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HOUSEHOLD ENERGY CONSUMPTION IN WEST SUMATRA. IMPLICATIONS FOR POLICY MAKERS

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Abstract—The results of a field survey on domestic energy consumption in West Sumatra are discussed within the context of Indonesian energy policy, particularly with regard to the problem of domestic kerosene subsidisation. Many energy planners believe that the heavy subsidies on kerosene are necessary to prevent deforestation and protect the poor. Inequalities in fuel consumption for different sectors of the population may vary for different uses. In formulating policies aimed at reducing inequalities it is helpful to consider the end uses of the fuels separately. Energy use in cooking and lighting and the villagers' attitudes towards different fuels are investigated to see what effect a removal of the kerosene subsidies would have. In the case of lighting, a removal or reduction in the subsidies would primarily affect the lowest income sector of the population, unless a system of loans or subsidies is established for the initial installation charges of electricity. For cooking the higher income group would primarily be affected, and reducing the subsidies would not cause considerable hardship to the villagers or adverse environmental effects as there are considerable underutilized forest resources in the region. However, unless suitable alternatives to kerosene are made available at reasonable prices, the villagers now using kerosene would consider it a retrogressive step in their standard of living to return to the use of smoky and inconvenient open wood fires.

INTRODUCTION

Many researchers in rural energy planning have pointed out that rural energy strategies should be assessed as part of an integrated rural development policy. Aside from the problem of agreeing on development objectives, which are not always consistent since there are frequently conflicts between the objectives of rural development and those of overall development, the long term priorities of energy planners may not coincide with the shorter term ones of the villagers themselves. Social and private assessments are likely to involve different criteria. A villager is not likely to be concerned with the economics of the subsidisation of kerosene, only with the market price. It is difficult to interest a villager in using a more efficient stove, being involved in a community woodlot if he is not directly experiencing the effects of deforestation by having to pay for fuel that was previously free, or having to spend more time in collecting wood.

A survey was conducted of domestic energy consumption in two West Sumatran villages and some of the results are summarized here. These are discussed within the context of Indonesian energy policy, particularly with regard to the problem of domestic kerosene subsidisation. An attempt is made to investigate the difference in the energy planners' priorities and those of the villagers for domestic energy use.

THE ENERGY OUTLOOK FOR INDONESIA[1-4]

Indonesia is rich in natural resources and, unlike most other developing countries, is a net exporter of energy. The last decade has been a period of rapid economic growth for the country, with an average GDP growth of 6.5% per year (1974–79). However, with a population of 150×10^6 and a population growth rate of 1.8% per year (1970–77) poverty is still wide spread; the per capita GDP was $440 in 1980. Indonesia is a large equatorial archipelago with a land area of nearly 2×10^6 km^2 distributed among over 13,000 islands. The population is very unevenly distributed, with about 64% concentrated on the islands of Java and Madura which comprise only 6.7% of the land area. This has not facilitated the development of the varied resource base as the resources are mainly situated at considerable distances from the densely populated areas where there is a high and rising energy demand.

Of the country's energy resources only oil has been substantially developed as the oil resources are readily available and require relatively little infrastructure for production and distribution. Petroleum and gas exports are an important source of government income,

accounting for 65% of total exports in 1979–80. Indonesia is one of the 12 largest o producers in the world, having a production level of almost 1.6×10^6 BPD (1979), projecte to reach 1.8×10^6 BPD by 1984. However, the rapid rise in domestic consumption o petroleum products, in part due to the growth in GDP but aggravated by the heavy subsidie on domestic oil products, could have serious implications for the country's developmen strategy. As petroleum production levels off, oil exports are likely to drop and the incom from petroleum products will decline.

In the long term there are many options open to Indonesian energy policy maker resulting from the diverse energy resources which are as yet relatively undeveloped. Natura gas reserves have been conservatively placed at more than 30×10^{12} ft^3. Coal reserves ar estimated at between 5 and 15 $\times 10^9$ t; however the 1979 production of coal was onl 250×10^3 t. Hydropower potential is estimated at 31,000 MW, primarily in the outer islands the installed capacity by 1977 was only 450 MW. There is also a promising geotherma potential, as yet untapped.

The main objectives for Indonesian energy policy, developed by the Ministry of Minin and Energy, are documented in the Third Five-Year Development Plan (1979–84).[5] Two o the immediate problems in trying to achieve the objectives are the increasing domesti demand for heavily subsidised oil products and the associated loss of revenue, and th overuse of forest resources causing deforestation and soil erosion, which is occurring mainl on the densely populated island of Java. There is a need to investigate ways of curbing thi increasing demand for oil products, and to ensure that the country's substantial biomas resources are being used in the most appropriate and efficient way.

