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A STUDY ON THE COST OF OUTAGE (ELECTRICAL ENERGY NOT SERVED) IN SELANGOR AND WILAYAH PERSEKUTUAN (WP) KUALA LUMPUR

by

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ABSTRACT

This study involves determining the cost of outages (electrical energy not served) in WP Kuala Lumpur and Selangor. The cost of outage calculations was made for Peninsular Malaysia's major electricity consumers, i.e. the residential, commercial, industrial and mining sectors. The type of outage losses for each consumer group was ascertained. A survey was conducted to obtain the necessary data for the calculations. Samples were taken from districts or mukims in WP Kuala Lumpur and Selangor based on type-of-house for the residential sector, business categories for the commercial sector, type-of-product manufactured for the industrial sector and tin mining companies in operation.

Keywords: Cost, Outage, Selangor, Kuala Lumpur, Consumer Groups, Commercial Sectors.

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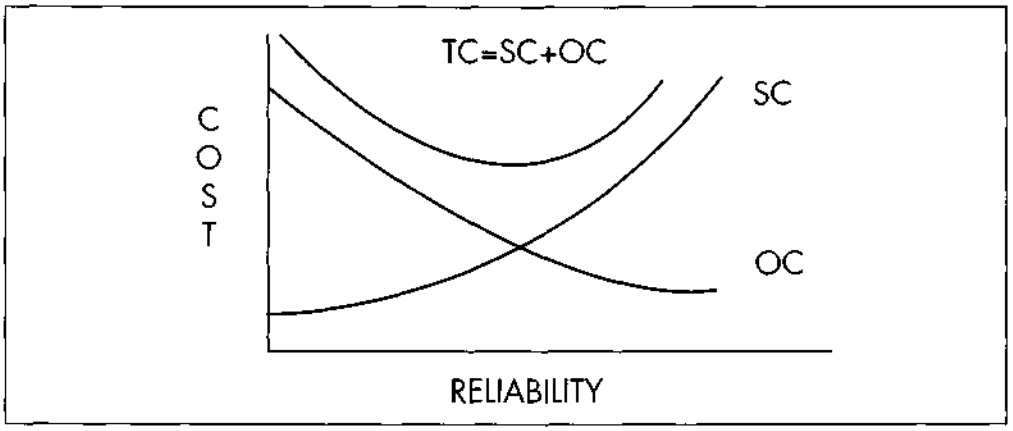
INTRODUCTION

Demand for electric power continues to increase each day. Electric utility companies must plan carefully to meet the ever increasing demand in terms of quantity as well as quality. The amount of electrical power interruptions or outages experienced reflect the quality and the reliableness of the electric power system. It is desirable that the social and economic cost of outages be balanced with the cost of having a reliable electric system as depicted in the following graph (Munasinghe, 1980).



To strike this balance the reliability level should optimally be where the incremental systems cost (SC) required to improve reliability and the incremental outage cost (OC) incurred are equal. This is the point where the total cost for optimum system investment is at a minimum (Total Cost(TC)= SC + OC) (Munasinghe, 1980; Team Consulting Engineering, 1986).

Besides being used as a balancing component, the cost of electric power outage can help utility planners establish reliability standards in generation, transmission and distributing planning, optimise power system, in power system operations and in determining pricing policy (Munasinghe, 1990).

This research project is an effort to determine the cost of outage in Malaysia. A study was conducted on Peninsular Malaysia's major electricity consumers, which are the residential, commercial, industrial and mining sectors (TNB Research, 1992). Since this was a pilot attempt, the study focussed on only two states, i.e WP Kuala Lumpur and Selangor. These two states were favourable choices since 40% of Peninsular Malaysia's electrical load is concentrated there.

GENERAL WORKPLAN

Our study on each electric consumer sector, i.e. residential, commercial, industrial and mining, covers the following five stages:

a. Cost Outage Derivation and Questionnaire construction
b. Pilot Survey
c. Questionnaire Review
d. Actual Survey
e. Data Compilation and Computation

Four sets of questionnaires, one for each sector, were used. Numerous discussions were held before and after the pilot survey in order to ready the questionnaires for the actual survey.

