INCORPORATION OF MEASUREMENTS AND CALCULATIONS IN BILLING METER

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ABSTRACT

There are various categories of Electricity consumers in tariff in every utility. Due to need of hour, this tariff has to be upgraded. Unfortunately such tariff changes cannot be incorporated in the billing meter but are easily possible in utility Billing software. Specifications are drafted in procurement of billing meters but billing software is flexible. Changes in Billing Meters on site is also not possible.

Since last few decades, reactive power and power factor have been important parameters in the tariff. To improve the efficiency of the system, utilities started imposing penalty on poor power factor. Further it introduced ToD tariff and also offered incentives to motivate the consumers to maintain better power factor. To avoid the penalty as well as to get the maximum incentives, consumers started using more and more capacitors with or without switching techniques. In many Indian utilities, billed power factor was calculated on monthly energy consumption parameter basis. To maintain this practice, utility specified meters to ignore export of reactive power from consumer to grid.[1]

These monthly measured parameters are based on import and export of reactive power and majority of the existing consumers are unaware of this method. Due to lack of knowledge of the engineering of measurement in billing meters, consumers are taking corrective actions at load end. Many a times to meet the 'Billed' power factor benefit, they tend to overcompensate the system.

Now recently the import as well as export of reactive power is monitored and based on the same, power factor calculations done. These both billing parameters are resulting into a huge bill amount.

In this paper, one case study is presented. To get more insight of the issue, the actual measurements were taken to study the load profile against billing parameters.

INTRODUCTION

Tariff is a very effective tool in energy management and electricity billing meters play an important role in implementation of multiple tariffs.

As per MERC order, [2] computation of electricity consumption including rkVAh leading has been incorporated in the billing of electricity. Also, as per MERC order, kVAh tariff will be implemented in Maharashtra from 1st April, 2020.

A standard, cohesive and transparent philosophy and practices with due consideration to consumers and utility are to be adopted for meter reading and billing for achieving a win-win situation. This is essential as lakhs of electricity meters for billing are installed in the system. Some multiple tariff meters use different tariffs for different amounts of demand. Multiple tariffs are made easier by Time of the Day (ToD) meters which incorporate or are connected to a time switch and have multiple registers.

As the influence of reactive power on the system losses and on the transfer capability of lines and transformers is significant, it is fair to determine a price for the kVArh and to install measuring devices. [3] The active and reactive meters were made separately as well as the active and reactive tariffs appeared separately in the electricity bill. A conventional electromagnetic meter can measure either active or reactive component. So there were two separate meters and two separate charges for active & reactive components. [4]

Latest trends in metering technology and state of art practices for meter reading, billing and collection of revenue with the special emphasis on customer relation management are presented. [5]

kVA as well as kWh charges are quantitative part of electricity bill as mandatory charges. rkVAh

charges are qualitative part of electricity bill as optional charges in terms of percentage wise incentives & penalties.
Thus the effects of conventional meters still remain in electricity billing. The electricity billing as well as the electricity metering technology hasn't developed even after Digitalization of billing meters.

Computing kVAh based on kWh and kVArh gives erroneous results under varying power factor condition and hence cannot be used. Hence the issue of kVA measurement for a consumer was limited to kVA maximum demand for a particular period and too for large number of consumers.

$$\text{kVAh} = \sqrt{(\text{kWh})2 + (\text{rkVAh})2}$$

where rkVAh considered is rkVAh Lag only

The phasor power in a non-harmonic environment with linear loads and elements consists of two components namely active and reactive. It is defined as the vector sum of the active and reactive components.

In a harmonic environment with nonlinear loads and elements, the apparent power consists of three components including distortion component. In this condition, the apparent power is greater than phasor power.

$$\text{kVAh} = \sqrt{kWh2 + (rkVAhLag + rkVAhLead)2}$$

where rkVAh considered is rkVAh Lag and Lead

Analysis of few latest electricity bills of consumers in Maharashtra state were carried out. It is observed that till September 2018, power factor calculations were done on the basis of only lagging component of reactive power. Leading component of reactive power was neglected and consumers exporting reactive power were getting maximum incentives up to 7% on total electricity bill excluding taxes and duties on unity billed power factor.
September 2018 onwards, after implementation of incorporation of export of reactive power, the same unity billed power factor become nearly zero power factor. From years together, consumers were getting maximum incentives but actually were exporting huge amount of reactive power.