DOMESTIC OIL SUBSIDIES

Many external energy experts, including World Bank advisors, have emphasised th need to reduce the subsidies on domestic oil products. There has been a reluctance on th part of the government to employ prices as a tool of management for a variety of reasons including environmental, income distribution and inflationary considerations. In 1980 kerosene and diesel fuel accounted for 70% of the total sales of petroleum products Comparison of the 1980 internal prices with off-refinery prices in Singapore (taken as th international prices) shows that it is these two products which are most heavily subsidised: the internal prices for kerosene and diesel were 21 and 28% of their respective internatio prices. Kerosene alone accounts for almost 50% of the total economic subsidy on oi products, with a subsidy of $1720 million in 1980.[1] The argument that price controls ar necessary to prevent erosion, and protect the poor are particularly relevant to the case o kerosene, which is primarily used in the household sector for basic needs such as cooking and lighting.

About 80% of the population, especially those in rural areas and low income groups, still use firewood for cooking. Population pressures have increased the demand for wood resulting in deforestation, soil erosion and all the associated problems.[6] With an increasing number of households turning to kerosene as a cooking fuel, it is believed that the subsidy on kerosene helps in reducing the overuse of forest resources, particularly on Java. However, Gillis[3] has calculated that if seen as an erosion control programme, the kerosene-cum-diesel fuel subsidy for 1979–80 cost about $77,000 per hectare protected. Since the most expensive replanting programme would only cost $500 per hectare, the oil subsidy seems to be a grossly inefficient means of preventing erosion.

A substantial amount of kerosene is consumed by the poorest sectors of the population, especially in rural areas where there are no alternative energy sources (such as electricity) for lighting. Although the heavy subsidy on kerosene helps the poor, several studies have suggested that it helps the higher income groups considerably more. According to 1976 expenditure data, the poorest 40% of the population used only 20% of the kerosene. The evidence suggests that for every one rupiah of kerosene subsidy benefitting the very poor, four rupiahs benefit the relatively well-off.[3]

Many authors[1,4] have suggested that the money involved in the subsidisation of kerosene would be better employed in developing alternative fuels for its replacement. This could involve the financing of rural electrification (initially to replace kerosene in lighting) and th

development and production of LPG, natural gas and coal—specifically geared to replace kerosene in cooking. Bechtel has also suggested the manufacture of ethanol from biomass and expanded use of charcoal. There is also the need for reforestation programmes (especially in Java) and for additional research and development into more efficient cooking stoves.

In order to assess the potential for such new technologies, more detailed data are required on the present household energy consumption patterns, and the villagers' attitudes towards energy use. Several surveys have been done in Java, where 70% of all domestic kerosene is consumed. However, very little work has been done in the outlying islands, with 36% of the population, which account for a surprisingly high 30% of the kerosene consumption, in spite of the fact that in most areas there are ample biomass resources available.

HOUSEHOLD ENERGY CONSUMPTION IN TWO WEST SUMATRAN VILLAGES

Two villages in West Sumatra were chosen for the survey on household energy consumption. Taruyan was a small isolated village of 41 households, and in common with 85%† of villages in West Sumatra had no electricity; the fuels used for cooking and lighting were wood and kerosene. The second village, Bukit Apit, was near the main town of Bukittinggi and much more developed, and was chosen so that an estimate could be made of the change in domestic energy use as development occurs and a choice of fuels becomes available. With a population of 603 households a census was impractical, and a sample of 40 households was taken. Three-quarters of the households had electricity, which was used primarily for lighting. The remainder used kerosene lamps. Both wood fires and kerosene stoves were used for cooking.

The results from the household survey are summarised in Table 1. The main domestic

Table 1. Annual energy use in domestic sector.

A: Taruyan (41 households; 243 household members)

	Manhours	Firewood (kg)	Kerosene (l)	Other (kg)
Cooking	62,800	93,200		2,400
Water collection	19,000			(as
Washing	14,300			bagasse)
Wood collection	13,700			
Food to farm	4,600			
Lighting	-		10,600	
Total	114,400	93,200	10,600	2,400

B: Bukit Apit (40 households; 265 household members)

	Manhours	Firewood (kg)	Kerosene (l)	Electricity (kWh)	Other (kg)
Cooking	54,100	70,200	10,200		3,100
Water collection	1,200	-	-		(as
Washing	13,900	25,700	1,900		coconut
Wood collection	400				shells)
Food to farm	-				
Lighting	-		3,700	13,600	
Total	69,600	95,900	15,800	13,600	3,100

†Private communication from Kepala P.L.N., Cabang Bukittinggi.

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Table 2. Calorific content of annual energy use in domestic sector, MJ.

