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Enhanced Time of Use Electricity Pricing for Industrial Customers in Malaysia

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Abstract

New Time of Use (ToU) tariff scheme known as Enhanced ToU (EToU) has been introduced on 1st January 2016 for industrial customers in Malaysia. EToU scheme is the advanced version of current ToU where the daily time frame is divided into six period blocks, as compared to only two in the existing ToU. Mid-peak tariff is introduced on top of peak-hour and off-peak tariff. The new scheme is designed to reduce Malaysia's peak hour electricity demand. On customer side, they could be benefited from the low off-peak tariff by simply shifting their consu mption. However, it depends on their consumption profile and their flexibility in shifting their consumption. Since EToU scheme is voluntary, each customer needs to perform cost-benefit analysis before deciding to switch into the scheme. This paper analyzes this problem by considering EToU tariff scheme for industry and customer's electricity consumption profile. Case studies using different practical data from different industries are presented and discussed in this paper

Keywords*: time-of-use, electricity-consumption, load-profile, industrial-consumer*

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1. Introduction

Malaysia's electricity utility company, Tenaga Nasional Berhad (TNB) introduced a new tariff scheme for industrial customer, known as Enhanced Time of Use (EToU). EToU scheme introduced three different rates for electricity consumption rather than only two in conventional ToU scheme. It is consists of Peak, Mid-peak and Off-peak [1]. These rates are applied differently between weekdays and weekend. Maximum charge is waived during weekend. EToU is purposed to encourage customer to use less electricity during peak hour that can reduce their electricity expenses. However, increment of electricity expenses might occur if customer fails to shift their consumption into lower rate hours and causing higher usage during peak hours. Customer must be able to analyses their daily consumption carefully in order to achieve the benefit. This paper analyse the impact of the new EToU scheme on the electricity bill of two different industrial customers with different load profile. It will help customers to identify the benefit of the EToU scheme and decide whether to switch into the scheme or remain to the old TOU scheme.

This paper consists of 5 sections. Concept of ToU is discussed in Section 2. The detail of industrial customer in Malaysia is explained in section 3. The case study and the result obtained for industrial customer using EToU is presented in section 4. Lastly, section 5 concludes the paper.

Basically, electricity demand would be very high when the customers using the appliances at the same time. Based on the theories, the higher the power transmitted, the higher the values of resistance that exist throughout the system. This scenario is known as the peak period and this would lead to the increment of the utilities cost as well as the total transmission loss [2].

Throughout the day or season, there would be peak and off-peak period. In fixed tariff program, higher tariff would be implemented in order to cover on the utility cost and the total loss. This gave disadvantage to both utility and customer at the same time. The disadvantage could be solved by few types of time-based electricity tariff. One of the types is known as Real-Time pricing (RTP). This type of time-based electricity tariff reflects the current electricity market

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structure. It is a dynamic rate where it is designed to reflect the balance of supply and demand. Each day, every hour gives different prices that is according to the real market clearing price [3]. On the other hand, ToU is defined as a long term pricing method that gives different prices based on time of day. This method reflects only in long term electricity power system cost [3]. ToU works when there is load shifting accurately done by customer. Load shifting is the method where customers were encouraged to change their time of electricity usage according to the electricity price implement by the utility in daily period so that the electricity demand could be stabilized throughout the day. However, both electricity tariff, RTP and ToU have their own advantages as well as the drawbacks of each system. Table 1 summarize on the advantages and disadvantage of both RTP and ToU electricity tariff [4].

In order to encourage the customer to shift their electricity usage, a good price signal should be obtained accurately. Time of use electricity tariff program is one of the price signals that should be implemented by utility for the customer. Time of use consist of different electricity price in different periods of time. Smart metering system is given to the customer to enable them to track their electricity usage based on the announced price that is given by utility form time to time [3]. The role of this metering system is critical as it gives the customer idea on how they can plan their electricity usage based on their appliances consumption. In a simple time of use program, the period blocks in a day only divided into two known as peak and off-peak period. Higher price would be given to the peak period while lower price can be obtained in the off-peak period [3]. The indication of the price is based on the average electricity price.