The survey areas for WP Kuala Lumpur are: Sek 1-100, Batu, Setapak, Kuala Lumpur and Petaling & Cheras. In Selangor they are: Shah Alam, Sepang, Petaling Jaya, Gombak, Kelang and Sabak Bernam. The following aspects were taken into consideration in selecting the above samples:

1. Multi-racial community
2. Development of the district
3. Location of the district

The areas were identified based on:

1. The Property Market Report
2. The Federation of Malaysian Manufacturers Handbook (FMM)
3. Interviews with officers from the Department of Valuation and Property Services Selangor
4. Maps

The respondents for the residential sector were chosen based on selected districts or mukims and the type of house, i.e. Bungalow, Semi-Detached houses, Terrace (Single/ Double Storey) houses, Apartments, Flats or Village (Kampung).

The commercial samples were selected from the following categories: Restaurants, Petrol Service Stations, Supermarkets, Department Stores, Hospitals, Banks, Educational Institutions, Consultancy Firms, Hotels and Others in the selected districts/mukim. The 'Others' category contains all the other types of commercial establishments not mentioned in the other nine categories, such as sundry shops, bakeries, laundrette services, and etc.

Samples for the industrial sector were selected based on the type of product they manufacture. These categories were obtained from the Federation of Malaysian Manufacturers Handbook 1991.

Five mining establishments in WP Kuala Lumpur and Selangor were enlisted for this study.

OUTAGE COST CALCULATIONS

Outage losses can be classified as direct or indirect (Berries, 1983). Direct losses are losses directly incurred during an outage due to the slowing down or termination of productivity. Indirect losses are costs incurred in reducing outage loss such as the cost for running a backup power supply.

For the residential consumer, direct losses may comprise of refrigerated food losses, spoilages of half cooked food and damage of electrical appliances whilst indirect losses involve the costs for alternative lighting and inconveniences experienced by the household during their leisure hour (time free from work) when they choose to stay at home but have to go out instead.

The household electricity related activities can be divided into leisure activities, such as watching television,reading,playing video games, etc., and household chores, such as cleaning using the vacuum cleaner, washing clothes using the washing machine, cooking using the rice cooker, etc. During power outages the leisure activities would be the most affected since household chores could be rescheduled to another time (Munasinghe, 1980). Other losses may come from spoiled refrigerated food or spoiled-while-cooking food. Electrical appliances may also be damaged. The household might also have to spend on candles or some other lighting source.

The quantifiable losses of the residential outages are identified as follows:

i. Leisure Losses (LL)
ii. Refrigerated Food Losses (RF)
iii. Spoiled-while-cooking Food Losses (SPF)
iv. Damages of Electrical Appliances (AL)
v. Alternative Lighting Source (ALS)

The LL are time dependent which meant that the longer the power outage the bigger the LL would be. Whereas the RF, the SPF and AL are time independent values that are directly cited by the customer for a given outage. The ALS is time dependent but quite difficult to quantify because people do not normally keep track of their ALS costs.

The LL for each household is obtained by getting the value of leisure of the household for one hour and multiplying it with the duration of power failure. In this study the leisure value is attributed only to those people with an income and their dependents. The money available for leisure is the income after subtracting personal and dependent relief as given for income tax deduction. Of course this varies with each person. This study uses the average income of the respondents in WP Kuala Lumpur and Selangor, i.e. about RM1600 as calculated from this study. The income value can also be tailored to each customer's income, but the outage value obtained after considering this factor does not show much discrepancy.

Using the average number of occupants in Malaysia, that is five from the 1990 consensus and assuming that a typical family consists of the father, mother and three school going

children, the average percentage of income used for leisure is calculated as the following:

$$\% \text{ Income for Leisure: } \frac{\text{Yearly Income - Personal \& Dependent Relief}}{\text{Yearly Income}}$$

$$: \frac{(1600 \times 12) - 5000 - 3000 - (800 \times 3)}{1600 \times 12} \times 100\%$$

$$: 45.8\%$$

whereby
- RM 1600 – household income of an average respondent
- RM 5000 – Income tax personal relief
- RM 3000 – Income tax wife relief
- RM 800 – Income tax child relief (one child)

Therefore, the percentage of income available for leisure is about half of the total income value. This value is an average estimate. To get the leisure value per hour, the person's income value per hour is calculated and multiplied by 0.458. The LL is therefore the leisure value per hour multiplied by the duration of power failure during 7.00 pm to 12.00 pm since the residential consumers are assumed to have most of their leisure hours in the evening (Munasinghe, 1980).