A: Taruyan (41 households; 243 household members)

	Manhours	Firewood	Kerosene	Other	Total
Cooking	65,900	1,388,700		22,100 (as bagasse)	1,476,700
Water collection	20,000				20,000
Washing	15,000				15,000
Wood collection	14,400				14,400
Food to farm	4,900				4,900
Lighting	-		399,200		399,200
Total	120,200	1,388,700	399,200	22,100	1,930,200
%	6.2	71.9	20.7	1.1	=100.0

B: Bukit Apit (40 households; 265 household members)

	Manhrs	Firewood	Kerosene	Elect.	Other	Total
Cooking	56,800	1,046,000	383,900		42,500 (as coconut shells)	1,529,200
Water collection	1,300	-	-			1,300
Washing	14,600	382,900	71,600			469,100
Wood collection	400					400
Food to farm	-					-
Lighting	-		140,100	49,000		189,100
Total	73,100	1,428,900	595,600	49,000	42,500	2,189,100
%	3.3	65.3	27.2	2.2	1.9	=100.0

activities involving substantial labour inputs are cooking, water collection, washing clothes, wood collection and carrying food to the rice fields (in the case of Taruyan). In Taruyan an average of 4.2 hr/household/day were spent in cooking, 1.3 in water collection, 1.0 in washing clothes, 0.9 in wood collection and 0.3 in taking food to the sawah. Wood collection involved relatively few manhours compared to studies done elsewhere, such as India,† since wood is still freely available in the surrounding jungle. Little time was spent in carrying food to the rice fields as this was only done during specific tasks such as harvesting. In Bukit Apit comparable time was spent on cooking and washing (3.7 and 0.9 hr/household/day respectively) but considerably less time on water and wood collection. Most households had private tanks and only 17.5% needed to collect water, either from the mosque or a neighbour's rain tank; an average 0.08 hr/household/day was spent in water collection. Of the families cooking with firewood only 12.5% collected it, the remainder bought it; this resulted in an average of 0.03 hr/household/day being spent in wood collection. Overall the average total domestic manpower input per household had decreased by almost 40% in Bukit Apit, reflecting the fact that considerably less effort needed to be spent on subsistence type activities in the more developed village.

Comparing the fuel consumption in the two villages, it can be seen that a higher level consumption is attained in Bukit Apit than in Taruyan, as might be expected. Using calorific content of the energy inputs‡ (Table 2), the average annual domestic en

†Reddy[7] found that an average of 1.7 hr/household/day were spent on wood collection in his study villages in Karnataka, S. India.

‡The conversion factors used in this paper are 1.05 MJ/manhr, 14.9 MJ/kg firewood, 37.7 MJ/L kerosene, 3.6 MJ/kWh electricity, 9.2 MJ/kg bagasse and 13.7 MJ/kg coconut shells. The value for the calorific content of wood used assumed that the moisture content of the wood weighed (which was air dry) was 20% on a dry basis. It is thus somewhat lower than the values used in many surveys which are quoted for oven dry

consumption per household is 47.1 GJ in Taruyan and 54.7 GJ per household in Bukit Apit. However, a comparison of absolute calorific values does not account for the different grades of energy sources (electricity, for example, is a much higher grade fuel than firewood) or the efficiencies with which the fuels are being used. Since energy was used less efficiently in Taruyan than in Bukit Apit, the difference between the two villages is likely to be higher if units of useful energy were used.

Looking at the composition of the fuels used, it can be seen that in Bukit Apit the contribution from firewood has decreased by nearly 7 percentage points, while that of kerosene has increased by 6.5 percentage points. The patterns of fuel use in cooking and lighting will be discussed in more detail in the following sections.

COOKING

All the households in Taruyan used tungkus (3 stone fires) and firewood for cooking, supplemented by small quantities of vegetable waste, primarily bagasse. Wood was a free fuel as it was collected from private plots or from the jungle. There was no evidence of deforestation in the area and ample resources were owned by the village for continued and even expanded use of wood as a fuel. The village owned 150 ha of forested land (including 10 ha of private cinnamon estates) which could provide an estimated minimum of 900 tonnes of wood annually;† this is approximately ten times the present annual fuelwood consumption.

Households collected on average 3.3 bebans or headloads a week, and only spent an average of 6.5 hr in fuel collection a week. Wood was collected by both men and women, and there were no complaints about the time involved in wood collection. When asked whether they would prefer to cook with kerosene, householders invariably replied that they would not consider using a fuel they had to pay for. However, several women were less than happy with the working conditions in the kitchens, which were frequently small, smoky and difficult to keep clean. There was also the constant risk of fire, especially in the dry season. Households used an average of 6.26 kg wood a day, which was used solely for cooking and boiling water for drinking. Clothes were washed in the stream, and the villagers ridiculed the idea of heating water for bathing themselves, which was an activity pursued by the softer breed of town-dwellers.

In Bukit Apit households used a mix of wood and kerosene for cooking. Out of the 22 households using wood only 6 collected it, either from private gardens or derelict houses (which were made from wood and bamboo). The remaining ones bought it daily from wood sellers who came in from the surrounding area. Households used an average of 6.95 kg of wood and 0.86 l. of kerosene for cooking, boiling water for drinking and heating water for washing.

