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Electricity Tariffs in Thailand: Structure, Objectives and Impact on System Load

Thirapong Vikitset*

Electricity was first introduced to Thailand during the reign of Rama V in 1882. It is now an indispensable source of commercial energy for an expanding economy. During the past 13 years, the peak demand for electricity increased from 2,101 MW in 1978 to 7,093 MW in 1990 which is equivalent to a compound rate of increase of approximately eleven per cent per annum (EGAT's Power Development Plan, 1990). The generating capacity expanded from 2,818 MW to 7,986 MW during the same period to satisfy the growing demand for electricity.

Rapid expansion in the power network necessitates an increasing allocation of resources into the power sector. At present the power sector has the largest share of total investment in the energy sector. As more resources are diverted into the power sector, the policy issue of resources allocation becomes increasingly more important. Once the policy is determined, it may be implemented through the power tariff, an effective instrument of resource allocation for the power sector.

The purpose of this paper is to discuss the relevant issues behind the current power tariff structure implemented on June 1, 1987. The paper begins with a discussion on the objectives of the power tariff followed by a summary of methods and guidelines for translating these objectives into an implementable power tariff. Finally, discussions of observable impacts on the system load and the trend in the future tariff development complete the paper.

*Associate Professor, School of Development Economics, National Institute of Development Administration.

A. OBJECTIVES OF THE POWER TARIFF

The objectives of the power tariff are interdisciplinary in nature which makes them susceptible to inconsistencies (Anderson and Turvey, 1977, and Munasinghe, 1982). These objectives may be classified as economic, financial, and sociopolitical. While there are quantitative indices for the economic and financial objectives, the sociopolitical objectives are rather abstract which, inevitably, introduces complexity into the implementation of the policy package. The weighting problem of each classification of objectives becomes an important policy issue to be resolved and translated into the tariff.

B. ECONOMIC OBJECTIVE

The economic objective emphasizes the efficiency aspect of the power tariff. An efficient power tariff is such that it maximizes the net benefit of a country. The benefit accrues to consumers as well as producers in terms of the consumer surplus and producer surplus[1]. An efficient power tariff may be derived from marginal cost pricing, the scope of which may be expanded to reflect the cost differences of electricity generation, transmission and distribution due to factors such as geographical location, time of day, and seasons[2]. Marginal cost pricing, the basis for designing an efficient tariff, also introduces a sense of 'economic equity' and some stability into the structure. Economic equity hinges on the concept that each consumer is charged according to his imposition on the power system cost from his electricity usage. Thus, a peak period consumer is charged more for electricity than an off-peak consumer.

Some stability is also built into the structure by spreading the power capacity investment, the bulk of the power system cost, evenly during the planning period[3]. This is translated into demand charges for the power consumers. In addition, the marginal cost tariff promotes energy conservation by sending correct economic signals to end users.

Deviations from an efficient tariff for whatever reasons will result in a deadweight loss which involves the redistribution of benefits between consumers and producers.

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[1] The distribution of benefit depends upon the nature of demand and supply and is not an efficiency issue.

[2] The benefits must, of course, be weighed against the cost of metering, administration, and the customers' costs of adjustment

[3] Assuming no unforseen event such as a major energy shock.

C. FINANCIAL OBJECTIVE

The financial objective is concerned with reinvestment in the power system. Expansion of the power system is dynamic and involves sizable amount of investment relative to the other energy sources. In an extreme case of 'free electricity', investment must be financed entirely by accumulating debt which exerts pressure on the country's financial stability. On the other hand, investment in the power system is too large to be financed entirely from the tariff revenue so that an 'appropriate' debt/equity ratio must be determined.

The financial rate of return or the self financing ratio are indicators for the financial criterion. In practice, there are some difficulties in applying either indicator (Collier, 1984). Their numbers are rather arbitrary and depend upon the fiscal condition of the country and/or the requirement of the creditor. The power tariff implemented in 1987 was required by the World Bank to generate at least an eight percent rate of return on revalued assets (Lorchirachoonkul and Vikitset. 1986).

D. SOCIOPOLITICAL OBJECTIVE

The sociopolitical objective depends upon the philosophy of the policy makers. Generally, the objective may be loosely stated that the tariff must be 'acceptable' and 'convenient' in implementation. In the case of the 1987 tariff the policy guidelines are:

(1) The retail tariff for a given group of customers will be uniform throughout the country. This requirement rules out the possibility of reflecting the cost differences in electricity generation and distribution between different regions of the country.

(2) The residential group's tariff is to be lower than the small business group's tariff.

(3) The manufacturing and mining groups' tariffs are to be lower than the large business group's tariff.

(4) Increases in the power bills of small customers such as a small residential customer are to be minimized.

(5) The large power customers should be able to reduce their power bills by improving the efficiency of their power usage or their load factors.

E. BLENDING THE OBJECTIVES

It is difficult or impossible to design a power tariff that satisfies all of the objectives. There are likely to be inconsistencies especially between economic and sociopolitical objectives. The inconsistency between economic and sociopolitical objectives stems largely from the structure of the existing tariff before the revision. The more distortions are inherent in the existing structure, the more likelihood there is of inconsistency between these two objectives.

There are likely to be consistencies between economic and financial objectives for an increasing cost power system since the system marginal cost is above its average cost. However, a declining cost power system characterized by large initial investment followed by smaller increments of investment may experience financial difficulties from marginal cost pricing.

