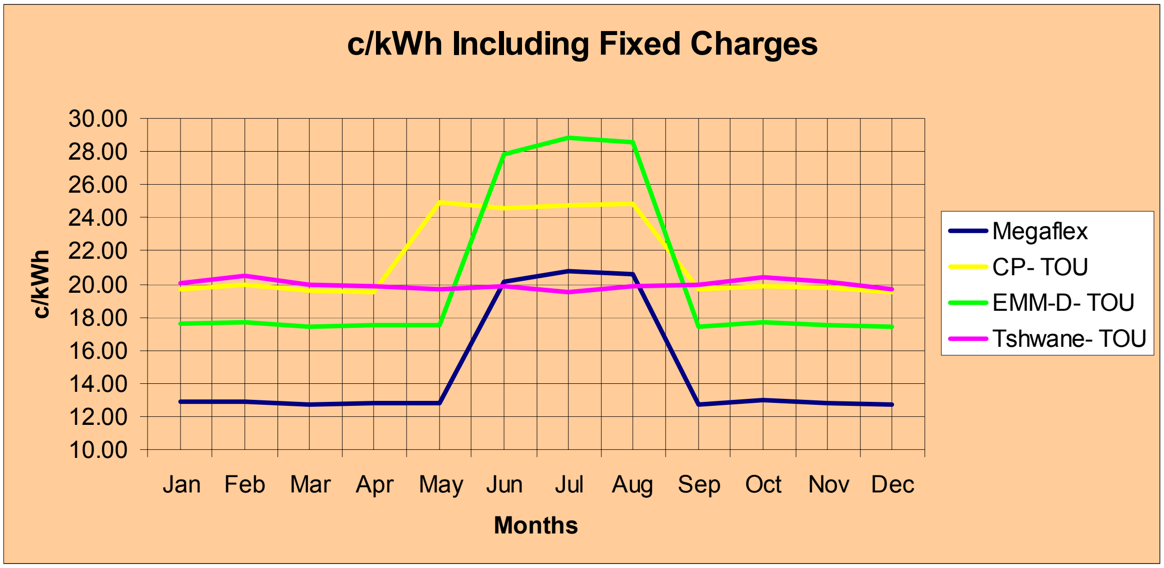


Fig 8 above: Tshwane 11kV Supply TOU Tariff: High Season

The TOU graphs below were obtained for a specific consumer with an average kVA demand reading of 4 296 kVA and average consumption of 2 558 010 kWh per month over 12 months with an average L.F. of approx. 78,5% accordingly. These graphs clearly demonstrate the different impacts, on a specific customer account, that the different tariff structures that exists at the Metropolitan Municipalities under consideration will result in.



The TOU tariff can also be referred to as a complex tariff. Due to the complexity of this tariff and the various factors that may affect the results the only way to draw a conclusion is to actually model metered data in a programme to compare the actual results.

However due to the relative large differences in the kVA part of the TOU costs between the metropolitan municipalities under consideration (Tshwane-R53,57, City Power- R33,15 and Ekurhuleni less 3% included-R13,65 per kVA) the following broad base guidelines may be applicable:

For relative very high load factor customers Tshwane will probably be the lowest and as the load factors decrease, to a level wherein most customers will generally fall, the lower kVA cost of Ekurhuleni will result in them be the lowest for TOU customers of all three.

It is also to note that for relative high load factor customers, as the one compared above, that the Tshwane TOU tariff results in that the bill for this type of customers will be lower than Eskom MegaFlex and without a definite stronger pricing signal during the winter months June, July and August.

It is further also to be noted that City Power TOU tariff has four(4) high season months (May to August) versus Eskom three(3) months (Jun to August)

FUTURE TARIFFS

Future tariffs charged to larger customers will probably be cost-reflective and include geographical differentiation resulting from the relative location of the markets from electricity generation plants as well as the physical layout of the country.