The signal price given in the time of use program essentially purposed to ensure the load shifting to be success. The expected outcome of the time of use program is that it should encourage the customers to shift their consumption to the period with lower price of electricity. By this change, the total consumption during the peak period and off-peak period can be stabilized that could give the average cost needed for the utility. The ToU rates will always depend on the daily load consumption of customers. Different rates are usually given to residential, commercial and industrial customer.

Table 1. Advantages and Disadvantages of Time-Based Electricity Tariff [4]

Time-based Electricity Tariff	Advantages	Disadvantages
Real-Time Pricing (RTP)	*Possibility of good planning for customer *Integration of renewable energy sources (RES) can be supported	*More complicated to be implement *Peak demand is risk to increase *Accurate communication and metering is needed
Time Of Use (ToU)	*Possibility of good planning for customer *Implementation is easy	*Reflection on the supply/demand is limited *Integration of renewable energy sources (RES) support is limited

2. Research Method

Industrial customer typically divided into few categories. It is defined by the electrical usage in their premises. The definition of each category is being explained in Table 2:

Table 2. Categories of Industrial Tariff [1]

Tariff Categories	Usage
D	Low Voltage Industrial Tariff
Ds	Special Industrial Tariff (For Consumers Who Qualify Only)
E1	Medium Voltage General Industrial Tariff
E1s	Special Industrial Tariff (For Consumers Who Qualify Only)
E2	Medium Voltage Peak/Off-Peak Industrial Tariff
E2s	Special Industrial Tariff (For Consumers Who Qualify Only)
E3	High Voltage Peak/Off-Peak Industrial Tariff
E3s	Special Industrial Tariff (For Consumers Who Qualify Only)

Industrial customers that consume high voltage electricity are categorized in E3 customer. This paper focused on the customer with E3 categories and analyses the impact of changing into EToU scheme according to their daily usage in the case study. Table 3 and 4 presented the period block of ToU and electricity prices that has been used for industrial customer in other countries as well as the period block and electricity prices that is being implemented in EToU scheme. The comparison between old ToU scheme and EToU for industrial customer with E3 category is shown in Table 4.

Table 3. ToU Period Blocks in Selected Countries [5-9]

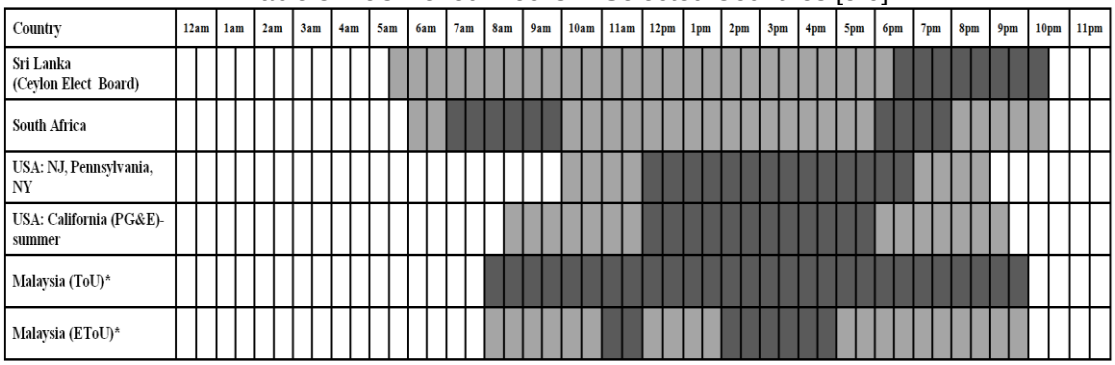

Table 4. ToU Prices in Selected Countries

No	Country	Time of Use Electricity Details	
		Period	Price
1	Sri Lanka (Ceylon Electricity Board) [9]	Peak	Rs23.00/kWh
		Mid-Peak	Rs7.30/kWh
		Off-Peak	Rs5.30/kWh
2	South Africa [6]	Peak	c24123/kWh
		Mid-Peak	c7774/kWh
		Off-Peak	c4526/kWh
3	New Jersey, Pennsylvina, New York (Orange & Rockland) [8]	Peak	$1.29/kWh
		Mid-Peak	$1.29/kWh
		Off-Peak	$0.113/kWh
4	California (PG&E) [7]	Peak	$0.25/kWh
		Mid-Peak	$0.23/kWh
		Off-Peak	$0.20/kWh
		Peak	-
		Mid-Peak	$0.22/kWh
		Off-Peak	$0.19/kWh
5	Malaysia (ToU) [5]	Peak	RM 0.337/kWh
		Mid-Peak	RM 0.202/kWh
	Malaysia (EToU) [5]	Peak	RM 0.39/kWh
		Mid-Peak	RM 0.31/kWh
		Off-Peak	RM 0.202/kWh
	*Industrial customers at high voltage (tariff E3)		

