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THE GROWTH OF ELECTRIC POWER PRODUCTION IN MALAYA¹

ROBERT F. KINLOCH

University of Malaya, Kuala Lumpur

ABSTRACT. The origins and early development of electricity production in Malaya are closely connected with the tin mining industry and with European participation in it. The present constitutes a turning point for the electricity supply industry since mining now consumes less than half the Federation's total electricity output; moreover, this share is expected to decline further in the future as a result of the fast-growing demand from industrial, commercial, and domestic consumers. Official projections for the next three decades envisage a tenfold increase in demand and the establishment of an integrated West Coast transmission system.

THROUGHOUT the world, electricity consumption is increasing more rapidly than aggregate energy consumption,² a trend of particular importance in those developing areas where present absolute levels of energy consumption are low, and where national economic development plans call for substantial and rapid increases in energy supply.

The early growth of electricity production in Malaya was based upon European mining, and the pattern of production and supply resembled, until recently, the pattern of other territories with a similar history. Electric power largely associated with the extraction and primary processing of export commodities, generation concentrated in the zones of export production and in rarely more than a single metropolitan area, and small supply systems developed in isolation has been the situation, and in many cases still is characteristic of Southeast Asia in general and of many African and Latin American countries. Malaya shares with these countries the problem of the lack of effective demand over wide areas and its corollary, a poorly developed transmission system. Demand in the urban

centers is rapidly increasing, and in order to meet this demand, and to broaden the base of the national energy economy, the harnessing of hydroelectric resources is taking an important share of power investment. Such is also the case in Burma, Thailand, and the Philippines. In these respects, in the development of regional and national transmission systems, based on water power and mineral fuel, Malaya is following the path towards integrated electric power generation and supply typical of the Western economies.

In the second place, the Malayan electricity supply industry, stimulated in the past by Western economic intervention and benefiting from relatively plentiful foreign exchange resources, has in some respects advanced slightly further than those of her neighbors. The 1962 per capita electricity production in Malaya (188 kWh) was exceeded in Asia only by Japan (1,308 kWh), Hong Kong (554 kWh), Taiwan (414 kWh), and Singapore (408 kWh).³ Greater progress has also been possible in the development of transmission by reason of the concentration of economic activity in the western Malayan states, in contrast to the situation in, for instance, Thailand, Indonesia, and the Philippines. Because of these advantages, the Malayan case may serve to illustrate some of those problems associated with electric power development

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¹ The Federation of Malaya, after its inclusion in the Malaysian Federation on September 16, 1963, became the States of Malaya. The author acknowledges help and advice given by several officers of the Central Electricity Board, States of Malaya, by D. H. Ball of Huttenbachs Ltd., and by D. W. Fryer, University of Malaya.

² United Nations, Department of Economic and Social Affairs, *World Energy Supplies 1958-1961*, Statistical Papers, Series J, No. 6 (New York: United Nations, 1963), Tables 1 and 13.

³ United Nations, Economic Commission for Asia and the Far East, *Electric Power in Asia and the Far East, 1961 and 1962* (New York: United Nations, 1964), pp. 47-48.

which are peculiar to developing countries.⁴ Chief among these is the adaptation of the electricity supply industry to economic and social goals within the framework of independent nationhood. Malaya's first and second Five Year Plans (1956-60, 1961-65) devote fifteen and thirteen percent, respectively, of nondefense expenditure to the expansion of electricity supply,⁵ with particular emphasis upon the provision of electricity for nascent manufacturing industry and for the rural population.

As Barnea has indicated:⁶

There is no possibility of industrialization without electrification . . . rural electrification in the underdeveloped areas is at the same time a more important and a more complicated task than in the developed countries.

EVOLUTION

The first electricity generating plant in Malaya was installed by tin mining companies in Perak, Selangor, and Pahang in the closing years of the nineteenth century (Fig. 1). The first public supply was started in 1904 with the commissioning of a small thermal station in George Town, Penang. A small hydroelectric station on a stream twelve miles northeast of Kuala Lumpur brought electricity to the chief town of the Federated Malay States in 1905. In the following years a number of oil-engine stations for municipal supply were built in such western Malayan towns as Johore Bahru, Seremban, Alor Star, and Malacca. But these developments were overshadowed by the generation of electricity undertaken by the expanding European sector of the tin mining industry.

Until the mid-1920's, generating stations were small and used a variety of fuels, including low-grade coal from the Batu Arang field in Selangor, local wood, charcoal, and imported oil, as well as water power.⁷ The Prai thermal station in Province Wel-

lesley on the mainland opposite Penang Island, with its 9.5 MW capacity was the largest in Malaya until 1926. With the extension of British activity and the growing use of gravel pumps and dredges in what had hitherto been a largely Chinese tin mining industry, the demands of the mining companies induced a very rapid increase in generating capacity in the late 1920's, principally in the main tin mining zones of the Kinta Valley and central Selangor. The concentrated demand in the former area led the British and Perak governments, together with tin mining interests, to establish the Perak River Hydro-Electric Power Company (PRHEP) in 1926. This company quickly became the largest electricity producer in the country. In 1926 too,⁸ the F.M.S. Electrical Department took over the municipal plant controlled by the Public Works Departments of the Federated Malay States. This authority thus became responsible for local municipal generation and supply in the main towns of the States and for a small distribution network in the Kuala Lumpur District based on the new Bungsar coal-fired station in Kuala Lumpur, which supplied the town and local tin mines.

The late 1920's saw an important upsurge in electricity production in Malaya. By 1929 public and private suppliers had reached a total output of 230 GWh.⁹ More than ninety percent of the units were, however, consumed in the tin mines. The demand for electricity in the Kinta Valley was such that the PRHEP, with a coal-fired 18 MW station at Malim Nawar and a 27 MW hydroelectric station at Chenderoh on the Perak River¹⁰ (the largest civil engineering project in Southeast Asia at the time of its construction in 1929), added to its system in 1933 a second thermal station of 9 MW capacity at Batu Gajah in the Kinta Valley. The output of the F.M.S. Electrical Department increased in equally spectacular

⁴ For a general discussion, see J. Barnea, "Economic Implications of Electrification in Under-Developed Countries," *Economic Development and Cultural Change*, Vol. 2 (1953-1954), pp. 371-79.

⁵ Government of Malaysia, *Interim Review of Development in Malaya under the Second Five-Year Plan*, (Kuala Lumpur: Government Printer, 1963), p. 22.

⁶ Barnea, *op. cit.*, footnote 4, pp. 375, 377-88.

⁷ F. Bolton, *Report on Electric Light and Power Supplies for Malaya* (London: Crown Agents, 1921).

⁸ In this year the Singapore City Council, which had since 1906 distributed electricity bought from the Singapore Tramway Company, completed the construction of its first generating station in the city at St. James.

⁹ One GWh (Gigawatthour) equals one million kWh.