Measurements were taken for 20 samples of rice cooking and the efficiencies of cooking with wood and kerosene were estimated from $\epsilon_0 = [(M_pC_p + M_mC_m + M_rC_r)(T_c - T_a) + M_rK_r]/M_fE_f$, where M_p, M_m, M_r, M_f are the masses of the pot, water, rice, fuel; C_p, C_m, C_r, C_f are the specific heat capacities of the pot, water, rice, fuel; T_c, T_a are the cooking and ambient temperatures; K_r is the energy requirement for the chemical reaction to take place; E_f is the calorific value of the fuel. The efficiency for cooking with wood was found to be about 7% and that for kerosene to be about 18%‡ (see Fig. 1). These efficiencies were used to calculate the useful energy used by the households. As expected considerably more useful energy was consumed by households in Bukit Apit than in Taruyan—almost twice as much (see Table 3). This was partly due to the additional fuel used in heating water for washing and also because more of the energy intensive foods, such as meat dishes, were cooked.

The households in Bukit Apit were disaggregated according to the type of fuel used, and it was very surprising to find that households using wood consumed 74% more useful

†Earl[8] has estimated that the annual increment of green wood per ha for equatorial rain forest is 6.0 tonnes. This is for virgin rain forest, and the annual increment in a village managed forest is likely to be considerably higher.

‡ϵ_0(wood) = 0.069 ± 0.018; ϵ_0(kerosene) = 0.18 ± 0.04.

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Table 3. Cooking in Taruyan and Bukit Apit.

	No. of households	Average no. of household members	Average wood consumption (kg/hh/day)	Average kerosene consumption (l/hh/day)	Useful energy+ (MJ/hh/day)	Time spent in fuel collection (manhrs/wk)	Time spent cooking (manhrs/day)	Fuel costs (Rp/hh/day)
Taruyan All households	41	5.9	6.26	-	6.5	6.6	4.2	0
Bukit Apit Households using wood	8	5.1	14.03	-	14.6	0	3.6	196
Households using wood and kerosene	14	8.6	11.84	0.87	18.3	0.6	4.6	240
Households using kerosene	18	5.7	-	1.24	8.4	-	3.0	105
All households	40	6.6	6.95	0.86	13.1	0.2	3.7	170

+Calculated using efficiencies of 7% (wood) and 18% (kerosene).

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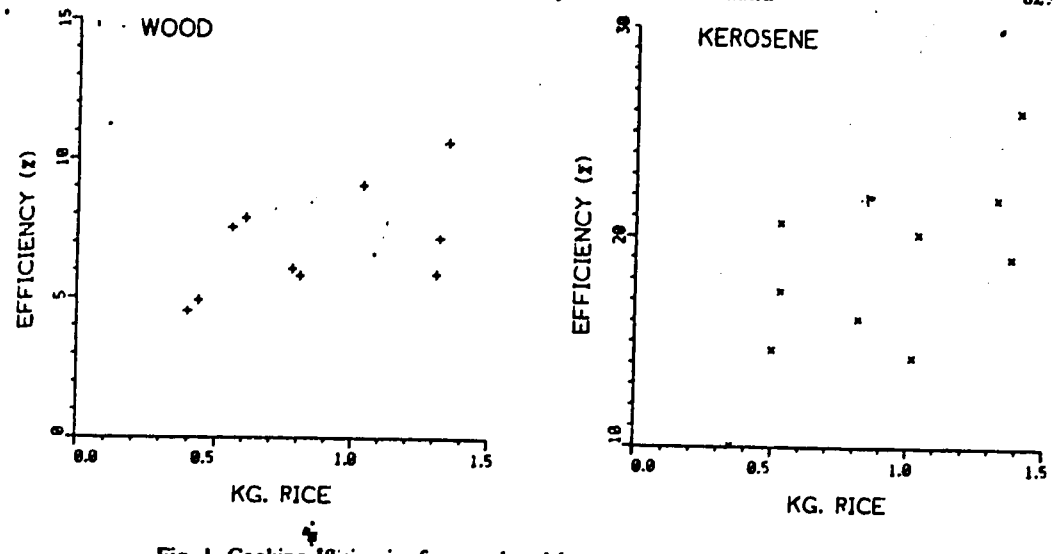

Fig. 1. Cooking efficiencies for wood and kerosene plotted vs kg of rice cooked.

energy on average as those using kerosene, although household sizes were comparable (see Table 3). Errors in respondents' answers cannot account for this large discrepancy, and it is likely that the efficiency calculated for wood is somewhat overestimated. The efficiencies were calculated for the specific task of cooking rice, rather than for total usage. It was observed that in general women did not extinguish any wood that remained after cooking, but it was left smouldering providing heat and light.† Wood tungkus were left burning between different dishes as they were more troublesome to light than the kerosene kampers, that could easily be turned off and relit.