3. Results and Analysis

This paper is the first to discuss on the EToU electricity tariff introduced by TNB Malaysia. Hence, the comparison for this case study can on only be done according to the simulation of load profile of few customers and the data received from TNB on the rate of EToU

electricity tariff. Case study for this paper uses the data of load profile from two type of industrial customer. The first case study involve an oil and gas factory located in northern region of Malaysia; while the other one is a manufacturing factory located in southern region of Malaysia.

3.1 Case Study 1

Figure 1 shows the hourly electricity consumption of the building from an oil and gas factory during weekdays and weekend. A selected Monday is selected as the weekday data while Saturday as weekend data. To ease the calculation, it is assumed that the profile for weekdays and weekends are the same throughout a month. It can be seen that the electricity consumption for this building does not provide a specific pattern as the hourly consumption is observed high and low at a random point of the day. The highest consumption is during weekend. This shows that this building is operating regularly throughout the month without implementing any working hour.

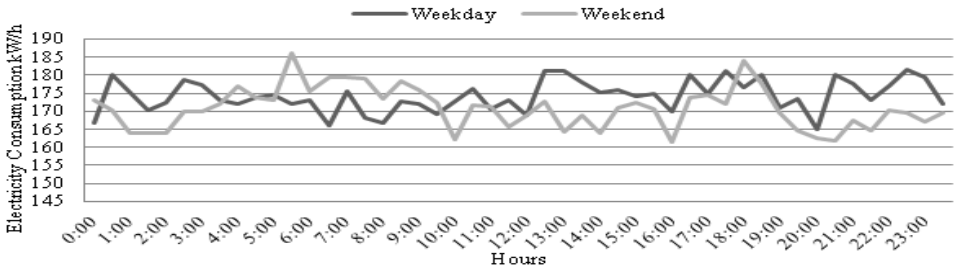

Figure 1. The Hourly Electricity Consumption of an Oil and Gas Factory

The hourly electricity consumption is then being analysed using the ToU and EToU data from TNB and the monthly total electricity bill is then being compared in the bar chart shown in Figure 2.

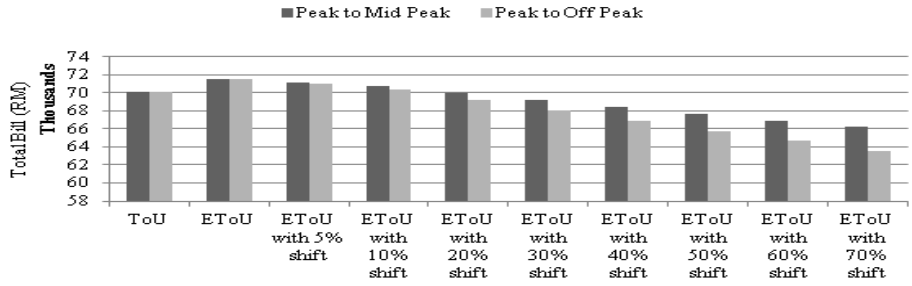

Figure 2. Electricity Bill Comparison for Oil and Gas Factory for ToU and EToU with and without load shifting

Figure 2 shows the electricity bill based on the customer usage from Figure 1. The horizontal axis of the bar chart is defined as the electricity scheme used by customer together with their total load shifting in a month. For example, ToU is defined as the customers' total bill when customer used ToU scheme while EToU with 5% shift is defined as the customers' total bill when customer change into EToU scheme and shift 5% of their total load from peak period into mid-peak period. In the bar chart, it is shown that the customer can opt to change into EToU scheme if they can shift 20% of their electricity consumption during peak period into mid peak period. This is because it can be observed that when a customer change from ToU into EToU scheme without shifting their electricity usage period from peak to mid peak or from peak to off peak, the electricity bill gives higher amount than the ToU electricity bill. Greater amount of

saving can be achieved when customer able to shift their usage period during peak hour to off peak period.