¹⁰ B. M. Hellstrom, "The Perak River Hydro-Electric Scheme," and W. J. M. Rennie, "The Construction of the Chenderoh Water-Power Plant of the Perak River Hydro-Electric Power Scheme," Excerpts Nos. 4974 and 4969 of *Proceedings of the Institute of Civil Engineers* (London), Vol. 239 (1935), Pt. 1.

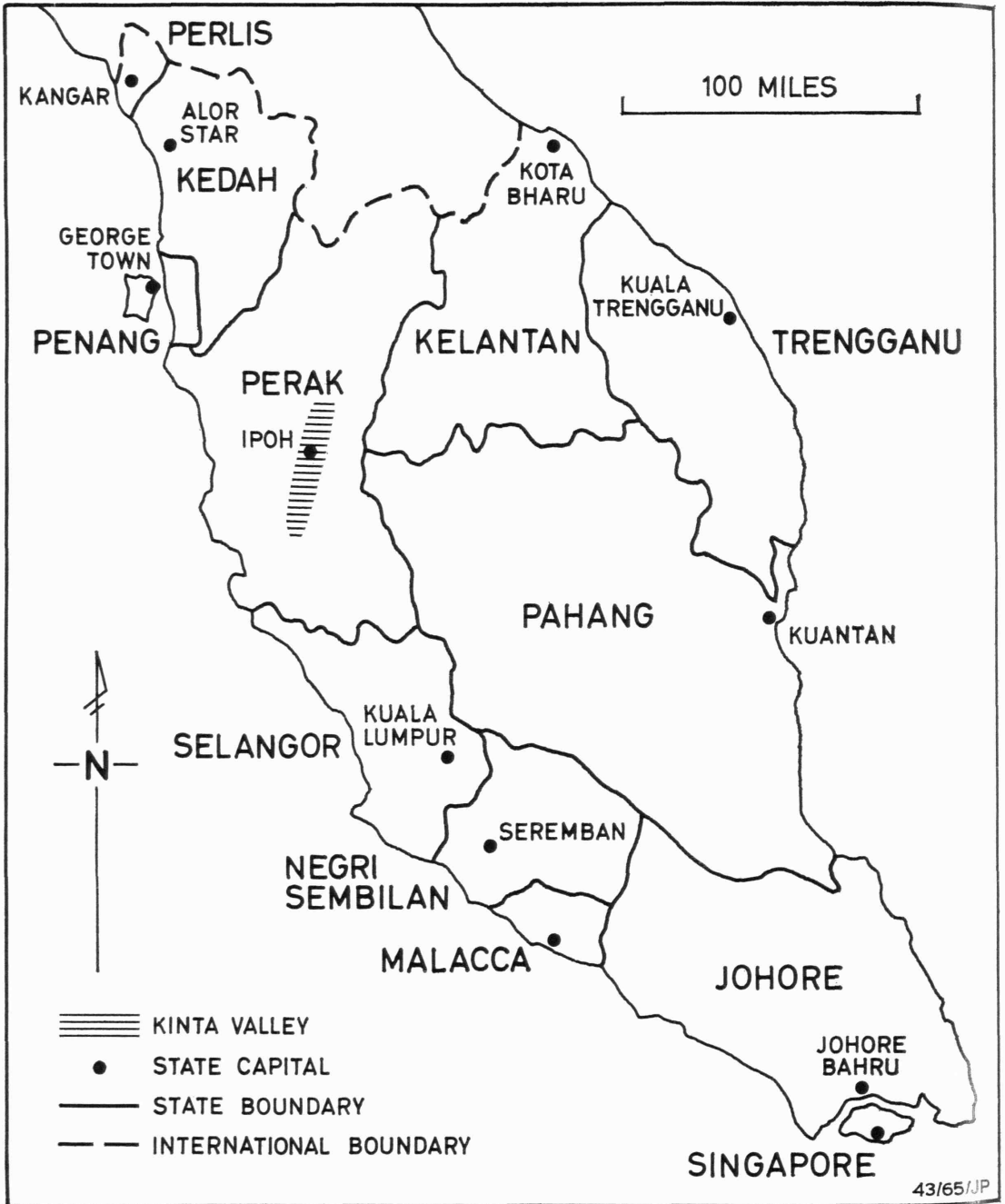


FIG. 1. The Federation of Malaya.

fashion, from 6.3 GWh in 1926 to 31.8 GWh in 1930, before being cut back by the effects of the Depression.¹¹

¹¹ Federation of Malaya, Central Electricity Board, *Fourteenth Annual Report, 1st September 1962–31st August 1963* (Kuala Lumpur: Khee Meng Press, 1963), Appendix XIII.

In 1937 the total generating capacity in stations of over 100 kW in the F.M.S. was 135 MW, of which eighty-five percent was owned by the PRHEP and mining companies.¹² The

¹² Federated Malay States, Electrical Department, *Annual Reports and Accounts for the Year 1937* (Kuala Lumpur: Government Printer, 1938), p. 50.

tin industry consumed more than four-fifths of all units generated, and even the Electrical Department, with its responsibilities for municipal supplies, sold eighty-five percent of the units it generated to the mines, chiefly around Kuala Lumpur. The close relationship between electricity sales and tin mining in the thirties is further illustrated by the effects of conditions in the industry upon sales. The F.M.S. Electrical Department sold 26.3 GWh in 1930. In the following year, as the full effect of the Depression hit tin mining, the Department's total sales fell by fifteen percent and continued to fall until 1934, when they were twenty-six percent below the 1930 level. Then, as mining activity picked up again, they rose to 78 GWh in 1937, only to be followed by tin output restrictions which cut the number of units sold in 1939 to twenty-nine percent below the 1937 figure.¹³ The effects upon PRHEP and mining company generation must have been considerably greater.

In its first four decades of development, up to the Japanese invasion, electricity development in Malaya was almost entirely the product of the mining economy. The major zones of generation and supply were the Kinta Valley and the Kuala Lumpur District, served respectively by the PRHEP's two thermal and one hydro station, and the Electrical Department's thermal station in Kuala Lumpur and small hydro station in the Ulu Langat valley nearby. Outside these areas public supplies were undertaken by the Electrical Department in the main towns of the F.M.S., by state departments in the other Malay States, and by a municipal authority in Penang. In addition, private companies, such as Huttenbachs Ltd., provided local (diesel-generated) supplies to several towns, and many mining companies, especially in isolated areas, generated their own supplies.

During these decades hydroelectricity played a relatively large role as a prime mover. In the F.M.S., hydroelectric stations in 1937 produced forty-five percent of the total units generated, fractionally more than steam turbine stations, with diesel power providing the remaining eleven percent.¹⁴ Chenderoh provided the bulk of the hydroelectric power.

Several mining companies in Perak and Pahang had small stations, whereas the Electrical Department's Ulu Langat station, bought from the Sungei Besi Tin Company in 1929, was of only 2.29 MW capacity. There was, however, no systematic attempt in the prewar years to develop hydroelectric power; more stations were constructed before 1940 than have been put into operation since, but the annual output of the largest postwar scheme alone is greater than that of all the prewar hydroelectric stations.