COSTS OF COOKING AND DAILY COOKING LOAD

It might be expected that the choice of fuels would be a function of price, income and non-price considerations (such as convenience). Wood was certainly used more by households with lower standards of living, or in the case of households using both wood and kerosene, larger families, but this seemed to be a result of perceived costs rather than actual ones. Only one of the householders using wood expressed a preference for it on the grounds of the taste of the food cooked, the remainder would have preferred kerosene, but said it was too expensive. However, as shown in Table 4 the average fuel costs for a family cooking solely with wood were nearly Rp 200 a day, compared to just over Rp 100 a day for a family using kerosene. In useful energy terms, the costs were comparable, since as already mentioned wood consuming households used almost twice as much useful energy as the kerosene consuming ones.

The capital cost of a tungku was negligible, since it was made by the villager from a few bricks, whereas that of a kampor was in the region of Rp 2000–3000.‡ However, this was a comparable price to that of a kerosene lamp, which all households possessed. In general it seemed to be the fuel, as much as the stove, that the villagers felt they could not afford. There might have been several reasons for this. Firstly, until recently wood was cheaper than kerosene, but a rapidly increasing price of wood and continued heavy subsidisation of kerosene eroded the difference. Secondly, wood tended to be bought daily in small bundles whereas kerosene was bought once or twice a week in larger quantities; to a family on a small daily source of income this could be an important factor. Thirdly, and this was probably the main reason, that householders who had been brought up using wood that was collected from neighbouring land and still free, had learnt from youth that

†A limitation in the definition of efficiency used is that by-products such as the provision of heat and light are not accounted for.

‡Market price, Bukittinggi, December 1981.

Table 4. Lighting in Taruyan and Bukit Apit.

	No. of households	Average no. of household members	Average kerosene consumption (l/hh/day)	Average electricity consumption (kWh/hh/day)	Average daily fuel costs (Rp/hh/day)
Taruyan					
All households	41	5.9	0.70	-	60
Bukit Apit					
Households using kerosene	10	6.1	0.89	-	75
Households using kerosene and electricity	4	6.8	0.38	0.94	81
Households using electricity	26	6.8	-	1.30	60
All households	40	6.6	0.26	0.94	72

kerosene was an expensive fuel, used by richer families. An additional factor that was important was that very low income families using wood still had the option of collecting it in times of financial stress.

The average time per household spent in cooking was 4.2 manhr/day in Taruyan and 3.7 manhr/day in Bukit Apit (Table 3). In Fig. 2 the total manhours per day spent on cooking is plotted against the time of day. The most obvious difference between the cooking load for the two villages is that meals were only cooked twice a day in Bukit Apit, where the men either did not come home for lunch or had a quick cold meal, compared to three times a day in Taruyan. It can be seen from Table 3 that less time was spent by households in Bukit Apit cooking with kerosene kampors (an average of 3.0 manhr/day) compared to those using wood tungkus (an average of 3.6 manhr/day). The larger households using both wood and kerosene used an average of 4.6 manhr/day. It is difficult to draw conclusive results from these figures as there are many factors influencing the time spent cooking, such as the types of food cooked and the size of family (affecting both the quantity of food cooked and the labour available for cooking). In the measurements on cooking efficiencies it was found that there was little variation in the average time taken per kg rice cooked by wood and by kerosene; for wood the average time was ≈42 min and for kerosene ≈46 min.

LIGHTING

All the households in Taruyan used kerosene lamps for lighting, and there was an average fuel consumption of 0.7 l./day. Three types of lamps were used: lampu stroom (hurricane lamps), lampu semporong (chimney wick lamps) and lampu toggok (small bottle wick lamps). The levels of illumination and the fuel consumption rates of the three lamps were very different. Average consumption rates were calculated from measurements taken in the field, and from the data collected on hours of use and total fuel consumption. the hourly consumption rate of hurricane lamps was approximately four times that of the large wick lamps and twenty times that of the small bottle wick lamps. Total fuel consumption was obviously dependent on the number and type of lamps used (which is related to income and home size), but seemed to be independent of the family size.

