

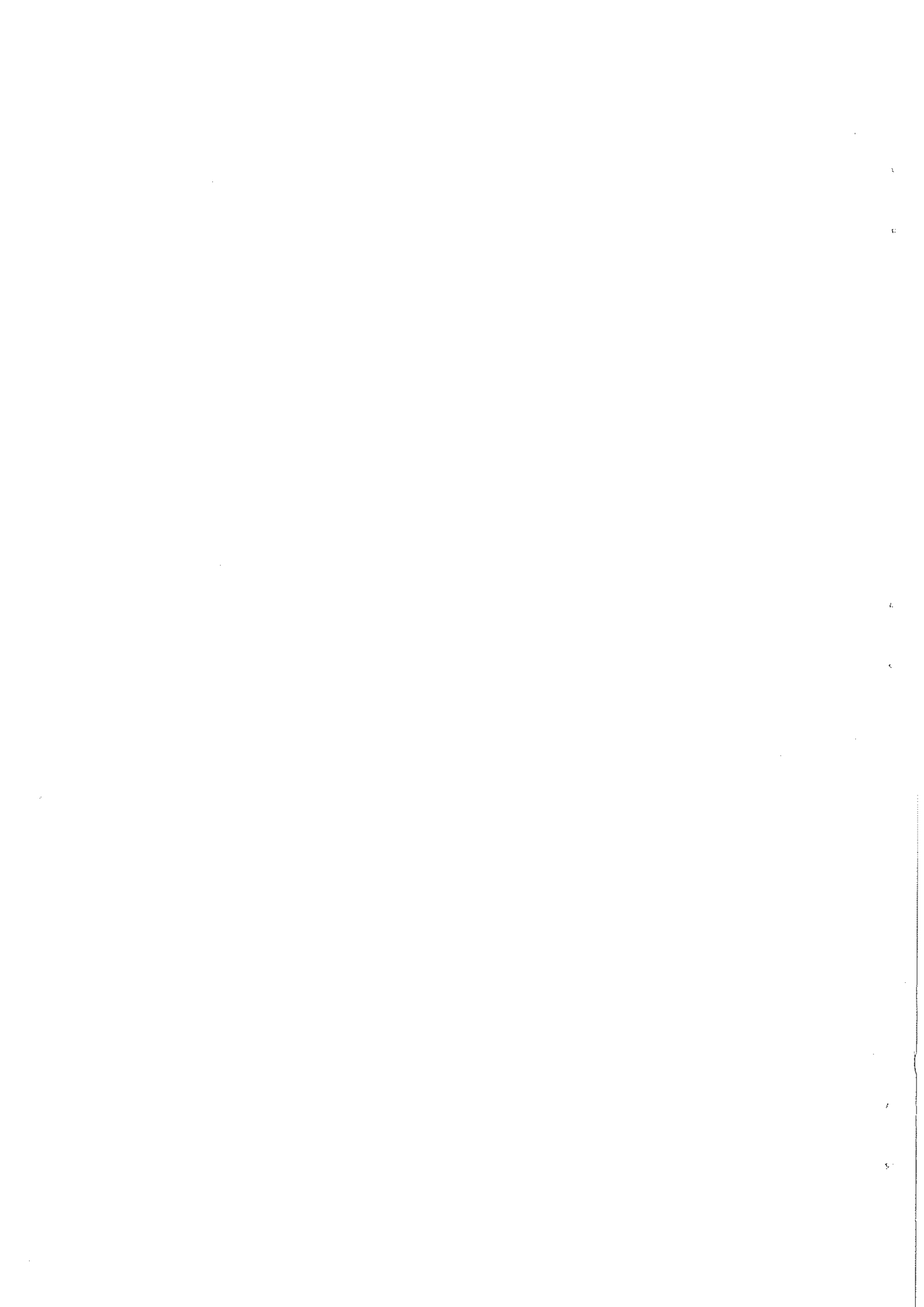
# The Economics of Energy in LDCs

A report on a workshop

*Edited by*

*Peter Pearson & Paul Stevens*

ECONOMICS  
DEPARTMENT



**THE ECONOMICS OF ENERGY IN LDCs**

A report on a workshop held on 28 September 1984  
at the University of Surrey

edited by

Peter Pearson

Paul Stevens

February 1985

Surrey Energy Economics Centre  
University of Surrey  
Guildford GU2 5XH

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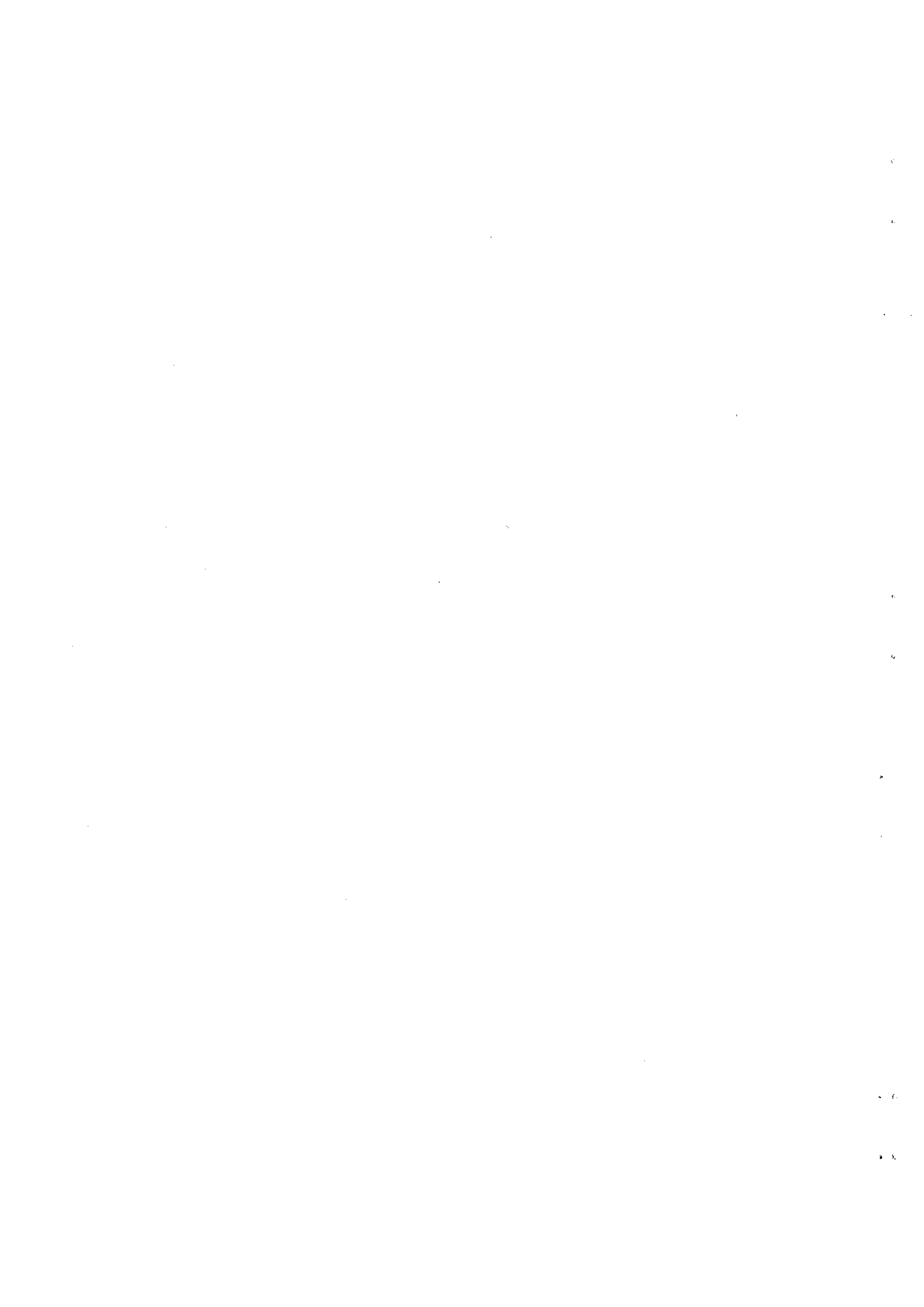
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## ACKNOWLEDGEMENTS

We would like to thank the Economic and Social Research Council for their financial support for the Workshop.

We would also like to thank the secretarial staff of the Department of Economics, University of Surrey - Liz Blakeway, Debbie Horwood and Sally Silverman, for their help with the organisation of the Workshop and the preparation of documents, including this report.



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## INTRODUCTION

The one-day Workshop, organised by Peter Pearson and Paul Stevens, with financial support from the Economic and Social Research Council, was held on 28th September, 1984, at the University of Surrey. It brought together more than forty people from a wide variety of disciplines and organisations to discuss issues in the economics of energy in LDCs. The participants' names, affiliations and interests are set out in the List of Participants. The Workshop demonstrated that despite the wide divergences of view among people concerned with energy policy issues in LDCs, there was one common tendency: that was for specialists to stress the importance of a broader perspective. Perhaps not surprisingly, however, there turned out to be more than one vantage point from which to view the scene.

We now turn to some of the main areas of debate that emerged during the Workshop.

### ISSUES IN THE ECONOMICS OF ENERGY IN LDCs

#### Economic Optimisation

The economic optimisation approach sets out to find economic policies (such as pricing and investment policies) that optimise the welfare of society as a whole. Newbery, in his paper, stressed the point that energy policy issues cannot sensibly be isolated from wider issues. Energy policy is only a part of economic policy in general and not an end in itself. Therefore, the object of energy policy cannot be as simple as trying to minimise energy consumption in a world of scarce resources. Such over-simplification can lead to facile suggestions - for example, that the efficiency of wood fires in rural areas can easily be doubled, thereby automatically halving fuel consumption and solving energy supply problems at a stroke.

to politics and policy was the way in which political decisions often impinged upon the nature of the technologies chosen. Stuckey pointed out, for example, that the optimal technology might not be disseminated unless the project had 'prestige' in government circles.