Postwar Developments

At the end of the Second World War much of the generating plant in Malaya had been destroyed or had to be written off. Generation picked up slowly, reaching prewar levels only by 1948. In the following year the responsibility for "promoting and encouraging" the generation of electricity in the newly established Federation of Malaya was vested in the Central Electricity Board (CEB), which took over government assets in the Malay States and Malacca.¹⁵ The other public utilities, the PRHEP, Huttenbachs,¹⁶ and George Town City Council continue their independent operations under license of agreement.

In the postwar years, and especially during the Korean War boom, the public utilities, faced with problems of acquiring new plant and of operating under the difficult conditions of Communist terrorism during the Emergency,¹⁷ were for some time unable to satisfy the demand for electricity. Security conditions severely hampered the efforts of the CEB to investigate potential sources of hydroelectric power. In 1954, an IBRD mission had recommended the investigation of¹⁸

small hydroelectric plants at sites sufficiently near the present or projected networks to be connected to them

¹⁵ Federation of Malaya, *The Electricity Ordinance* (No. 30 of 1949).

¹⁶ Huttenbachs Ltd., with diesel generating plants in several towns in Kedah and Negri Sembilan, was taken over by the CEB at the end of 1963.

¹⁷ A State of Emergency was declared in 1948 and was terminated in 1960. Terrorist activity declined after 1953. For a brief account, see Federation of Malaya, *Official Year Book 1961* (Kuala Lumpur: Government Printer, 1961), Ch. XV.

¹⁸ International Bank for Reconstruction and Development, *The Economic Development of Malaya* (Baltimore: Johns Hopkins, 1955), p. 105.

¹³ Federation of Malaya, Central Electricity Board, *Fourteenth Annual Report*, Appendix XIII.

¹⁴ *Annual Reports . . . 1937*, footnote 12, p. 47.

but only one, the 0.9 MW Robinson Falls station in the Cameron Highlands, was completed during the following eight years. The slow progress in this sphere was not the result of the Emergency alone. Hydrological records in Malaya are still less than adequate and, more important, it has been apparent for some years that the rapidly increasing Malayan demand for electricity makes it more economic to invest in medium and large hydroelectric schemes.

As in other countries, the lengthy period required for the investigation and construction of major hydroelectric schemes has meant that existing and new thermal stations have had to fill the gap between demand and supply. The first turbo-alternators of the Connaught Bridge oil-fired station at Klang were commissioned in 1953 to ease the burden of the aging 26.5 MW Bungsar (Kuala Lumpur) station, the main source of supply for the Selangor system. A steam turbine station at Malacca was commissioned in 1959, and, to meet the growing industrial demand on the Federation side of the Johore Straits another started operation at Johore Bahru in 1963. In the Kinta Valley, the PRHEP's Malim Nawar station was extended by the addition of 24 MW capacity in 1958-1959, and a further 40 MW in 1964. In total public supply generating capacity in the Federation rose from about 131 MW in 1949-1950 to about 440 MW in 1964. The latter figure includes the second 50 MW of the Cameron Highlands project mentioned below. In 1963, private capacity¹⁹ amounted to about 72 MW; the chief stations were operated by mining companies at Sungei Lembing, Bukit Besi, and Kuala Rompin on the East Coast, and by the two new petroleum refineries recently constructed at Port Dickson on the West Coast.

Expansion also took place in the transmission network of the CEB and in the construction of diesel power stations for the supply of smaller population centers outside Perak, Selangor, Negri Sembilan, and Malacca. The CEB network was extended between 1950 and 1962 from Seremban to Muar in the south, and from Rawang to the Selangor-Perak border in the north. In 1963 the Cameron Highlands scheme was linked to the Selangor CEB network with the construction of the first 132

TABLE 1.—ELECTRICITY GENERATION AND CONSUMPTION IN THE FEDERATION OF MALAYA, 1951 TO 1963

Year	Units used, as % of all units used				
	Total gross units generated	Generated by CEB	Mining	Industrial and commercial	Lighting and domestic
	GWh	%	%	%	%
1951	704.2	24.9	77.1	9.6	13.3
1957	1,069.3	42.3	64.0	19.4	16.6
1963	1,621.6	55.0	49.5	28.9	21.6

Source: Monthly Bulletins of Statistics; CEB Annual Reports.

kV lines in the country. Small diesel stations for public supply, operated by the CEB, licensees, or by the Government in New Villages established during the Emergency, have been built in most small towns and many villages outside the networks of the CEB and the Kinta Electrical Distribution Company (the supply subsidiary of the PRHEP). The CEB also operates a number of larger diesel stations with capacities of up to 8.5 MW. These are used to supply large towns, such as Butterworth in Province Wellesley, Taiping in northern Perak, Alor Star in Kedah, Kluang and Batu Pahat in Johore, and the main East Coast towns: Kuantan, Kuala Trengganu, and Kota Bahru.

Prominent features of the rapidly rising electricity demand and output since 1945 have been the growing importance of the CEB, and the declining proportion of units sold that have been taken by the mining industry (Table 1). The uncertainty expressed by the IBRD mission concerning the tin mining industry's future demand for electricity²⁰ was partly confirmed by the International Tin Council's restrictions on Malayan output in 1958. But on this occasion the effects of a decline in mining activity were cushioned by rising demand from other electricity consumers. In 1958-1959, when the full force of the restrictions was felt, the CEB's total sales were only 2.4 percent below those of the previous year, in spite of a twenty-seven percent fall in the number of units sold to the mines. The effect upon the PRHEP was more severe, since eighty-five percent of the company's sales are to the tin mines.²¹ But the experience

¹⁹ Information supplied by the Chief Electrical Inspector, Central Electricity Board.

²⁰ International Bank, *op. cit.*, footnote 18, p. 362.
²¹ Perak River Hydro-Electric Power Company, *Directors' Reports and Statement of Accounts for the Year Ended 31st July 1959* (London: 1959), p. 10.

of the CEB, and mining's declining share of total consumption, indicate the growing emancipation of electricity supply from dependence upon the mining economy. Over the period 1949-1950 to 1962-1963 the overall consumption of electricity for commercial and industrial use has increased by 704 percent, for lighting and domestic use by 400 percent, and for mining use by sixty-five percent.²² This also illustrates the emergence of the Federation's economy from the colonial pattern described by Ginsburg, in which raw materials are mined and processed by foreign companies and²³

the maldistribution of income . . . means a small market for electrical energy in the home and in local industries.

THE PRESENT SITUATION

Generation

The map and table below (Fig. 2, Table 2) show the principal generating stations and distribution agencies in the Federation in 1963. In the operational year 1962-1963 the four main public utilities, CEB, PRHEP, George Town City Council, and Huttenbachs, produced eighty-nine percent of all units generated in the Federation, with the CEB producing somewhat less than twice as many as the PRHEP, its nearest rival. In extreme contrast to the early years, mining installations now produce only six percent of units generated.²⁴ The major utilities have extended their supply facilities to include almost all the mining zones of the West Coast; private installations of more than 1 MW capacity are restricted to the Port Dickson refineries, the BBC transmitter at Johore Bahru, and to iron and tin mines operating to the east of the Main Range and in northern Perak. A few small hydroelectric stations constructed before the First World War in Perak are still operated by mining companies.