The total cost of outage for the residential sector is defined as:

Time Dependent Loss (RM/kWh) (TDL) + Time Independent Loss (RM) (TIL)

where; –
$$TDL = \frac{\Sigma \text{ LL (RM)} - \Sigma \text{ S (RM)}}{\Sigma \text{ (PD x DPF) kWh}}$$

- $TIL = [\Sigma \text{ SPF} + \Sigma \text{ RF} + \Sigma \text{ AL}]$(RM)
- S : Savings from the electricity bill
- LL : Leisure Loss, – SPF: Spoiled-while-cooking Food Loss
- RF : Refrigerated Food Loss, – PD : Peak Demand (kW)
- AL : Damages of Electrical Appliances
- DPF : Duration of Power Failure

As with the residential sector, the commercial sector's losses could also be described as direct losses and indirect losses. Direct losses encompass revenue, wages, rent, and spoilage of goods and indirect losses include the cost of using power backup system. The commercial sector losses are also divided into time dependent and time independent

losses. The time dependent losses include operations loss(OL), sales loss(SL) and backup fuel cost(BC). Time independent losses are fixed losses incurred during an outage irrespective of the outage duration, which include goods/equipment loss(GL) and restart cost(RC).

The total cost of outage for the commercial sector is:

Time Dependent Loss (RM/kWh)+ Time Independent Loss (RM)
(TDL) (TIL)

where; – $$TDL(RM/kWh) = \frac{\sum OL + \sum SL + \sum BC - \sum S}{\sum (PD \times DPF)}$$

$$TIL\ (RM) = \sum GL + \sum RC$$

- S : Savings from the electricity bill
- OL : Operations Loss, – SL : Sales Loss
- BFC : Backup Fuel Cost, – PD : Peak Demand (kW)
- DPF : Duration of Power Failure

Two types of outages are defined for the Industrial sector, i.e outages with or without prior notice from the electric utility company. If an outage is announced by the utility company in advance, production can be rescheduled, resulting in a lesser loss by the industrial company. The type of losses differ from one industrial company to another based on the type of product(s) produced. However, the type of losses commonly incurred by industries when there is no prior notice given by the utility company are: Production, Material, Equipment, Rental, Recovery, Net opportunity(profit/revenue) and Contract sales.

On the other hand, if there is advance notice of outage given, the production and material losses can be deterred. In this study, the industrial sector's outage losses are categorized in terms of normal condition losses and maximum condition losses. Normal condition losses are losses that have not reached its maximum, i.e. if the duration of outage is prolonged the losses would increase. Maximum condition losses on the other hand, are losses that have reached its maximum, i.e. if the duration of outage is prolonged the cost would still be the same. These two types of losses are further divided into Time Independent Losses (TIL) and Time Dependent losses (TDL). For the industrial sector, there are several parameters that can be considered as TIL, for example computer data/program, damage of equipment, etc. In this study, only the damage of equipment loss is taken into consideration because it can be easily quantified.

The Normal Condition Losses (TDL + TIL):

$$TDL(RM/kWh) = \frac{\sum NP + \sum PC + \sum RL + \sum BFC - \sum S}{\sum (MD \times DPF)}$$

where :

- NP : Net Opportunity loss,
- RL : Recovery Loss,
- S : Saving
- MD : Maximum Demand(kW)
- PC : Production Cost
- BFC : Backup Fuel Cost
- DPF : Duration of Power Failure

TIL (RM) = Σ EL, where : EL = Equipment Losses

The Maximum Condition Losses (TDL + TIL):

$$TDL(RM/kWh) = \frac{\Sigma NP + \Sigma PC + \Sigma BFC - \Sigma S}{\Sigma (MD \times DPF)\ kWh}$$

where : All parameter are the same as normal loss except Σ DPF (Σ DPF is the Maximum loss)

TIL(RM) = Σ EL + Σ UNEC

where : - EL: Equipment Losses
- UNEC = ML + RSL + CSL + OL

where :