The economic cost of deviations from a perfectly efficient tariff which is derived from marginal cost pricing may be measured in terms of welfare or deadweight loss which involves a transfer between consumer surplus and producer surplus. On the other hand, a tariff generating revenue that deviates from the financial target may result in a larger debt burden for the country or forced savings by the customers depending upon whether the generated revenue is below or above the financial target. The costs of a tariff that deviates from the sociopolitical guidelines are more difficult to gauge since it involves 'political transfer' such as loss of parliament seats and administrative power. The blending or trading off between these three objectives has an element of art since there are no hard and fast rules to follow. Whatever the final outcome, the structure will be characterized by some cross subsidies or transfers between different groups of customers and also between customers and power producers. It is the weight given to each affected group that determines the tariff structure that is consistent with the 'integrated' tariff policy.

Since an efficient tariff may be readily quantified, it is convenient to base the design of the tariff initially on the efficiency criterion. The tariff may then be tested for consistency with the financial and the sociopolitical objectives. The 'benefits' of adjusting the efficient tariff for other objectives may then be weighed against the welfare or the deadweight loss.

F. ORGANIZATION OF THE POWER SECTOR

Currently, the power sector in Thailand is organized around three power authorities, each with a state enterprise status. The Electricity Generating Authority of Thailand (EGAT) is responsible for electricity generation and transmission with its network covering all regions of Thailand[4]. EGAT sells its electricity at the bulk level to the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA) which, in turn, sell their purchased power at the retail level to end users.

MEA is responsible for power distribution in the Bangkok Metropolitan area and the small neighboring provinces of Samutprakarn and Nonthaburi while power distribution for the other provinces is under the responsibility of PEA.

MEA's relatively small service area is characterized by high consumer density which is in contrast to PEA's much larger service area. The different coverage of service areas results in relatively lower distribution costs for MEA.

G. DESIGN OF THE POWER TARIFF

Design of the power tariff is based initially on the efficiency criterion. Marginal cost pricing of the power system where costs and benefits are shadow priced will achieve maximum net benefits to a country which satisfies the efficiency criterion.

There are basically two periods to be considered for the marginal cost pricing exercise. The short run marginal costs are the costs of meeting a marginal increase in electricity consumption with fixed capacity while the long run marginal costs are the costs of meeting a marginal increase in electricity consumption, sustained indefinitely into the future (Munasinghe, 1982). The definition of long run marginal costs assumes that the power producer has complete flexibility to plan for the expansion of an appropriate mix of power plants to satisfy the forecasted increases in power demand.

If the outage costs caused by increasing demand pressure on the system capacity in the short run could be estimated, then the capacity expansion will be optimum when the marginal savings of reduced outage costs due to capacity expansion equal the marginal costs of capacity expansion. Theoretically, the optimum capacity expansion condition implies that the short run marginal costs are equivalent to the long run marginal costs.

[4] EGAT buys a negligible amount of electricity from the Lao People's Democratic Republic and Malaysia while PEA also generates a small amount of power from its diesel, mini and micro hydro plants.

In practice, it is unlikely that the short run marginal costs will be equivalent to the long run marginal costs. It may be convenient to estimate the marginal costs on the long run basis based on the power producer's development plan. This is a forward looking concept which will provide appropriate economic signals to the customers of their imposition on the system costs. However, there are difficulties in estimating a fairly accurate long run marginal cost since a very long planning period is required. Inevitably, the longer is the planning period the less accurate will be the expansion plan.

It was decided (in 1984) to estimate three sets of power system marginal costs. One set utilizes data between 1975 and 1984 which is a proxy for the short run marginal costs. The second set of marginal costs utilizes data between 1985 and 1989 which, at that time, represented the power system's five year expansion plan. This is a crude proxy for the long run marginal costs. Finally, the third set of marginal costs is the combination of the first two sets in that it utilizes data from 1975 through 1989.

The degree of consistency with the financial objective is the criterion used in selecting the set of marginal costs to be a basis for designing an efficient tariff (Lorchirachoonkul and Vikitset, 1986).

The marginal costs of generation, transmission, and distribution were estimated for the Thai power system at all voltage levels with allowances for losses and reserve margin for the three periods discussed above. However, estimates were not made for the marginal costs of customers. In the Thai system, the power customers pay directly for the installed meters so this cost component does not appear in the tariff structure. Other 'customer' items such as the cost of a transformer cannot be assigned entirely to the customer's costs. An arbitrary allocation of such an item can be designed but in the 1987 tariff revision, such items are considered as capacity costs.

H. MARGINAL COSTS OF GENERATION AND TRANSMISSION

Hydroelectric, gas and fuel oil fired, lignite fired, combined cycle, gas turbine, and diesel power plants make up the generation network for the power sector. The proxy plant method was employed to estimate the marginal cost of power generation. This approach answers the question of what is the marginal plant required to serve a marginal increase in power demand during a given period. There are two periods, the peak period and of- peak period, considered in the revision of the 1987 tariff. The marginal generation cost of each plant is estimated and compared with the load duration curve to determine

the marginal plant. The marginal plant for both the peak and off-peak periods turns out to be the gas/fuel oil fired thermal power plant (Lorchirachoonkul and Vikitset, 1986). The marginal cost of transmission is then estimated and 'added' on to the marginal generation cost. The marginal costs of generation and transmission are the basis for the design of the bulk tariff where EGAT sells its power to MEA and PEA. Table 1 presents EGAT's marginal costs of generation and transmission which are based on data from its investment plan from 1985 through 1989. The marginal generation cost for this period was selected since it yields revenue for EGAT that is closest to the required rate of return (Lorchirachoonkul and Vikitset, 1986).