The role of the major prime movers in 1962-1963 was: steam turbines produced seventy percent of all units generated, diesel sixteen percent, and hydro stations fourteen

percent.²⁵ This does not fully reflect the impact of the Cameron Highlands hydroelectric project, since only the first 50 MW of the full 100 MW capacity were commissioned in 1963. This project involves the diversion of three easterly draining streams in the Cameron Highlands, via two tunnels and a storage reservoir, to an underground power station at Jor (Fig. 4).²⁶ The tailrace waters of this station, together with the Batang Padang River, will provide the power for the 150 MW Woh station now under construction a few miles away. The Jor power station represents a 150 percent increase in Malayan hydroelectric capacity and also the first significant exploitation of the country's potential since the completion of Chenderoh. Both the Jor and Woh power stations are designed to provide some peaking capacity to complement the thermal stations of the lowlands. Power from the Jor station is transmitted to the CEB central network, in which the main loads are 100 miles to the south. Figure 3d indicates the scheme's contribution to the CEB system, in particular the use of the Jor station to meet peak demands.

Location

The location of generating capacity, other than diesel, still shows a marked concentration on the West Coast (Fig. 2), which corresponds to the dominance of that region in all sectors of the economy. The existence of a number of large mining companies in Pahang and Trengganu has not stimulated the extension of electricity supplies to large areas, since the mines are located in areas of low population density and weak purchasing power.

The location of steam turbine stations is today clearly linked to coastal sites. The only exceptions to this in recent years were the Bungsar station in Kuala Lumpur, finally shut down in 1963, and the two PRHEP stations. The inland stations of the 1930's were fueled from the Selangor coalfield, but with the post-war expansion in Southeast Asian petroleum production, and the relatively high cost of the poor quality local coal, all Malayan

²² Federation of Malaya, Central Electricity Board *Annual Reports*, 1950 to 1963 (Kuala Lumpur).

²³ N. S. Ginsburg, *Atlas of Economic Development* (Chicago: University of Chicago, 1961), p. 88.

²⁴ *Fourteenth Annual Report*, footnote 11, Appendix XII.

²⁵ *Fourteenth Annual Report*, footnote 11, Appendix XII.

²⁶ Central Electricity Board, *Cameron Highlands Hydro-Electric Scheme* (Kuala Lumpur, Straits Times Press, 1963); Hochtief AG and Philipp Holzmann AG (Joint Venture Cameron Highlands), *Cameron Highlands Hydro-Electric Scheme Malaya* (Essen: n.d.).



FIG. 2. Major transmission lines and generating stations of more than 100 kW capacity in Malaya, 1963. The transmission systems of the Central Electricity Board and Perak River Hydro-Electric Power Company are shown.

TABLE 2.—PRINCIPAL GENERATING STATIONS IN THE FEDERATION OF MALAYA, 1963

Station	Agency	Prime mover	MW capacity
Connaught Bridge	CEB	Steam Turbine	80
Malim Nawar	PRHEP	Steam Turbine	54*
Jor	CEB	Hydroelectric	50**
Penang	George Town C.C.	Steam Turbine	30
Malacca	CEB	Steam Turbine	30
Chenderoh	PRHEP	Hydroelectric	27
Batu Gajah	PRHEP	Steam Turbine	24
Johore Bahru	CEB	Steam Turbine	20

* Additional 40 MW capacity being installed.

** Additional 50 MW capacity being installed.

thermal stations were converted to petroleum fuel after the war. The attractions of steam turbine stations on the coast are obvious: direct tanker-to-station fueling, cooling water supply, and distances of not more than fifty miles from the main West Coast load centers. The two PRHEP thermal stations maintain their position because of the exceptionally concentrated load in the Kinta Valley.

The location of the hydroelectric stations is equally, though perhaps more obviously, restricted by factors of site suitability and load centers. The larger hydro stations built so far, Chenderoh, Jor, Robinson Falls, Ulu Langat, the Rahman Hydraulic Tin Company's station at Klian Intan in Upper Perak, all correspond to the greater gradients and heads available in the Main Range of northern and central Malaya. Malayan streams are in general well graded, so that potential sites for high-fall stations tend to lie well into the Main Range and to lack extensive natural storage possibilities. With the exceptions of Chenderoh and some of the small mining stations, the hydro stations so far constructed or under investigation are all high-fall; consequently, their output varies with seasonal fluctuations in rainfall and runoff. In the first year of operation, the ratio between maximum and minimum output from the Jor station was of the order of three to one.²⁷ In the western lowlands, variable flow, flood liability, and shifting channels present considerable obstacles to the construction of run-of-the-river schemes but several such stations are planned for tributaries of the Pahang River in inland Pahang.

The locational restrictions observable in the case of hydro and steam turbine stations do

not apply to low and medium capacity diesel plants; indeed this is the principal advantage of the latter. With a range of capacity of up to 9 MW, the diesel plant is suited to the supply of small loads, and diesel stations show the widest spread over the country. They form the only source of supply for isolated mining and industrial consumers and, more important, for nonindustrial population centers outside the main networks. Diesel stations thus constitute the only means of supplying electrical power on the East Coast and in much of the northern and southern extremities of the West Coast. Although diesel electricity supply costs are relatively high, they are less so than the construction of lengthy transmission lines to outlying centers. Compensation for cleared rubber land, the costs of clearing jungle and of providing insulation against frequent thunderstorms, make line construction charges heavier than in other countries.²⁸

Consumption

From the map of supply and demand zones (Fig. 5) it will be seen that of the Federation's maximum demand of 267 MW in 1963, 257 MW occur on the West Coast, and only 10 MW in the three East Coast States of Pahang, Trengganu, and Kelantan, which contain one-sixth of the Federation's population. Furthermore, about four-fifths of the total maximum demand is located in zones Ib and Ic, most of this in southern Perak and Selangor. These two states remain the foci of mining, indus-

²⁷ Information supplied by the Hydro Division, Central Electricity Board.

²⁸ K. H. Wong, "Some Techno-Economic Considerations in the Development of the Central Electricity Board's Transmission and Distribution Networks in the Federation of Malaya," in United Nations, Economic Commission for Asia and the Far East, *Proceedings of the Regional Seminar on Energy Resources and Electric Power Development, Bangkok, December 1962* (New York: United Nations, 1962), p. 305.