MSEDCL could implement the same tariff easily in September as separate recording registers were available in existing 2 or 4 quadrant billing meters in hardware for measurement of rkVAh import as well as rkVAh export. The readings were taken from these registers and then billing software was modified for calculations.
After knowing the facts, consumers were confused initially and panicked due to loss of incentives and impose of penalties due to excess export of rkVAh by same consumers and counted by MSEDCL. Both the situations of Import as well as Export of Reactive power were calculated on the basis of kVAh only. At the time of implementation of this in billing method in Sept.2018, MSEDCL reduced the incentives as well as penalties by 50% than offered before.
Now it is proposed to implement kVAh billing w.e.f April 2020. This means that technique of measurement of unit of efficient use of electricity (Billed PF) will be converted in tariff by calculation of import as well as export of reactive power (kVAh)

To understand facts as well as tariff, here is case study of Rubber Industry (HT). There are three distribution transformers. One is HT/HT and other two are HT/LT. After knowing the facts of export of rkVAh, HT capacitor bank on HT Transformer was switched OFF and Target PF was achieved through additional LT capacitors with restricted leading PF set on LT side and achieved best possible PF at HT billing point without excess harmful export.

CASE STUDY 1 - RUBBER INDUSTRY (HT)

Table 1: Summary of active and reactive energy for different months – Rubber Industry (HT)

Month	kWh	kVAh	rkVAh	rkVAh	rkVAh
			Lag	Lead	Total
Aug.18	543210	543960	11685	0	11685
SEP'18	531615	532395	11055	136890	147945
Oct'18	551625	557700	42300	91470	133770
NOV'18	474915	480510	40470	102255	142725
DEC'18	592800	606240	86745	41220	127965
JAN'19	534525	543645	66030	59505	125535
Feb'19	517890	521850	35520	36090	71610
Mar'19	560700	563055	30015	19260	49275
APR'19	492720	494280	19170	25755	44925

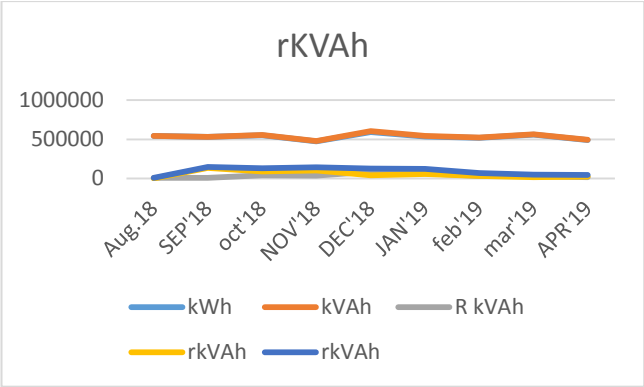

Fig 1: Variation of kWh, rkVAh lag and rkVAh lead

Table 2 : kVAh import and export

Month	kVAh w.r.t Lag	kVAh w.r.t Lead	kVAh w.r.t Total
Aug.18	543210	543210	543336
SEP'18	531615	548957	551817
oct'18	551625	559157	567613
NOV'18	474915	485799	495898
DEC'18	592800	594231	606454
JAN'19	534525	537827	549068
feb'19	517890	519146	522817
mar'19	560700	561031	562861
APR'19	492720	493393	494764

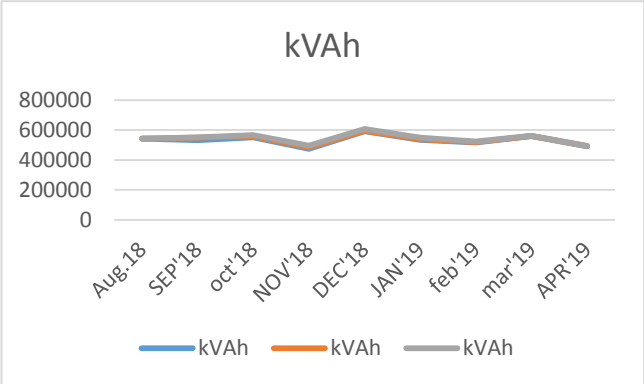

Fig 2 : Variation of kVAh import and export

Table 3: Power Factor Comparison

Month	Billed PF w.r.t Lag	Billed PF w.r.t Lead	Billed PF w.r.t Lag+Lead
Aug.18	1.000	1.000	1.000
SEP'18	1.000	0.968	0.963
oct'18	1.000	0.987	0.972
NOV'18	1.000	0.978	0.958
DEC'18	1.000	0.998	0.977
JAN'19	1.000	0.994	0.974
feb'19	1.000	0.998	0.991
mar'19	1.000	0.999	0.996
APR'19	1.000	0.999	0.996

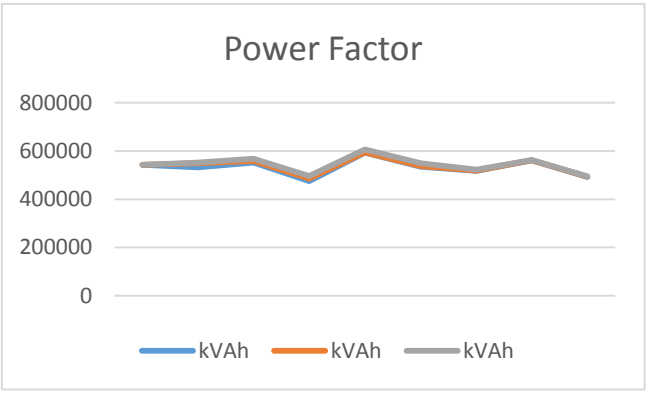

Fig 3: Variation of PF due to separate measurement of lead, lag and total reactive power

From above sample case we could experience how the entire billing structure has changed due to few parameters only.