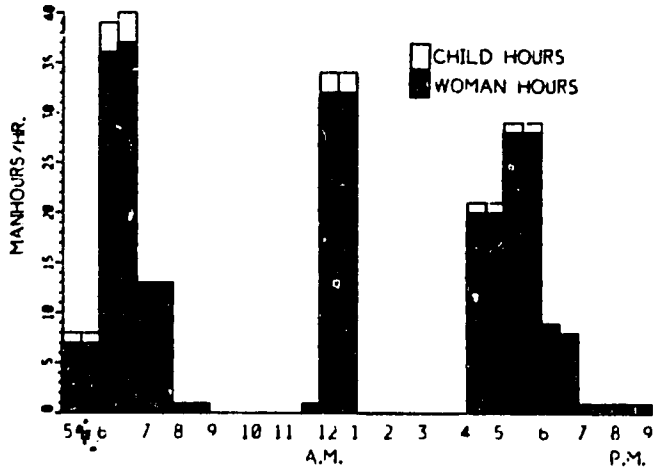

Fig. 2(a). Daily cooking load for Taruyan; the labour input is plotted against the times of cooking, showing the relative contribution from women and children.

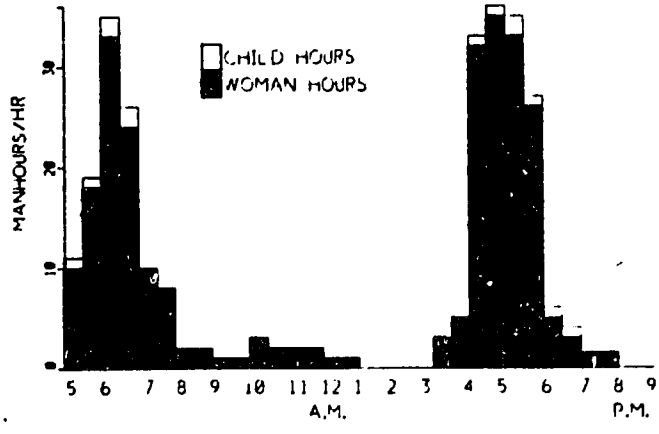

Fig. 2(b). Daily cooking load for Bukit Apit; the labour input is plotted against the times of cooking, showing the relative contribution from women and children.

In Bukit Apit, where households had a choice of electricity or kerosene for lighting, ten households used solely kerosene lamps, with an average consumption of 0.9 l. a day. This higher level of consumption reflects the fact that although kerosene was used by the poorer sector of the households in Bukit Apit they still tended to have a higher standard of living and larger homes than the villagers in Taruyan. These households would all have preferred electric lighting but could not afford the installation costs. All of the households using electricity owned at least one kerosene lamp, which was necessary because of the frequent power cuts in the region, but only four used both electric lighting and kerosene lamps on a regular basis. These households used an average of 0.4 l. kerosene a day and 940 W of electricity, compared to 1300 W used by the households using purely electrical lighting. The households using both types of lighting tended to use the kerosene lamps in the kitchen or bedrooms where they did not have electrical connections.

COSTS OF LIGHTING AND DAILY LIGHTING LOAD

If the costs of lighting are compared† (Table 4), it can be seen that households using solely electric lighting are paying less per day in electricity charges than the costs to those

†Using the market prices in Bukittinggi (December 1981) and P.L.N.[9]

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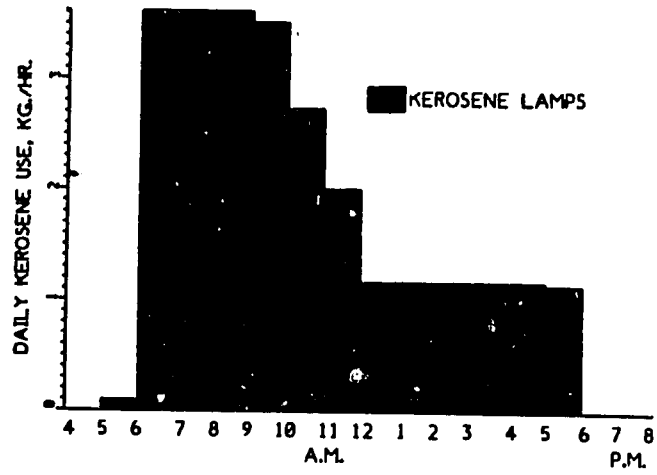

Fig. 3(a). Daily lighting load for Taruyan; average hourly kerosene consumption is plotted against the times of lighting.

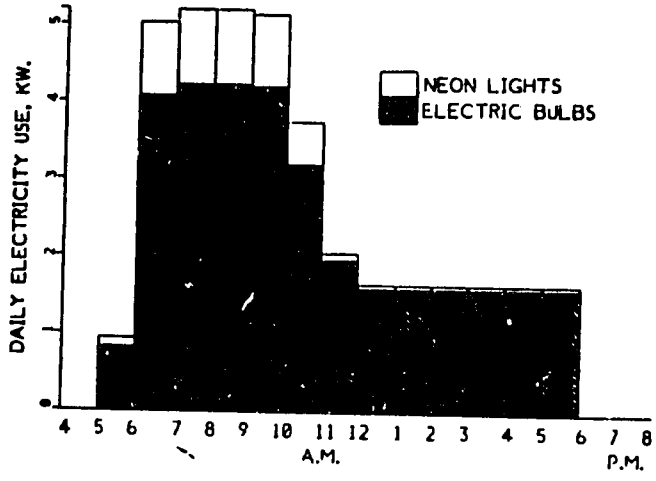

Fig. 3(b). Daily lighting load for Bukit Apit; average hourly electricity consumption is plotted against the times of lighting showing the relative contributions of neon strip lights and incandescent bulbs.