Table 1. Marginal costs of generation and transmission, 1985-1989

Capacity (1984 prices)	*Baht/kW/month*
Generation[1]	79.59
Transmission	
High voltage	48.34
Medium voltage	48.34
Operation and maintainance outside power plant[2]	50.10
Total	
High voltage	178.03
	(171.04)
Medium voltage	178.03
	(171.04)
Energy	1.02 baht/kwh

Notes:
High voltage = 69 kV and above
Medium voltage = 11 kV and above
Figures in parentheses are shadow values
Marginal energy cost is based on 1984 border oil prices
$1 is approximately 25.00 baht
[1] Gas/fuel oil fired power plant
[2] Operation and maintenance costs of transmission system, system operation and general plant plus annuity of investment in communication system, administration building and office equipment

Source: Lorchirachoonkul, V. and Vikitset, T. *Thailand Power Tariff Structure Study*, a report submitted to NEA, 1986.

I. MARGINAL COSTS OF DISTRIBUTION

The marginal cost of distribution estimated for the period 1975 through 1984 was combined with the marginal costs of generation and transmission discussed above to

provide a basis for the design of the retail tariff. Again, this combination is selected on the basis of its degree of consistency with the rate of return requirement. The marginal cost of distribution for MEA, PEA and the total distribution system, which is the integrated costs of MEA and PEA, are presented in Table 2.

It may be seen that the marginal cost of distributing electricity to the provincial areas at medium and low voltage levels, the bulk of power consumption, is considerably higher than the corresponding cost for metropolitan areas. Since it is the government policy to implement a uniform tariff for the country, the integrated marginal distribution costs of MEA and PEA are the basis for the retail tariff design. The implication of the uniform retail tariff policy is the subsidies given to the PEA customers from the MEA customers.

Table 2. Marginal costs of distribution, 1975-1984

Voltage Group	*MEA*		*PEA*		*Integrated*	
	Capacity	*Energy*	*Capacity*	*Energy*	*Capacity*	*Energy*
69 kV and above	177.56	1.17	153.60	1.21	164.15	1.19
11 kV and above	205.48	1.18	275.86	1.27	244.88	1.23
380 V and above	253.20	1.21	344.00	1.34	304.03	1.28

Notes:
Capacity cost in baht/kW/month
Energy cost in baht/kWh
source: Same as Table 1

J. THE EFFICIENT TARIFF

The efficient tariff is designed for both the bulk and retail levels. The efficient demand and energy charges may be derived from the relevant marginal capacity and energy cost of the marginal plant and other economic parameters (Lorchirachoonkul and Vikitset, 1986).

The bulk tariff is derived from the marginal costs of generation and transmission. It is designed as a simple kilowatt-hour charge that includes the capacity cost component or demand charge converted into kilowatt-hour or energy charge at the system load factor. The flat rate bulk tariff was designed because it is simpler to administer than a two part tariff with a demand charge and an energy charge. There is no economic advantage to be gained from a two part tariff at the bulk level since end users receive their signals from the retail tariff.

Even though marginal costs were estimated for both the peak and off-peak periods, the time of day or time of use tariff was not implemented in 1987. For the case of Thailand, the efficient tariffs at the bulk and retail levels are the marginal costs presented in Tables 1 and 2 respectively.

K. COMPARISON BETWEEN EXISTING AND EFFICIENT TARIFF

Even though grouping of consumers is not required under a purely efficient or marginal cost, tariff classification of consumers become necessary for practical implementation and for sociopolitical reasons. It was decided to modify the existing consumer classification before 1987 such that the groupings become more comprehensive. For example, the industrial group before 1987 was regrouped as manufacturing and mining and the medium manufacturing and mining subgroup was added into this new classification. Classification of consumer under the existing tariff and under the 1987 structure are presented in Table 3. Table 4. compares

Table 3. Consumer classification under 1984 and 1987 tariff structure

1984		*1987*
MEA	*PEA*	*MEA and PEA*
1. Residential	1. Residential	1. Residential
2. Business	2. Business	2. Business
2.1 Small Business	2.1 Small Business	2.1 Small Business
2.2 Large Business	2.2 Large Business	2.2 Large Business
		2.3 Specific Business[1]
3. Industry	3. Industry	3. Manufacturing and Mining
3.1 Small Industry	3.1 Small Industry	3.1 Small Manufacturing and Mining
3.2 Large Industry	3.2 Large Industry	3.2 Medium Manufacturing and Mining
3.3 Off-On Peak	3.3 Special Rate	3.3 Large Manufacturing and Mining
3.4 Special Rate		3.4 Special Rate
		3.5 Specific Industry[2]
4. Government Hospital and Education	4. Government Hospital and Education	4. Public Organization
		4.1 Government Office
		4.2 Non Profit Organization
		4.3 Public Utilities (water works)
5. Street Lighting	5. Street Lighting	5. Agricultural Pumping
	6. Agricultural Pumping	

Special rates are for the smelting of ore, metals, or electrolytic manufacturing

Notes

[1] Currently only hotels are in the specific business category

[2] Currently no specific industries are relegated to this category

Source: Same as Table 1

the relative consumption of electrical energy of all the customer groups in the MEA and PEA areas. It may be observed that the proportions of energy consumption for the residential and manufacturing and mining groups in the total energy consumption are relatively higher in the PEA areas.