ML = Material Loss
RSL = Restart Loss
CSL = Contract sales loss
OL = Other Loss

In developing the mining outage calculation the following factors were considered:

i) The down time lost in production caused by power outage could not be recovered because all mining companies operate 24 hours a day. Whatever losses they incur in a day could never be recovered.

ii) The tin ore price varies from one day to the other based on the commodity price index in Kuala Lumpur Stock Exchange market. The total cost loss due to outage will be dependent on this.

iii) There are basically two modes of dredging operation, i.e Stripping mode and Treating mode Stripping mode (digging soil from ground until ore level) does not require much electricity supply compared to treating mode (digging at ore level and separating the ore from soil).

iv) There is no normal loss in the mining sector, all losses are a maximum loss.

Based on the above information the outage cost formula for the mining sector was developed. The TDL and TIL values are shown below:

$$TDL(RM/kWh) = \frac{\Sigma LR + \Sigma RC + \Sigma BFC + \Sigma UC - \Sigma S}{\Sigma (MD \times DPF)}$$

Where:

- LR : Loss Revenue,
- BFC : Backup Fuel Cost,
- S : Savings,
- DPF : Duration of Power Failure
- RC : Rental Cost
- UC : Utility Cost
- MD : Maximum Demand(kW)

TIL(RM/ Interruption) = Σ EL

Where : EL = Equipment loss

Based on the parameters above four set of questionnaires were developed, one for each consumer sector.

RESULTS

The breakdown of respondents for the sectors is summarised in Tables 1,2,3,4, and 5. The number of respondents for the residential sector was 577. On the other hand a total of 231 samples was accepted from the commercial sector.

Table 1 Breakdown of the Residential and Commercial Respondents in Selangor

Areas	Residential		Commercial	
	Sample	%	Sample	%
Shah Alam	46	15.44	34	24.29
Petaling Jaya	36	12.08	10	7.14
Klang	65	21.81	28	20.00
Gombak	28	9.40	16	11.43
Sabak Bernam	73	24.50	29	20.71
Sepang	50	16.78	23	16.43
Total	298	100	140	100

Table 2 Breakdown of the Residential and Commercial Respondents in WP Kuala Lumpur

Areas	Residential		Commercial	
	Sample	%	Sample	%
Kuala Lumpur	75	26.88	31	34.07
Batu	51	18.28	18	19.78
Setapak	52	18.63	19	20.88
Petaling & Cheras	37	13.26	15	16.48
Sek 1-100	64	22.94	8	8.79
Total	279	100	91	100

Table 3 Breakdown of the Commercial Respondents based on Business Category

	Categories	Selangor		W Persekutuan	
		Sample	%	Sample	%
1	Restaurants	15	10.71	9	9.89
2	Petrol Ser. Stations	11	7.86	11	12.09
3	Supermarkets	5	3.57	6	6.59
4	Departmental strs	6	4.29	3	3.30
5	Hospital or clinics	14	10.00	15	16.48
6	Banks	3	2.14	10	10.99
7	Educational Ins.	8	5.71	6	6.59
8	Consultancy firms	34	24.29	10	10.99
9	Hotel or motels	4	2.86	1	1.10
10	Others (eg. grocery, bookstore, laundry et)	40	28.57	20	21.98
	Total	140	100	91	100

For the industrial sector, the number of completed questionnaire was 60. The response received through mailing and follow-up telephone appointments was quite bad, with 15 respondents out of 115. However, the response to direct telephone contacts for appointments was fairly good with 45 questionnaires received out of 127 attempts. Out of the 60 completed questionnaire, only 33 were accepted for use in the outage calculations (see Table 5).

A total of 4 out of 5 mining companies responded to the survey (two in Sepang, one in Kuala Selangor and one in Kuala Langat).

The cost of outage value for each sector had been determined through the methods discussed above. Table 6,7,8 and 9 shows the respondents average duration of outage and frequency for the last three months prior to the survey.

The highest loss incurred in the residential sector was the leisure loss. Spoiled-while-cooking food loss, refrigerated food loss and damages of electrical appliances were rather minimal.