using kerosene or a mix of fuels. Almost half of the cost of electric lighting is in the form of the fixed charge (Rp 720 a month for an average 450 W installation). The average initial outlay for households using kerosene lamps is only Rp 12,500, whereas that for household using electricity is Rp 79,500, including installation and connection charges. The monthly fuel costs are comparable (slightly more for kerosene), but the initial outlay for electric lighting is approximately six times that of kerosene lamps. The fact that many household chose electric lighting, in spite of the increased costs, reflects not only the convenience of electricity but also the superior level of illumination obtained. Kerosene lamps may appear very romantic, but the sight of three or four children gathered round one lamp, straining to do their homework, soon dispels the romance.

The time profile for lighting in the two villages is shown in Fig. 3. It is worth noting that since both villages are situated close to the equator there is very little variation in the lighting load throughout the year, with lighting being used from about 6 p.m. to 6 a.m. Unlike the time profiles for cooking, those for lighting are very similar for both villages with a low level of lighting being maintained even into the small hours of the morning

Table 5. Fuel mix in Bukit Apit; the number of households and percentage of total households using different cooking and lighting fuels are shown.

COOKING \ LIGHTING	Kerosene	Kerosene and Electricity	Electricity	Total
Wood	3 (7.5%)	-	5 (12.5%)	8 (20%)
Wood and Kerosene	3 (4.5%)	1 (2.5%)	10 (25%)	14 (35%)
Kerosene	4 (10%)	3 (7.5%)	11 (27.5%)	18 (45%)
Total	10 (25%)	4 (10%)	26 (65%)	40 (100%)

Table 6. Fuel mix in Bukit Apit; the average daily kerosene consumption (in l.) per household is shown

Decreasing Kerosene Use →

↓ Increasing Kerosene Use

COOKING \ LIGHTING	Kerosene	Kerosene and Electricity	Electricity
Wood	0.89	0.38	0
Wood and Kerosene	1.76	1.25	0.87
Kerosene	2.13	1.62	1.24

This is very understandable in a small isolated village such as Taruyan, especially since many villagers are superstitious, but it is interesting that the same pattern is maintained in a more developed area. In Bukit Apit both types of lighting can satisfy the required load: in the case of kerosene the small bottle wick lamps tend to be used in the morning hours; in the case of electricity low wattage bulbs are used.

WHO BENEFITS FROM THE KEROSENE SUBSIDIES?

The data on daily fuel consumption in Bukit Apit was disaggregated into the nine possible mixes of fuel use for cooking and lighting in an attempt to see which sector of the population benefitted most from the kerosene subsidies. Unfortunately it had not been possible to collect data on household income for two reasons: it was frequently difficult for villagers to estimate accurately what their income was (especially if they were supporting other family members outside the household, or receiving additional income from relatives working in urban areas); in an initial trial survey it was found that villagers were often not very happy to answer questions relating to their income, although willing to respond to questions on fuel use. For the sake of building up a good rapport with the villagers it was decided not to include questions on income.

In Table 5, the number of households using the different fuel mixes are given, and in Table 6 the average daily kerosene consumption for each type of household.† A somewhat arbitrary division has been made into households with an option of fuel use for cooking and lighting (category A, shaded in the two figures) and those without an option for either

†These were calculated from the observed average kerosene consumption (l./household). For cooking, wood: 0.0, wood + kerosene: 0.87, kerosene: 1.24. For lighting, kerosene: 0.89, kerosene + electricity: 0.38, electricity: 0.0.

cooking or lighting, or both (category B). It was observed that, in general, households with an option on the type of fuel they used had a higher standard of li This is supported by the fact that out of the 30 electrified households (i.e., those who afford the initial outlay for electricity), 25 fall into the first category. Of the five house with electricity who use wood for cooking, four households would have preferred kerosene but were prohibited from doing so by the costs (although these were perc costs rather than actual costs, as mentioned in the last section).

The figures on average daily kerosene consumption per household shown in Tab reflect the decreasing use of kerosene as richer households turn to electricity for ligh and the increasing consumption of kerosene as kampors are used for cooking. The aver daily consumption for households in category A is 1.14 l., which is comparable to average for category B of 1.03 l. However, whereas in the first category there is variation between the different types of households (the range is from 0.87 l. to 1.6 there is a much larger difference between the households consuming least kerosene those using wood for cooking and electricity for lighting, and therefore consuming kerosene) and those which use kerosene for both cooking and lighting (with an aver daily consumption of 2.13 l.). Thus the households benefitting least from the subsidisat of kerosene, and those who benefit most both fall into the category of households no option for fuel use.