There are basically two types of tariff in the structure before 1987 i.e. a one part tariff where there are only energy or kilowatt-hour charges and a two part tariff where

Table 4. Distribution of consumer groups under the 1987 tariff structure

Consumer Group	*Percentage Distribution*[1]	
	MEA	*PEA*
Residential	18.69	33.13
Small Business	11.26	5.58
Large Business	14.71	1.55
Specific Business	2.66	3.00
Small Manufacturing and Mining	13.20	13.87
Medium Manufacturing and Mining	9.88	9.88
Large Manufacturing and Mining	15.75	20.85
Special Rate	3.30	0.93
Government Office	5.72	8.14
Non-profit Organization	2.65	1.54
Public Utilities	2.18	1.68
Agricultural Pumping	-	0.65
	100.00	100.00

Note
[1] Percentage distribution in 1986 by energy consumption
Source: Same as Table 1

there are both demand and energy charges. The two part tariff applies to the industrial and large business groups whereas the one part tariff applies to the other consumer groups. In the one part tariff, the kilowatt-hour charges are on a flat rate basis except for the residential and small business groups where the tariffs are increasing blocks of kilowatt-hour charges. There is an option of a time of use (TOU) tariff for the MEA's large business and industrial customers and for EGAT's direct customers. However, the TOU tariff option appears to be insignificant as only one EGAT direct customer and three MEA customers requested for this option. It was decided to retain the two types of tariff in the 1987 structure. Although the principle of TOU tariff was approved by the subcommittee on energy policy formulation, it was not implemented until early 1990 for the large manufacturing and mining customer group. When compared with the efficient tariff, large distortions inherent in the existing structure may be observed.

The demand charges in the two parts tariff are considerably below the efficient tariff while the energy charges are considerably above the efficient energy charges. If the efficient tariff were to be implemented the distortions in the tariff before 1987 would have affected the power bills of almost all customers, the degree of which would depend upon their consumption patterns and the rate differences between the efficient and the existing tariff. The degree of distortions and their effects on the customers' power bills may be illustrated for the major consumer groups.

Residential Group

Proportions of the residential customers' energy consumption in the total energy consumption were about 19 percent and 33 percent in the MEA and PEA areas respectively in 1986. The existing tariff is characterized by increasing kilowatt-hour charges allocated into nine blocks ranging from 0.07 baht per unit to 2.11 baht/unit (Table 5.) There is an additional 15 percent charge on the total bill for consumption exceeding 1,500 baht per month. The existing nine block tariff results in average rates of 1.7726 baht/unit and 1.4677 baht/unit for MEA and PEA respectively.

Load factors of the residential group were found to be 66.9 percent for MEA customers and 46.6 percent for PEA customers in a recent load patterns study using data recorded in 1989 (Lorchirachoonkul and Vikitset, 1990). The average rates of

Table 5. Residential and small business tariff, 1984[1] (baht/kWh)

Residential		*Small Business*	
Units of Consumption	*Tariff*	*Units of Consumption*	*Tariff*
0 - 5	5 baht[2]	0 - 40	89.72[2]
6 - 15	0.70	41 - 300	1.81(1.77)
16 - 25	0.90	301 - 1000	1.92(1.77)
26 - 35	1.17	1001 - 3000	2.04(2.00)
36 - 100	1.65(1.60)	3001 upward	2.21(2.17)
101 - 150	1.75(1.70)		
151 - 300	1.83(1.78)		
301 - 400	2.04		
401 upward	2.11		

Notes

1 Figures in parentheses are rates in 1986 when reductions of 5 satangs/unit were announced for consumption between 36 and 300 units for residential consumers and 4 satangs/unit for small business consumers. Additional surcharge of 15 per cent on the total bills it levied on bills exceeding 1,500 baht/month

2 Fixed charge

Source: Same as Table 1

the residential customers generated by the efficient tariff may then be estimated to be 1.90 baht/kWh for MEA customers and 2.17 baht/kWh for PEA customers. Thus, if differences between the load factors in 1987 and 1989 are not significant the average increases in the power bills will be 0.13 baht/unit for the MEA customers and 0.71 baht/kWh for the PEA customers.

Small Business Group

The small business customers consumed about 11 per cent of the total energy in the MEA areas and about 6 per cent in the PEA areas in 1986. Similar to the residential tariff, the small business tariff is an increasing kilowatt-hour charge allocated into 5 blocks (Table 5). The existing small business tariff results in average rates of 2.2268 baht/unit for PEA and 2.1417 baht/unit for MEA.

Load factors of the small business customers were estimated in the 1989 load patterns study to be 57.8 per cent for MEA customers and 62.6 per cent for PEA customers (Lorchirachoonkul and Vilkitset, 1990). The average tariff rates generated by the efficient tariff would have been 2.00 baht/kWh for MEA customers and 1.95 baht/kWh for PEA customers. It appears that this group of customers are already paying more than the efficient tariff rates. When the small business tariff is compared with the residential tariff it is seen that the average rates for small business are greater than the corresponding residential rates for the first 500 units (Table 6). The pattern is reversed for consumption greater than 500 units when the average rates are higher for the residential group which is not consistent with the sociopolitical guidelines discussed above.