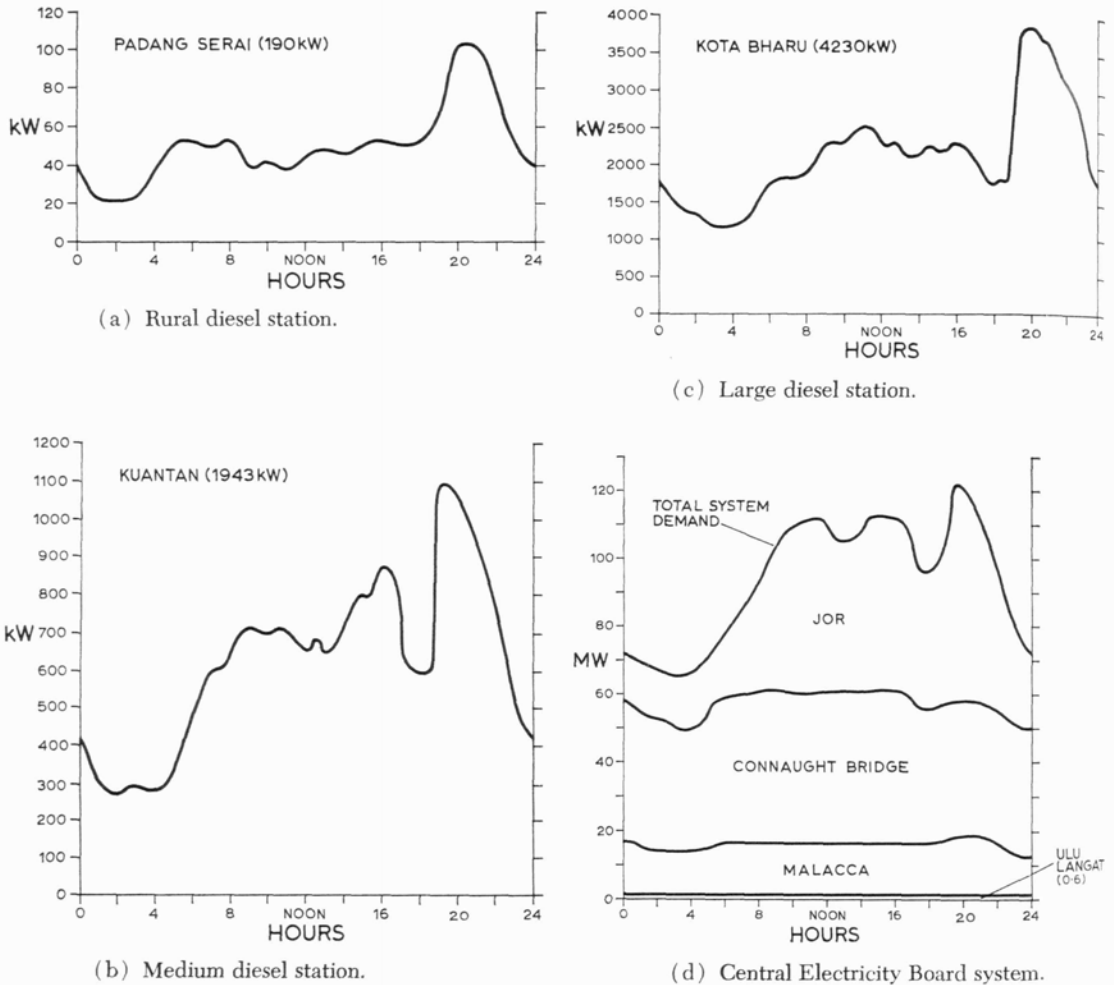


FIG. 3. Representative station and system daily load curves (August, 1963).
(Sources: CEB and Huttenbachs Ltd.)

trial, commercial, and domestic consumption of electricity.

Regional and local differences in the pattern of electricity consumption are indicated in the daily load curves of representative systems and stations (Fig. 3). The chief contrast lies between the load curve characteristic of predominantly domestic and commercial consumption, typified by the small diesel stations, and the load curve of the CEB system, which shows a more balanced combination of demand by different consumer categories over the twenty-four hours of the day. Many rural and small town diesel stations are operated for twelve hours or less per day, since demand is chiefly for shop and domestic lighting in the early hours of the evening. On the

CEB system, mining and industrial consumption during the day, together with evening domestic and commercial demand, have helped in recent years to produce an annual load factor of sixty-seven percent.²⁹

Rural Electrification

The extension of electricity supply to the rural population occupies a prominent place in the Federation Government's national and rural development plans. For a number of reasons such extension for the present represents a social service rather than the tapping or creation of profitable new markets. Even in developed Western countries, rural elec-

²⁹ *Fourteenth Annual Report*, footnote 11, p. 35.



FIG. 4. Construction of the Ringlet reservoir dam, part of the first stage of the Cameron Highlands scheme. Water from the 1.48 million cubic feet reservoir reaches the underground Jor power station, 1,900 feet below, through several miles of tunnels. (CEB photograph).

trification poses major economic problems, by reason of the small and dispersed demand, and usually necessitates some form of subsidization. In Malaya, as in the rest of Asia, rural purchasing power is weak and the costs of rural electricity distribution and generation are high.

Asian countries have been urged to adopt rural electrification programs in order to improve the amenities of the rural majority of their populations, and to increase rural productivity.³⁰ The Malayan CEB program consists mainly in the extension of existing power lines to nearby villages, but in some cases use has to be made of small diesel generators (Fig. 6). Government grants towards capital

costs are available, but very rarely do revenues cover operating costs in the first few years. In 1959–1960 only seven of the thirty-four CEB diesel stations produced an operating surplus.³¹ To increase the profitability of rural electrification, rural demand must be created or stimulated. Such demand as exists at present is for domestic lighting which, although it improves welfare and amenities, does not directly generate increases in rural income. The productive use of electricity in this context depends upon the application of electricity to farming and to the provision of employment in the agricultural off-season in the form of cottage or rural industry.³²

³¹ K. H. Wong, *op. cit.*, footnote 28.

³⁰ United Nations, Economic Commission for Asia and the Far East, *Proceedings of the Regional Seminar . . .*, p. 17; see also United Nations, Economic Commission for Asia and the Far East, *Rural Electrification* (New York: United Nations, 1954).

³² United Nations, Economic Commission for Asia and the Far East, *Proceedings of the Regional Seminar . . .*, p. 19; see also E. W. Golding, "Rural Electrification in Developing Asia," *Far East Trade*, Vol. 17, No. 4 (April 1962), pp. 427–29.