If the total kerosene consumption of each type of household is calculated, it is fo that the 62.5% of the households in category A consume 28.45 l. (i.e., 63.3% of the kerosene), and the remaining 37.5% of households use 16.47 l. (i.e., 36.7% of total kero consumption). Thus on average the kerosene subsidies benefit both categories of ho holds equally. However, as the results in Table 6 show these benefits were very inequit distributed in the case of households in category B, depending on what type of fuel used for cooking or lighting. In 1981 the kerosene subsidy was Rp 320/l.,† resulting in average annual subsidy of Rp 128,000/household (≈$100/household).

The total energy used for cooking and lighting by both categories of households be calculated using fuel equivalency values of 5.5 kg wood/l. kerosene for cooking 1.6 l. kerosene/kWh electricity for lighting.‡ It is found that both category A househ and category B ones consume similar amounts of energy for cooking —11.2 and 11. firewood equivalent/household/day respectively. However, for lighting households category A, with an average consumption of 2.08 l. kerosene equivalent/household consume almost 70% more energy than those in category B, with an average consump of 1.24 l. K.E./household/day. There appears to be a much greater variation in the u energy available to the different households in the case of lighting, than in the ca cooking.

CONCLUSIONS

In Taruyan there was little variation in fuel consumption between the households the villagers appeared fairly content with the traditional methods of cooking and light although they had a somewhat lower standard of living than the villagers in Bukit A However, several families had left the village to live in urban areas. The constra domestic energy supplies is unlikely to be a major factor in the problem of rural-ur migration, but it should be considered when evaluating integrated rural develop strategies.

In Bukit Apit where there was greater variation among households in both the and quantity of fuel used, there was increasing dissatisfaction with the traditional me of cooking and lighting. In the case of cooking kerosene stoves were preferred, main their convenience and ease of operation and control, but also because they were c and smoke free. Only one family chose to cook with wood because of the flavour food, and no families objected to the odour of the kerosene stoves. The main reas not adopting kerosene as a cooking fuel was the perceived costs. If this perception o were to alter with time, as is likely if the heavy subsidisation of kerosene is contin

†Assuming the internal price (Rp 85/l.) to be 21% of the international price.

‡The fuel equivalency value for cooking was calculated from the field data obtained in West Sum for lighting was estimated from data collected in other Indonesian surveys.[10,11]

considerably increased use of kerosene for cooking is likely. In the case of lighting all families would have preferred electricity, due to the superior level of illumination produced and its convenience, but the main constraint was the initial cost of installation.

The disaggregated data on kerosene consumption in Bukit Apit suggests that although on average the subsidies benefit all households equally, there is considerable variation in the benefit to households in the lower standard of living category (with no option on fuel use for cooking and lighting) depending on what methods they use. In general the subsidies benefit the richer households in the case of cooking (who are more reliant on kerosene stoves) and the poorer households in the case of lighting (who cannot afford electricity).

Although, for lighting, the kerosene subsidies are benefitting the lower income sector of the population, they also tend to maintain the lack of equity in the quality of life for the villagers. The recommendations from energy planners that the money involved could be more usefully employed in expanding the electrification programme would improve the living conditions of the villagers, if it were accompanied by a system of loans or subsidies for the initial installation charges for the poorer villagers. As mentioned previously, the monthly costs for lighting with electricity are slightly lower than those for kerosene.

In the case of cooking there appears to be a greater conflict between the aim of the energy planners to reduce kerosene consumption and the aspirations of the villagers, as increased use of kerosene stoves has led to higher standards of living for those who can afford them. Although wood is being used very inefficiently, even when it is bought, there is no evidence of deforestation.† Attempts to introduce improved wood or charcoal stoves should concentrate as much on improving the performance of the stove as regards ease of control and operation, reduction of smoke and fire risks, as on increasing the efficiency of the stove.

Reducing the kerosene subsidies as far as cooking goes would mainly affect the higher income sectors of the population, and would not be likely to cause any considerable hardship to the villagers or adverse environmental effects (as considerable supplies of wood are still available). However, the villagers at present using kerosene would consider it to be a retrogressive step in their standard of living to return to the use of smoky and inconvenient open wood fires. It is unlikely that some of the alternatives suggested by energy planners (such as LPG and natural gas) would be available at costs comparable to that of subsidised kerosene, although others (such as the expanded use of charcoal and coal briquettes) might be feasible options. As yet there is no obvious solution to the problem of maintaining living standards if the kerosene subsidy is reduced.

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†Agam has large underutilized forest resources of approximately 60,000 ha[12] capable of providing a minimum of 3.6×10^5 t of wood/yr.

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