Table 6. Comparison of average tariff between residential and small business groups. 1984 and 1987 (Baht/Unit)

Units of Consumption	*1984*[1]		*1987*	
	Residential	*Small Business*	*Residential*	*Small Business*
5	1.0000	17.9440	1.0000	17.6240
15	0.8000	5.9813	0.8000	5.8747
25	0.8400	3.5859	0.8400	3.5248
35	0.9343	2.5632	0.9343	2.5177
100	1.3670	1.9532	1.3540	1.9432
200	1.5335	1.6646	1.5170	1.8566
300	1.6290	1.8331	1.6113	1.8277
400	1.7378	1.8428	1.7135	1.8406
500	1.8074	1.8518	1.7928	1.8486
600	1.8578	1.8565	1.8457	1.9089
700	1.8939	1.8599	1.8834	1.9519
800	1.9277	1.8624	1.9118	1.9842
900	1.9830	1.8940	1.9693	2.0092
1000	2.0315	1.9208	2.0154	2.0293
2000	2.2490	2.1104	2.2227	2.2297
3000	2.3215	2.1736	2.2918	2.2964
4000	2.3578	2.2541	2.3264	2.3473

Notes

[1] Rates include 15 percent surcharge for power bills exceeding 1500 baht/month

Source: Same as Table 1

Two Part Tariff

Existing demand and energy charges for the large business and manufacturing and mining group deviate considerably from their corresponding efficient values. Demand charges range from 85 baht per kW per month for high voltage large industry consumers to 98 baht per kW per month for low voltage large business consumers compared with the efficient demand charges of 164 baht and 304 baht for high and low voltage respectively. In contrast, the energy charges range from 1.41 baht/unit to 1.52 baht/unit which are considerably above the efficient energy charges.

Table 7 compares the average tariff rates for small manufacturing and mining demanding power at the low voltage level generated from the existing tariff and the efficient tariff. This group of customers consumed about 13 per cent of the total energy in the MEA areas and 14 per cent of the total energy in the PEA areas.

Table 7. Comparison of average cost between existing and efficient tariff for low voltage small manufacturing and mining customers.

	1984 Structure	*Efficient Tariff*
Demand Charge (baht/kW)	98	304
Energy Charge (baht/kWh)		1.28
0 - 50 units per maximum kilowatt	1.46	
51 - 200 units per maximum kilowatt	1.45	
201 - 400 units per maximum kilowatt	1.44	
401 units upward per maximum kilowatt	1.43	
Average Cost (baht/kWh)		
Load Factor 10%	2.79	5.44
Load Factor 60%	1.67	1.97
Load Factor 100%	1.58	1.69

Source: Same as table 1

Load factors of this group of customers were estimated in the 1989 study to be 60 per cent for both the MEA and PEA customers. It may be seen from Table 7 that the average tariff rate for this group would have been increased by about

0.30 baht/kWh at this load factor. Even though an average customer could improve his load factor to 100 per cent his average tariff rate would still increase by about 0.11 baht/kWh. Again, this is not consistent with the given sociopolitical guidelines.

L. EFFICIENT TARIFF AND FINANCIAL OBJECTIVE

The efficient tariff was derived from a selected set of marginal costs that generate the lowest rate of return during the test period from 1986 through 1989. Nevertheless, this tariff still exceeds the minimum rate of return requirement by about three percent (Lorchirachoonkul and Vikitset, 1986). The excess revenue generated by the efficient tariff provides some flexibility for trading off between the efficiency and sociopolitical objectives.

M. ADJUSTMENT OF THE EFFICIENT TARIFF

It was considered that the efficient tariff, while providing improved economic signals to the customers and achieving a return greater than the financial target, is sociopolitically unacceptable. There are several ways that a marginal cost based tariff can be adjusted. The inverse elasticity rule or an equal proportion change in the rates for all customer groups are some examples of the methods of adjustment. In the case of the 1987 tariff revision, the adjustments followed the sociopolitical guidelines given above.

After the efficient tariff was formulated there was a series of reductions in international oil prices in 1986 which led to similar reductions in the domestic oil and gas prices (Lorchirachoonkul and Vikitset, 1986). The reductions in oil and gas prices lower the cost of electricity generation and provide more financial leeway for the efficient tariff adjustments.

Manufacturing and Mining and Business Groups

Demand charges of the manufacturing and mining and business groups are the candidates for adjustment. The minum rate of return is the benchmark for the downward adjustment of the demand charges (Lorchirachoonkul and Vikitset, 1986). The downward adjustments apply to only the low and medium voltage groups, the majority of electricity consumers.

Table 8 presents the adjusted demand charges for the manufacturing and mining and business groups. It is seen that the high voltage demand charges increased slightly under the adjustment procedure.

Despite the adjustment of the demand charges which, in effect, involves cross subsidy from high voltage to medium and low voltage consumers, a considerable proportion of low voltage manufacturing and mining customers still face larger power bills (Lorchirachoonkul and Vikitset, 1986). To alleviate the financial burden of the low voltage consumers it is decided to merge the demand charges of the manufacturing and mining consumers into a uniform charge for all voltage levels (Lorchirachoonkul and Vikitset, 1986).