Some tariff structures are energy unit based (c/kWh basis and are thus not time based), whereas the cost of producing electricity is based on hourly and seasonal TOU tariff structures. Some customers in the industrial sector have already been converted to the TOU basis. The opinion is held that, in order for the wholesale pricing to be cost reflective, it should be TOU based.

However comparisons of a TOU based tariff can always be compared with an energy unit based tariff c/kWh. The point is that the industrial sector is probably more concerned about the per unit production cost of electricity than in comparisons of TOU tariffs.

Therefore should the per unit c/kWh comparison not reflect the correct pricing signals they would probably not respond to it, e.g. Ekurhuleni Metropolitan Municipality: Although EMM TOU tariff signals out a very strong pricing signal in their High season peak period c/kWh, the much lower pricing signal in the Low season peak period c/kWh resulted in that the comparison energy unit based cost c/kWh over a 12-months period would not really have an extreme negative impact for the average high load factor Industrial Consumer.

The following clause is an extract from the **EDI DRAFT Regulatory Framework for Distribution Industry of South Africa, July 2004, Revision3, Draft for External Consultation:-**

“Pricing and Tariffs:- Harmonisation of the many different structures currently used by municipalities and Eskom is one of the many challenges facing the EDI restructuring programme. The NER has begun on a process of tariff rationalization, but will need to establish a clear policy on the objectives of tariff harmonisation including the method and timeframes that are anticipated.”

CONCLUSION

Electricity Tariff Structural difference currently exist in various municipalities.

The TOU costing principle will be of utmost importance to minimize the peak demand and system usage.

Future tariffs charged to customers should be cost-reflective including geographical differentiation resulting from the relative location of the markets from electricity generation plants as well as the physical layout of the country.

Pricing signals for different load factors signal different messages to customer’s at various Municipalities due to tariff structural designs e.g. higher kVA charges and lower kWh charges versus Lower kVA charges and higher kWh charges within TOU tariffs. It is therefore necessary that a national framework with strict guidelines be implemented to get rid of incorrect perception that may exist with large power users regarding tariff cross subsidies that are needed.

While consumers of electricity have every reason to question the tariff structures of monopolistic utilities they also have a responsibility to analyze their own consumption patterns with a view to both reducing electricity cost as well as increase efficient usage of electricity.

Today no excuse should exist for any person involved in metering of customers electricity consumption using programmes in which accuracy’s is suspect. It is therefore the duty of all persons involved in metering, both to themselves and to their customers, to insure the accuracy of weights. Honesty of intention requires that he/she shall do more than merely believe that their “scales” are correct, it is their unquestionable duty to their customers to know that they are correct. Yes, yes!

Unfortunately, it is a fact that metering knowledge, as taught in universities, technikons or learned by way of in house experience, has a limited life. This will always be due to the ongoing developments in new metering technologies. In view of this, all people involved in metering or billing of electricity, especially complex metering and tariffs must continually update their knowledge of developments.

Although spreadsheet applications may not be the ultimate tool to check and verify vast amounts of consumers profile data obtained from meters, its application as an effective “Check Tool” to verify consumer accounts and consumption patterns should not be under estimated.

Due to the fact that all data is openly and transparently available in a spreadsheet, its real value lies in the fact that it may be utilized as a **training tool.** to assist personnel and customers to understand the basic principles of tariffs and electricity (Peak, Standard, Off-Peak, kVA, kW, kWh, kVARh, kVAh, excess of 30% reactive energy, 0,96 PF, power factor, power factor correction, profiles, maximum demand, etc.).

Lastly, although not the least, where profile data is available, the SMS (super metering spreadsheet) maybe very effectively used as a **budget tool** to model the impact of new tariffs on a customer’s annual electricity bill.

Note:-The author & presenter wants to make it clear that the content, discussions, comments or views included in/on this paper do not necessarily represent the position or views of Ekurhuleni Metropolitan Municipality.

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