LIST OF VARIOUS PARAMETERS AVAILABLE IN THE BILL

Parameters - Connected Load (kW), Sanctioned Load (kW)
Contract Demand (kVA), Tariff, Feeder Voltage,
Previous Highest Month, Previous Highest Bill Demand
Billing History - Bill Month, Units, Bill Demand (kVA), Bill Amount (□)
Current Consumption Details - kWh, kVAh, rkVAh (Lag), rkVAh (Lead), kW (MD), kVA (MD).
Billing Details (Parameters) - Avg. PF, Billed PF, LF, ToD Zones (timings, rate, units, demand, charges)
Billing Details (□) - Demand charges, Wheeling charges, Energy charges, ToD Tariff EC, FAC, Electricity Duty, Other charges, Tax on sale, PF Penal charges / PF Incentives, Charges for excess demand, Debit bill adjustment, Total current bill

ISSUES OBSERVED AT OTHER CONSUMERS' END RELATED TO BILLING METER

1) Display of parameters not visible.
2) All billing parameters not available in the meter display.

3) Metering box has external glass which is either broken or has a dark film. Due to the same, display is not clear.
4) Display of parameters is available by scrolling the push button on meter. But the same scrolling button with front external glass is sealed by utility.
5) rkVAh Lead reading is not available on display of the meter.
6) Due to various makes of meters, there are differences of availability of display of parameters. Display of power factor is either instantaneous or average / billed.
7) Display of Parameters is with four quadrant symbol. The same is generally not understood by common consumers.
8) If any consumer wants to monitor the readings on display manually, it is time consuming due to auto scroll of parameters.

CLOUD BASED ENERGY MANAGEMENT

Tariff meter manufacturers offer an independent online system to monitor various billing parameters. It can be accessed anywhere, anytime and comes with smart facilities like mobile application, alarm, alerts, auto email etc.

FEATURES AND BENEFITS

1) Availability of parameters on real time basis which will benefit monitoring and managing utilization.
2) ToD basis analysis and consumption reports will benefit demand side management and managing use during peak and non-peak hours.
3) Various graphs and trends benefit scheduled efficient use of electricity.
4) Various alerts, pop ups, warnings etc. will benefit in studying deviations from target.
5) Consumption figures can be utilized to review specific energy consumption.
6) Online and historical data is useful for costing of end product as well as target setting for further conservation.
7) Available data is useful for study of environmental aspects, carbon credits, and greenhouse effect.
8) Available readings will help in resolving power quality issues.
9) Available data, history, event monitoring will help in case of any failure analysis or technical disputes with any external agency.

DISCUSSIONS

There are around 29 to 30 electrical parameters found in electricity bill which contribute in final computation of electricity bill. Even in this Digital world, consumers only pay attention to Gross Bill amount compared with previous months, due date with Prompt Payment Discounts, Last date of Payment etc. Consumers neither pay attention to nor try to understand Load Factor, its importance and incentives available on same. In absence of such data, capacity and rating of solar power plants is decided blindly as a tool of Energy Conservation. Actually solar is alternate energy source.
Whereas per second basis, lot of basic measured as well as computed parameters are available from the in built billing meter.
If at all individual consumers decide to work on issues like Energy Conservation, Sub metering, SCADA, Energy Management, he has to depend on instantaneous survey, study, analysis and measurements. Permanent procurement is not affordable till date.
Under such circumstances, utilities can provide same on line information and have additional income from consumers. As it is, the same data is already with utilities at present. Only with some provision of regulations and rules updates, can be shared with consumers.

CONCLUSION

With the advent of advanced metering infrastructure and True RMS meters with RS485, RS232 ports with Ethernet facility, it is possible to view all the parameters online from any part of the world. Lot of information can be generated through these available readings.

Billing system can become transparent for consumers. Electricity boards can also give alerts, warning, messages, emails etc. to consumers.

For getting quality and stable power supply, there should be commitment from both sides namely end Consumers as well as utilities. If measurements and calculations in Billing Meter are incorporated, it will be beneficial to

consumers and help resolve many issues on both sides.

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