Table 8. Adjusted demand charges by consumer group (baht/kW/month)

Consumer Group	*380V*	*11–33kV*	*69 kV*
Large Business	238.60	231.59	172.05
Specific Business	233.39	226.53	168.29
Small Manufacturing and Mining	236.49	229.54	170.52
Medium Manufacturing and Mining	235.10	228.19	169.52
Large Manufacturing and Mining	231.60	224.79	167.00
Special Rate	–	220.96	164.15
Marginal Capacity Cost	304.03	244.88	164.15

Source: Same as Table 1

The uniform demand charges for the manufacturing and mining groups are now higher than the high voltage demand charges for large and specific business groups. To redress the balance the medium and high voltage demand charges of these two groups are merged into uniform demand charges while leaving intact the low voltage demand charges (Table 9).

Table 9. Tariff structure for manufacturing and mining and business groups, 1987

Consumer Group	*Demand Charge (Baht/kW)*			*Energy Charge (Baht/kWh)*		
	HV	*MV*	*LV*	*HV*	*MV*	*LV*
Large manufacturing and mining	170	170	170	1.22	1.22	1.22
Medium manufacturing and mining	174	174	174	1.23	1.23	1.23
Small manufacturing and mining	177	177	177	1.23	1.23	1.23
Special rate	165	165	165	1.20	1.20	1.20
Large business	229	229	229	1.23	1.23	1.28
Specific business	216	216	233	1.23	1.23	1.28

HV = high voltage
MV = medium voltage
LV = low voltage
Demand charge in baht/month
Energy charge in baht/kwh

Notes: A four percent discount on the total bills of manufacturing and mining customers is allowed due to further reductions in energy prices.

Source: Same as Table 1

Residential and Small Business

Even though the average tariff rate for the residential group is considerably below the efficient rate, the reduction in energy prices made it possible for the tariff to satisfy the minimum financial constraints with essentially the same structure. The 1987 residential tariff is thus the same as the 1984 structure but with a further reduction of 0.02 baht/kWh for consumption between 36 and 400 units.

The 1987 small business tariff is also based on the 1984 structure but with some modifications for consumption greater than 500 units to satisfy the sociopolitical guidelines. The 1987 tariffs for the residential and small business groups are presented in Table 10. Under the 1987 structure the average tariff for small business is greater than the average residential tariff for all consumption units (see Table 7).

Table 10. Residential and small business tariff, 1987 (baht/kWh)

Residential		*Small Business*	
Units of Consumption	*Tariff*	*Units of Consumption*	*Tariff*
0 - 6	5.00	0 - 40	88.12
6 - 15	0.70	41 - 300	1.77
26 - 35	1.17	301 - 500	1.88
36 - 100	1.58	501 - 1000	2.21
101 - 150	1.68	1001 - 3000	2.43
151 - 300	1.76	3001 upward	2.50
301 - 400	2.02		
401 - 800	2.11		
801 upward	2.43		

Source: Same as Table 1

Other Consumer Groups

Other consumer groups consume relatively small amounts of electricity (Table 4). It is decided to keep the tariff of government offices, non-profit organizations and agricultural pumping groups at essentially their existing levels. The simple flat rates of 1.82 and 1.84 baht/kWh are thus applied to the government office and non-profit organization groups respectively. Similarly, a flat rate of 1.17 baht/kWh is the tariff for agricultural pumping, the smallest consumer group. The rate for agricultural pumping applies only for the off peak period and the rate is slightly below the efficient energy charge. There are two tariffs for the public utilities

group. A government office rate of 1.84 baht/kWh applies to this group for a demand of less than 30 kW. For demand from 30 kW upward, a two part tariff is applied with demand charge of 167 baht/kW which is the adjusted demand charge for high voltage manufacturing and mining (Table 8) and energy charge of 1.23 baht/unit which is the same as the energy charge for the manufacturing and mining group. The reason for the two-tier tariff for the public utilities is to alleviate the increase in financial burden for large consumers under a flat rate of 1.84 baht/unit. The two part tariff results in lower power bills for most of the public utilities large consumers.