Sales losses in the commercial sector were experienced most by the Petrol Service Station and Departmental Store categories. Findings also show that Hotels, Petrol Service Stations, Hospitals and Restaurants do considerably invest in backup power system.

In the industrial sector the Food, Beverage and Tobacco category had the highest outage value for normal condition losses as well as for maximum condition losses. The Electrical / Electronic Product, Fabricated Metal Product and Textile & Leather Industry categories also show a significant outage loss at maximum condition losses.

Table 4 Breakdown of the Industrial Respondents based on Type of Product

No	Industrial Products	Ref Pages	Selangor						Kuala Lumpur					Total
			S. Alam	P. Jaya	Klang	Gombak	S. Bernam	Sepang	K. Lumpur	Batu	Setapak	P & CHRs	Sek 1-100	
1	Food, Beverage And Tobacco	55–100			1					1				2
2	Textile, Wearing Apparel And Leather Ind	101–119	1											1
3	Wood And Wood Products, Including Furniture	120–136			1									1
4	Paper And Paper Products, Printing and Publishing	137–148								1				1
5	Chemical And Chemical Products	149–220	1	2	1									4
6	Rubber Products	149–220			0	1				1				2
7	Plastic Products	149–220		2		1				1			1	5
8	Non-Metallic Mineral Products	221–248	1		0									1
9	Basic Metal Products	249–262		1	1					1				3
10	Fabricated Metal Products	263–317	3	1	2									6
11	Electrical and Electronic Products	318–381	3	1	2						1			7
	Total		9	7	8	2	0	0	0	5	1	0	1	33

Table 5 Breakdown of the Mining Respondents

No	District	No of Samples
1	Sepang	2
2	Kuala Selangor	1
3	Kuala Langat	1
	Total	4

Table 6 Average Outage Duration and Frequency in 3 months (Residential)

District or Mukim	Time Out hr	Frequency	District or Mukim	Time Out hr	Frequency
Setapak	3.94	2	S. Bernam	7.4	3
Batu	4.23	2	Sepang	3.8	2
K. Lumpur	1.28	1	Shah Alam	3.6	2
Sek 1-100	2.78	2	Gombak	6.1	2
P/Cheras	2.05	1	Klang	3.8	2
W. P.	2.86	2	P. Jaya	3.0	1
			Selangor	4.6	2

Table 7 Average Outage Duration and Frequency in 3 months (Commercial)

District or Mukim	Time Out hr	Frequency	District or Mukim	Time Out hr	Frequency
Setapak	1.99	1	S. Bernam	3.8	3
Batu	2.20	1	Sepang	3.8	2
K. Lumpur	1.87	1	Shah Alam	2.8	2
Sek 1-100	4.42	2	Gombak	2.4	1
P/Cheras	1.68	1	Klang	3.8	3
W.P.	2.03	1	P. Jaya	2.2	2
			Selangor	3.2	2

Table 8 Average Outage Duration, Startup time and Frequency (Industrial)

MAXIMUM CONDITION

No	District	No of Samples	Outtime (Hrs)	Startup (Hrs)	Frequency
1	Shah Alam	1	4.83	1	1
2	Petaling Jaya	4	24.41	34.38	3
3	Klang	6	28.14	18.67	1
4	Gombak	1	1.67	1.91	1

No	District	No of Samples	Outtime (Hrs)	Startup (Hrs)	Frequency
1	Batu	2	9.84	3.33	2
2	Sek 1-100	1	33.45	5.00	1

NORMAL CONDITION

No	District	No of Samples	Outtime (Hrs)	Startup (Hrs)	Frequency
1	Shah Alam	7	17.67	9.5	1
2	Petaling Jaya	5	10.58	1.25	3
3	Klang	2	22.64	7.01	1
4	Gombak	1	2	0.25	1

No	District	No of Samples	Outtime (Hrs)	Startup (Hrs)	Frequency
1	Batu	2	23.77	0.15	2
2	P/Cheras	1	4.25	0.67	1

Table 9 Average Outage Duration, Startup time and Frequency (Mining)

No	District	No of Samples	Outtime (Hrs)	Startup (Hrs)	Frequency
1	Sepang	2	15.42	2.63	4
2	Kuala Selangor	1	15.37	3.33	3
3	Kuala Langat	1	2.21	0.62	2

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