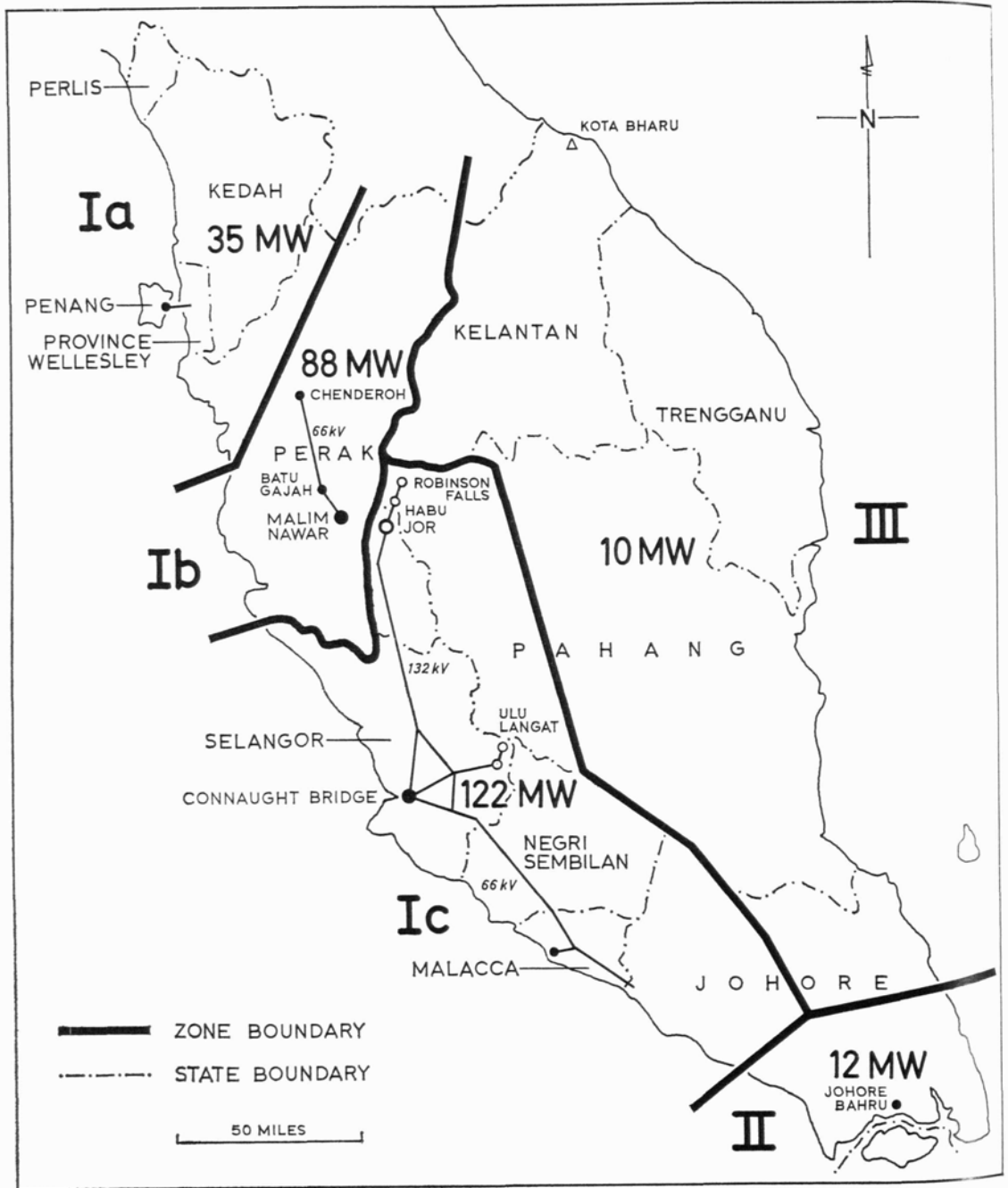


FIG. 5. Maximum demand zones, 1963.

(Source: J. Sharples, 1964).

The chief Malayan agricultural activities, rice and rubber cultivation, do not offer obvious avenues for the application of electricity. Water pumping for irrigation, which consumes large amounts of energy elsewhere in Asia, is not often required in Malaya because

gravity flow is generally available. The primary processing of latex offers no better prospects, and the load fluctuations of other rural energy consumers, such as the timber mills, are often too great for the small plant capacity of rural diesel stations.



FIG. 6. The opening of a 3×28 kW rural diesel station.

(CEB Photograph).

The prospects for rural and cottage industry in Malaya and Southeast Asia have been outlined by Fryer. His conclusion, that the greater part of Malayan industrial growth will take place in the large urban areas,³³ seems an understatement in the light of the very limited government investment in rural industry most of it in handicrafts such as batik textile printing.³⁴ Indeed the development of rural industry, were it to be pressed, would face far greater obstacles than the lack of electric power. The lack of managerial and labor skills, to say nothing of the economics of small-scale production, might render such a policy little more than an exercise in social nostalgia.³⁵

³³ D. W. Fryer, "The Development of Cottage and Small Scale Industries in Malaya and in South-East Asia," *Journal of Tropical Geography*, Vol. 17 (1963), pp. 92-98.

³⁴ Government of Malaysia, *Interim Review of Development* . . . , pp. 7, 22.

³⁵ The term is Galbraith's. "In the United States this interest in handicrafts rarely leads us to advocate a return to a handicraft industry. We realize . . . that

In short, rural electrification in Malaya will serve for a considerable time the important but limited end of improving rural amenities. It may thus assist indirectly in generating economic growth by increasing the consumption propensities of the rural population; the wider application of electricity in rural areas will depend on increases in productivity achieved by other means.

Industrialization

The prospects of a high and steady rate of increase in the Malayan labor force for many years ahead, and the need for a diversification of production to avoid dependence upon tin and rubber have lent urgency to industrialization. Government policy in this sphere is pas-

it is costly and inefficient and that the returns are inherently meagre. But we enthusiastically recommend handicraft industries to other people who are better conditioned to poverty. Economic missions to the underdeveloped countries regularly urge the revival of the 'traditional' industries." J. K. Galbraith, *The Liberal Hour* (London: Hamish Hamilton, 1960), pp. 129-30.

sive, aiming primarily at the attraction of private investment by the provision of a suitable infrastructure and tariff protection for industrial development.³⁶ The first fruits of this policy have been described as³⁷

a small light industries boom, largely centralized around the capital city, Kuala Lumpur.

The present structure of electricity supply facilities on the West Coast has, however, permitted a measure of manufacturing dispersal within that region. Thermal and hydroelectric systems are available to supply the industrial estates which have been established on the outskirts of Johore Bahru, Seremban, Kuala Lumpur, Ipoh, and Butterworth. A second estate is proposed between Kuala Lumpur and Klang, and when the PRHEP and CEB systems of the central West Coast are linked to the CEB system based on the Prai thermal station, the development of an industrial estate at Taiping will be assisted. The type of industry now being established in Malaya, mainly light chemical, pharmaceutical, food, metal, and plastic manufacturing, can be accommodated without great difficulty within the CEB's expansion program. Such industries are attracted to the labor markets of the major urban centers, which already have grid supply facilities or a large thermal station. The extension of the CEB grid may also facilitate the creation of further industrial estates in urban centers now served by diesel stations.

Although industrial and commercial consumption of electricity is increasing at a rate faster than that of any other consumer group,³⁸

³⁶ E. L. Wheelwright, *The Industrialization of Malaya* (Melbourne: Melbourne University Press, 1965), *passim*.

³⁷ Wheelwright, *op. cit.*, footnote 36, p. 116.