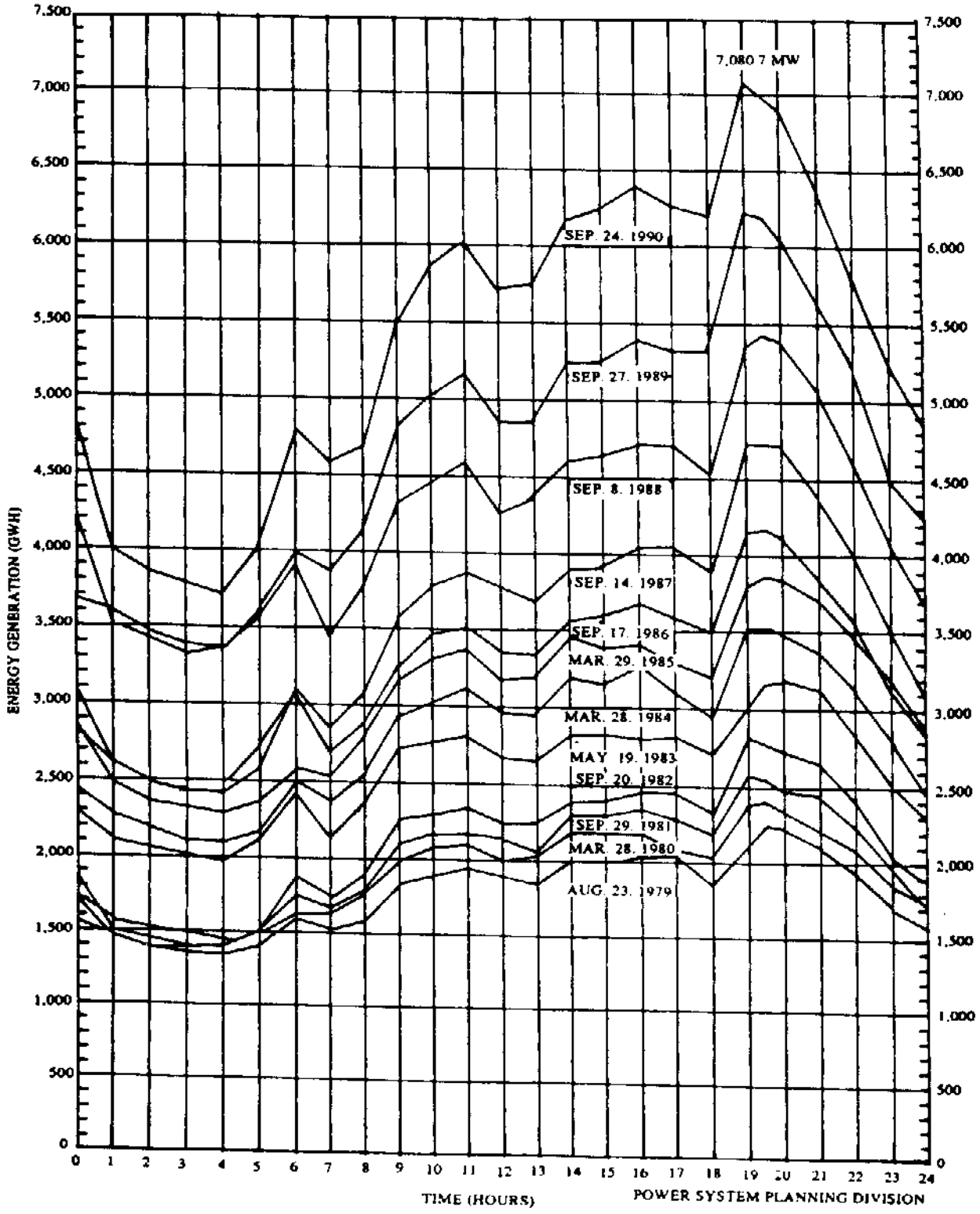
The rates for these groups are somewhat below the efficient tariff rates. The final structure of the 1987 tariff affected about two per cent of the total customers in the form of increased power bills. These two per cent of the total customers are mostly small manufacturing and mining customers with low load factors and small business customers with consumption greater than 500 units per month.

In summary, the final version of the 1987 tariff succeeded in improving the economic signals to the manufacturing and mining, and the large business customers. These two major groups accounted for about 60 per cent of the total energy consumption in the MEA areas and about 49 per cent in the PEA areas.

O. IMPACTS OF 1987 TARIFF ON THE LOAD SYSTEM

Figure 1 and Table 11 show the patterns of load growth for Thailand during the past decade. The causes of changes in the load patterns may be explained in terms of the price effect and the growth effect. Price effect reflects the behavior of power customers in deciding the feasibility of substitutions between electricity and its close substitutes as a result of changes in the relative prices and their income effects. The price effect may cause a shift in a customer's peak demand to other appropriate time periods. On the other hand, the growth effect reflects the growth in electricity demand induced by economic growth. The growth effect applies to existing customers that decide to expand their capacity and also to new customers.

The patterns of load growth in Figure 1 suggest little changes in the structure of the overall load curve. Although more research is needed to study the behavior of each consumer group the overall patterns in Figure 1 do suggest that the overall load growth may be characterized mainly by the growth effect. The maximum demand elasticity with


7,080.7 MW
SEP. 24. 1990
SEP. 27. 1989
SEP. 8. 1988
SEP. 14. 1987
SEP. 17. 1986
MAR. 29. 1985
MAR. 28. 1984
MAY 19. 1983
SEP. 20. 1982
SEP. 29. 1981
MAR. 28. 1980
AUG. 23. 1979
ENERGY GENERATION (GWH)
TIME (HOURS)
POWER SYSTEM PLANNING DIVISION

respect to GDP declined slightly towards the end of this decade which implies that the growth effect may be weakening relative to the mid 1980s when there was a strong economic recovery in 1987.

Table 11. Economic growth, electricity demand and power system capacity, 1985-1990[1]

Year	*LE*	*GGDP*	*MD*	*ED*	*SC*	*EL*
1985	68.75	3.5	3878.4 (9.33)	3356.57 (10.87)	6459.73	2.7
1986	67.66	4.5	4180.90 (7.80)	24779.53 (6.09)	6637.23	1.7
1987	67.99	8.4	4733.90	28190.16	6886.65	1.6
1988	67.04	10.4	5444.00 (15.00)	31996.94 (13.49)	6916.30	1.4
1989	66.59	9.5	6232.70 (14.49)	36457.01 (13.94)	7282.86	1.5
1990	69.50	9.5[2]	7093.70 (13.81)	43189.19 (18.41)	7986.16	1.5

Notes

1 Figures in parentheses indicate growth rates
LF=load factor MD=maximum demand in MW
ED=energy demand in GWH GGDP=growth rate of GDP
EL=elasticity of MD with respect to GDP

2 Estimated

Source: Lorchirachoonkul V. and Vikitset, T., *Time of Use Tariff*, a report submitted to CIDA, 1991

Since the implementation of the 1987 tariff there were no significant changes in the system load factors during the period 1987 through 1989. This is consistent with the load growth that is induced mainly by the growth effect. The likely explanation is that although the tariff sends more accurate economic signals to the manufacturing and mining, and large business customers, there are no incentives for these customers to shift their loads from the peak period to the other periods which will improve the system load factor.