3.2. Case Study 2

Case study 2 presents the electricity consumption pattern of a manufacturing factory. This customer consumes higher range of electricity compare to customer in case study 1. Figure 3 illustrates the hourly electricity consumption of the manufacturing factory.

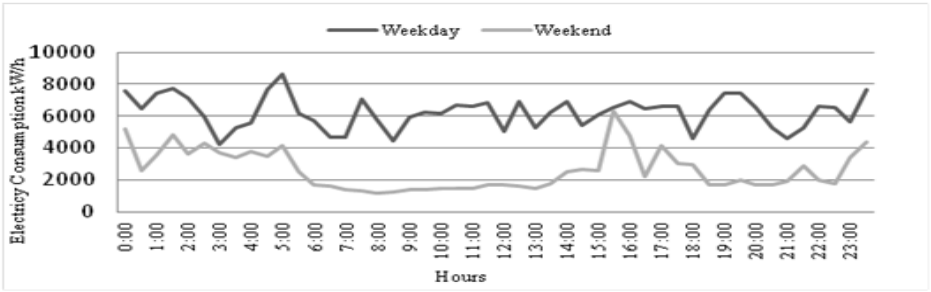

Figure 3. The Hourly Electricity Consumption of a Manufacturing Factory

The electricity consumption during weekday is observed higher compare to weekend consumption. The highest electricity consumption is during working hours. While during weekend, the electricity consumption remains lower than weekday throughout the day. This shows that this factory operates mainly during weekday. The electricity consumption data is then being analyses into monthly electricity bill and the comparison of the data is shown in Figure 4.

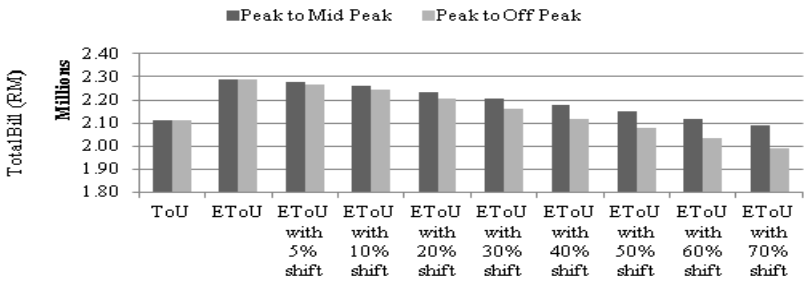

Figure 4. Electricity Bill Comparison for Manufacturing Factory for ToU and EToU with and without load shifting

The horizontal axis of the bar chart in Figure 4 is defined as the electricity scheme used by customer together with their total load shifting in a month. For example, ToU is defined as the customers' total bill when customer used ToU scheme while EToU with 5% shift is defined as the customers' total bill when customer change into EToU scheme and shift 5% of their total load from peak period into mid-peak period. Based on Figure 4, if customer change into EToU scheme without making any load shifting, it will gives higher electricity bill. Load shifting of minimum 70% from peak to mid peak is required in order for the customer to gain saving of RM20325.61 from the old ToU scheme's electricity bill. When shifting the electricity consumption from peak to off peak, only 50% of the load needed to be shift in order to gain lower electricity bill. This would mean that this customer needs to change most of their working hour in order to gain benefit from the EToU program. Based on the assessment, the customer is advised to stays with the old ToU scheme if they are unable to shift their electricity consumption during peak period to mid peak or off peak period.

4. Conclusion

The paper is focused on helping customer to choose to change into new EToU scheme or stick with the old ToU scheme. The finding has compared the electricity bill for ToU and EToU scheme for two industrial customers. Based on the result, it can be seen that an industrial customer can change into EToU scheme if they can shift their load consumption from peak to mid peak according to their load profile. More comprehensive research can be done in order to analyses more method that can help customer in choosing the scheme based in their daily load profile.

Acknowledgements

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