³⁸ Wheelwright, *op. cit.*, footnote 36, pp. 72, 74; also "Industrialization in Malaya" in T. H. Silcock and E. K. Fisk (Eds.), *The Political Economy of Independent Malaya* (Canberra: Australian National University, 1963), pp. 227-28 states that domestic consumption of electricity in the period 1957-1962 increased four times as fast as industrial and commercial consumption. This conclusion was based on official statistics which have since been revised: States of Malaya, Department of Statistics, *Monthly Statistical Bulletin of the States of Malaya, March 1964* (Kuala Lumpur: Government Printer, 1964), p. 69, footnote 1. The revised figures indicate an annual increase between 1957 and 1963 of 15 percent in industrial and commercial consumption, 13 percent in domestic consumption.

much mining and some industrial power is still nonelectric. In 1962 almost half a million horsepower of nonelectric machinery, equivalent to 370 MW, were used by mining and industry.³⁹ These installations indicate the extent to which the CEB is unable to supply electricity to outlying mining, and to a much lesser extent, industrial consumers. But in the present pattern of manufacturing growth, with its emphasis on suburban industrial estates, new manufacturing establishments find little need for, or advantage in, their own power supplies.

The commissioning of the Cameron Highlands hydro station in 1963 enabled the CEB to reduce electricity tariffs slightly, but this and future hydroelectric developments will not produce cheap electric power by world or Southeast Asian standards.⁴⁰ There is, therefore, no likelihood of the growth of power-intensive manufacturing based on hydroelectric power, such as has taken place in Mindanao, where a major scheme has been developed in isolation from existing Philippine electricity demand centers. The Cameron Highlands and planned new schemes will feed directly into the transmission system of the West Coast, thus reinforcing the orientation of industry to that region.

The role of electric power in Malayan industrialization thus reflects national economic policy. Power supplies are furnished to manufacturers who prefer locations in and around the urban centers of the West Coast. The extension of the transmission system has to some extent enabled manufacturing to develop away from the favored location around Kuala Lumpur, but no use is made of electric power development to attract manufacturing into the less developed areas of the East Coast. Given these conditions, the electricity supply industry has been successful in meeting the demands made of it.

FUTURE DEVELOPMENT⁴¹

The CEB estimated for the IBRD mission

³⁹ Federation of Malaya, Machinery Department, *Annual Report 1962* (Kuala Lumpur: Government Printer, 1963), Table IX.

⁴⁰ Tariff rates for ECAFE and other countries are given in United Nations, Economic Commission for Asia and the Far East, *Electric Power in Asia and the Far East, 1961 and 1962*, Table 18.

⁴¹ J. Sharples, *A Long-Term Forecast of the Development of Electricity Supplies in the States of*

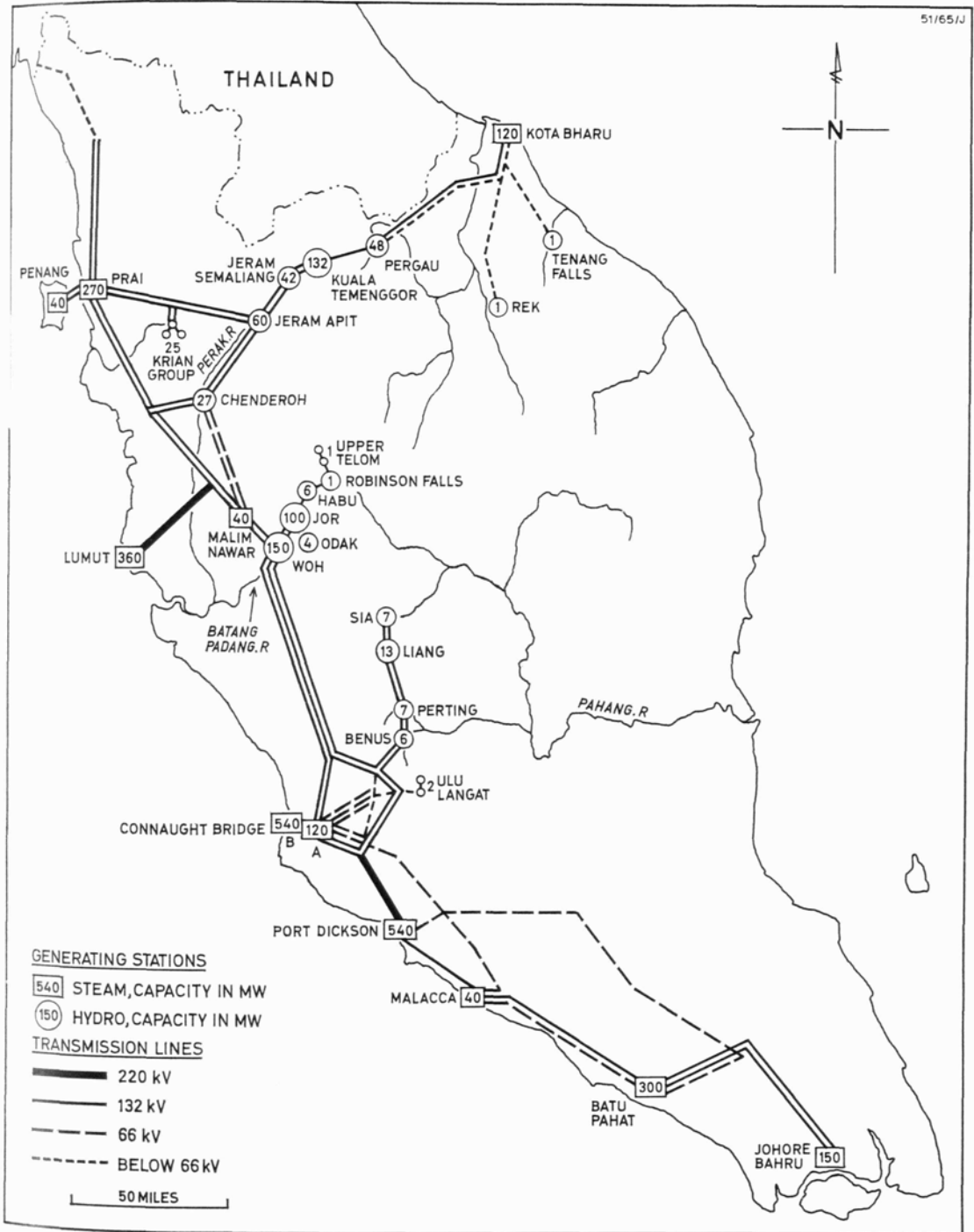


FIG. 7. Projected public utility generating stations and transmission lines for 1993.
(Source: J. Sharples, 1964).

in 1954 that the hydroelectric potential of the country amounted to about 260 MW. In his 1964 forecast of future development, Sharples, the former General Manager of the CEB, noted that:⁴²

the total hydroelectric potential of Malaya has not even been approximately assessed. [But] the quantities of this form of power from sources from which the energy can economically be transmitted to the presently more developed western States of the country probably do not exceed 750 MW.