The importance of load shift from the peak period to other periods is illustrated in Table 12. It may be observed that the major contributors of the customers' peak demand to the system peak are the residential, specific business, and large manufacturing and mining customers. Over 90 per cent of these customers' own peak

contributes to the system peak demand (Lorchirachoonkul and Viketset, *Time of Use Tariff*, 1990). The TOU tariff was not implemented until January 1990 and then only for the large manufacturing and mining customers which consumed about 13 per cent of total energy in the MEA areas and 13.7 per cent in the PEA areas. The structure of the 1990 TOU tariff is shown below:

period	Demand Charge (baht/kW/month)	Energy Charge (baht/k Wh)
18.30 - 21.30 (peak)	180	1.22
08.00 18.30 (partial peak)	90	1.22
21.30 - 08.00 (off peak)	0	1.22

The above TOU provides incentives for a customer to shift his load from the peak period to other periods (Lorchirachoonkul and Vikitset, *Time of Use Tariff*, 1990). Although the detailed studies of the TOU tariff impacts on the system load have not been undertaken, it is likely that the tariff helped to improve the system load factor to 69.5 per cent in 1990. Preliminary findings from interviews with three customers under the TOU tariff early in 1991 provide some information on the customers' reaction to the TOU tariff.

Not all three customers understood fully the potential benefits that can be derived from the TOU tariff. Only one customer showed some understanding and willingness to study the feasibility of shifting his load from the peak period to other periods. A strong public relations campaign to sell the idea of load management may thus be recommended so that maximum benefits can be reaped from the TOU tariff.

At one company, an interview with a group of engineers responsible for the company's power system found that the company did not study the feasibility of shifting the company's load because electricity is not a major cost item. In addition, the performance of the company is very satisfactory and so there are no needs for extra effort in managing the load. In this company, the owner may not be aware of the benefits from the TOU tariff since the issue of load management was not raised by the engineers in charge. It may be essential that the top executives be informed of the potential benefits from the TOU tariff to the company as well as to the country.

Table 12. Contribution of customers' peak demand to system peak, 1989

Customer Group	*Percent Contribution*
Residential	100.00
Small Business	83.29
Large Business	77.91
Specific Business	100.00
Small Manufacturing and Mining	77.41
Medium Manufacturing and Mining	81.27
Large Manufacturing and Mining	97.38
Special Rate	95.74
Public Utilities	96.48
Government Institutions	60.56

Source: Lorchirachoonkul V. and Vikitset T., *Load Patterns Analysis of* MEA and PEA Electricity Consumers, a report submitted to CIDA, 1990

Only one customer, in the textile industry, operating on a three shifts basis managed to shift his load without incurring any significant expenses. The owner of the company himself agreed to be interviewed and said that his company simply shifted its input preparation period from the peak period to the partial peak period. Some of these shifts may be managed without much difficulty, for example, automatic water pumping was controlled such that the operation did not occur during the peak period. At the time of the interview, the company was still in the process of further research on load management. This company saved about 12 million baht of power bills in 1990.

In order to have a clear understanding of the customer's load pattern, an interview is useful in supplementing analysis from the load data. One customer's load curve shows a shift from the peak period to the partial peak period. However, when the plant manager was interviewed, it turned out that what appeared as a shift when the TOU tariff was in effect was simply a shut down for maintainance during the peak period on the day that the load was recorded.

P. FUTURE TRENDS IN TARIFF DEVELOPMENT

At the time of this writing (July, 1991), the subcommittee on energy policy formulation is considering a report on the revision of the 1987 tariff. It is anticipated that the new tariff will provide correct economic signals on a wider scale when compared with the 1987 tariff. However the subsidies for small customers in the residential group consuming up to a given level of consumption are likely to be retained.

The new retail tariff will still be uniform throughout the country for a given

customer group. This is to conform to the government policy of decentralizing industrial activities from the Bangkok metropolitan area to the provincial areas. Without this uniform tariff policy, the tariff will be higher in the PEA areas which will be in conflict with the industrialization policy.

There may be reclassifications of customers in such a way that consumers with similar load patterns will be relegated to the same group. It is likely that the TOU tariff will be implemented for other manufacturing and mining, and large business groups. A recent study on the benefit of the TOU tariff suggests that the TOU tariff will be beneficial to these customers in terms of reduced power bills and to the country in terms of reduced capacity expansion requirements. Other customer groups' consumptions are too small to offset the cost of metering and administration (Lorchirachoonkul and Vikitset, *Time of Use Tariff,* 1991). Moreover, the load shift from the peak period to other periods is considered impractical for some customers such as residential customers. The most important feature of the new tariff, if approved, will be the energy escalating clause which will allow an automatic adjustment of the energy charge in accordance with the changes in the prices of energy used in electricity generation that are beyond control of EGAT. This will assure that the economic signals to customers will be consistent with the changes in energy prices.

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