He added that unless the unexplored areas to the east of the Main Range are opened up, not more than one-quarter of the country's electric energy demand thirty years hence will be met from hydroelectric stations. This implies that although the country's hydroelectric potential is considerable, and that although the relative share of hydroelectric may increase to some extent, the bulk of the country's needs will in the long term be met from thermal sources.

The increases in thermal capacity required to meet an estimated maximum demand of 2,880 MW in 1993,⁴³ are in part to be achieved by extending the capacity of the existing thermal stations at Connaught Bridge, Malacca, Johore Bahru, and Malim Nawar, and in part by the construction of new stations on the West Coast at Prai, Lumut, Port Dickson, Batu Pahat, and the first steam turbine station on the East Coast, at Kota Bahru (Fig. 7). All these stations, with the exception of Malim Nawar, will be on the coast; one of them might be a nuclear power station.

The principal plans for harnessing water power affect two river systems: the Batang Padang-Cameron Highlands, and the Upper Perak River. The second stage of the Cameron Highlands scheme, the Woh power station on the Batang Padang River, is now under construction. With an initial 100 MW capacity, it will supply an interconnected CEB-PRHEP

Malaya (Kuala Lumpur: Central Electricity Board, 1964); "A Long-Term Forecast of the Development of Electricity Supplies in the Federation of Malaya," *Journal of the Singapore-Malaya Joint Group*, Vol. 6, No. 2 (1961), pp. 2-20; "Regional Survey 1955 to 1960 and Forecasts for 1965, 1970, 1975, and 1980 for the Federation of Malaya, Singapore, Sarawak, Brunei, and North Borneo," *Transactions, 6th World Power Conference* (Melbourne: 1962), Vol. 1, pp. 107-19.

⁴² Sharples, 1964 *op. cit.*, footnote 41, p. 7.

⁴³ Sharples, 1964 *op. cit.*, footnote 41, p. 9.

TABLE 3.—MAXIMUM DEMAND IN THE FEDERATION OF MALAYA, 1963, AND FORECAST FOR 1993

Zone	Maximum demand 1963		Maximum demand 1993	
	MW	%	MW	%
Ia	35	13	520	19
Ib	88	33	400	14
Ic	122	46	1,500	54
II	12	4	200	7
III	10	4	160	6
Total	267	100	2,880	100

Source: Sharples, 1964.

system. The Upper Perak River, upstream from Chenderoh, is estimated to be capable of taking a further 260 MW of generating capacity. A 60 MW station is to be constructed at Jeram Apit by 1976, and a 132 MW station at Kuala Temenggor by 1984. These stations will lie between, and some distance from, the nearest demand centers in Province Wellesley-Penang and Perak. Other smaller projects involve the development of smaller stations on inland tributaries of the Pahang River, with a link to the West Coast network across the Main Range. Similar run-of-the-river schemes are proposed for the Krian River. Outside these areas, a number of potential sites exist in northern Kelantan and Trengganu, but here the weak prospects of an adequate demand make their development within the next two decades more doubtful.

The CEB's projected transmission network for 1993 (Fig. 7) indicates that the whole of the East Coast, with the possible exception of Kota Bahru, will then still remain outside the main network. Diesel plants will, therefore, continue to supply the electricity needs of the East Coast, unless industrial developments in such towns as Kuantan and Kuala Trengganu should warrant the construction of steam turbine stations or the exploitation of local hydroelectric potential. Outlying points on the West Coast may also continue to be served by diesel stations, which also perform a useful peak-logging function on larger systems.

The distribution of electricity demand forecast for 1993 shows some points of interest (Table 3). Demand in the three East Coast states, zone III, is not expected to be more than six percent of the total in 1993, barely more than the present proportion. On the West Coast the share of total maximum demand in southern Perak, Selangor, Malacca,

Negri Sembilan, and northern Johore (zone Ic) is expected to increase considerably. From this it may be inferred that the present concentration of economic activity in the central West Coast region is expected to increase over the next thirty years, and that no significant degree of industrialization is expected outside the West Coast.

It is generally considered that electricity consumption by the mining industry is now at or near its peak, and that the coming years will see a stabilization in demand from that quarter. The working of low grade tin deposits in the future will maintain energy demand, even though tin output may fall. The greater part of the expected increase in consumption will, therefore, come from manufacturing industry, commerce, and domestic use. Industrial development in Malaya is still in its infancy, and even though per capita domestic demand may never reach levels typical of temperate climates, there is room for major increases in this category too.⁴⁴

The main feature of planned developments in transmission is the integration of the West Coast in a network which will extend to southern Johore and to Perlis, combining the CEB and PRHEP in the same system. Work has started on the Selangor-Penang connection. It is not considered likely that Kota Bharu, the main population center on the East Coast, will be connected within the next two decades, and then it will be via the Upper Perak River hydro stations along the northern frontier of the country. By 1993 certain zones will be net exporters of electricity: zone Ic will export to southern Johore and southern Perak, whereas the Upper Perak River stations in zone Ib will export to Province Wellesley and Penang.

CONCLUSION

The present annual per capita consumption of electricity for all purposes in Malaya stands

⁴⁴ For an estimate of the potential demand for electricity for use in space-cooling, see M. G. Graham, "Factors affecting the future pattern of the world energy market," *Transactions, 6th World Power Conference*, Vol. 10, pp. 3975-996.

at about 220 kWh. The increases in consumption forecast for 1993 (when population is estimated to reach 17.5 million),⁴⁵ will raise this figure to between 800 and 900 kWh. This will be a significant increase, but 900 kWh per capita is no more than the present level of consumption of such countries as Denmark, Ireland, and Israel. Electricity production at this level will entail the development of almost all the Malayan hydroelectric potential, and heavy reliance will have to be placed upon imported fuel for thermal electric generation, unless major petroleum fields are discovered within the Federation of Malaysia, or until the costs of nuclear generation can be reduced to acceptable levels.

The Malayan government policy of emphasizing the provision of electric power for industrial growth in the western states, which constitute the more attractive zone for private capital investment, should be viewed from this light. The construction of thermal stations, the development of a West Coast transmission system, and the exploitation of hydroelectric resources in conjunction with the extension of the system are all measures which will reinforce the economic dominance of the western states. Some dispersion of industrial growth within this region will be possible, but since hydroelectric potential is limited and inadequate in itself to attract industrial development to the less developed eastern states, such a policy of electric power supply can do little to offset the current disadvantages of the East Coast.

This situation has important repercussions on the success of the rural electrification program. Unless private or government investment in 'suprastructure' is directed to the less attractive rural areas, electricity supply will be restricted to nondynamic amenity purposes. The contention that rural electrification can directly help to improve rural incomes and productivity is undeniable, but the full success of such a program depends upon co-ordinated development over a much wider field than electricity supply alone.

⁴⁵ Sharples, 1964 *op. cit.*, footnote 41, p. 4.

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