#### Substitution between Commercial Energy and Traditional Energy

The extent of substitution and its implications proved to be a source of major disagreement. This emerged in two areas, the specification of the models presented by Pearce and Westoby, by Hughes and by Newbery and whether or not empirical studies showed the existence of significant substitution. The main area of substitution which gave rise to disagreement was that between kerosene and woodfuel.

The models in the papers cited above assumed in much of what they did that there was in fact no substitution. However, it was not always clear whether this assumption was a simplifying assumption or an expression of reality in the longer term. Pearce and Westoby suggested that in the short term a lack of substitution was realistic. Hughes and Newbery suggested that in the longer term, for the size of price change likely to be politically feasible, the estimated impacts of such price changes were unlikely significantly to overestimate the true impacts. The assumed lack of substitution caused considerable unease for a number of the participants who argued that by ignoring substitution, the policy recommendations arising from such models were in danger of generating serious externalities in terms of environmental damage. It was further argued that the policy recommendations would also lead to impacts on income distribution that had not fully been taken into account in the papers which had concluded that changing CE prices would have limited distributional impacts.

This particular argument then led on to a debate which recurred throughout the day as to whether or not empirical work showed the existence of such substitution. The general consensus was strongly in favour of the existence of substitution and its consequent importance to energy policy makers, although it was vigorously argued that this view was not supported by econometric studies. This led to a further debate over whether the data base was adequate to support econometric work. It was argued by Pearson and Stevens that energy forecasting methods that failed to take account of potential substitution of commercial and traditional energy were seriously flawed and might offer poor guidance to energy policy-makers.

#### Problems of Data Availability and Relevance

There was general agreement that data on energy in the LDC's was a problem but considerable disagreement over what precisely was the nature of the problem.

References to the general inadequacy of statistical data not surprisingly recurred. Some argued that the problem was an absence of data, while others argued that data did exist but was in a format that was fragmented and non-comparable. This led on to a view expressed by some participants that the problem was not the need for more data collection but rather for more 'efficient' data collection. It was also pointed out that there were significant gaps in knowledge; for example, the lack of any economic data on the performance of small pumping sets.

A second area of concern was the relevance of the data. First there are the problems of moving from micro to macro studies, together with the issue of just how disaggregated the data should be. Howes pointed out wide differences between geographically proximate villages. This linked in to

the second aspect of the type of data needed and the need to formulate the 'correct' questions. Many argued that the data required covered more than simply energy data and that the examination of energy data (and problems) in isolation from the general context would lead to misleading results. On several occasions concern was expressed at the idea that policy implications were being derived from studies based on wholly inadequate information.

### Energy Technology

As Barnett pointed out, rural energy technology choice is now (albeit belatedly) widely recognised to be exceedingly complex, for economic, social and technical reasons. There is a need to avoid the technical mis-matches of the past. Among other things this requires the development of an appropriate analytical framework for rural technology choice which would permit proper comparative evaluation of both new and existing technologies in given end-uses.

On the demand side, it is clear that there has been a failure to understand and investigate the requirements, resources and hence the "effective" demand of actual and potential end-users for new appliances. As a result, appliances with inappropriate economic and technological characteristics (including price) or with an inappropriate balance of characteristics, have met with an unenthusiastic response despite the considerable amounts of resources devoted to their development and diffusion. This has been especially the case where the purchase of a new appliance does not lead to cash savings for those people for whom the price of fuel is not cash but rather the opportunity cost of labour time spent in collecting and preparing woodfuel, vegetable matter or dung. Thus, although much is now known about many of the technical characteristics of both new and old

conversion devices, far too little is known about their social and economic performance characteristics in different end-uses among different groups of people in different regions and economic circumstances.

Barnett's paper addresses this issue of technology choice directly, while the papers by Foley, Leach, Howes and Stuckey all related to aspects of technology choice. Foley addressed himself especially to the issue of technical mismatches - the wrong appliances offered to the wrong people at the wrong prices - "wrong" because they failed the market test and were not chosen and adopted by their intended users. Although people are beginning to mature in their knowledge of the problems of developing and disseminating new appliances, there are structural rigidities in the way funds are disbursed; for example, agencies and ministries often prefer not to supply resources to rural users in the form of general loans, to be used as the borrowers think fit - instead, ministries would rather use the resources to develop or promote specific devices which may or may not match the needs and resources of the anticipated users. And in the case of projects funded from overseas, people from developed countries often fail to make sensible use of local expertise which is much more readily available for older technologies, such as steam, than for newer and less-conventional technologies.

#### Biomass and Environmental Issues

Concern was expressed over the current and future adequacy of the supply of biomass fuels, clearly vital in rural areas and for the urban poor. Leach, however, stressed that in several countries (for example, India, Pakistan and Sri Lanka) these fuels are used in substantial amounts by the highest income households, even in urban areas, and thus, in some cases, there is a positive cross-sectional income elasticity of demand. He noted

that the tendency for household size to rise with income may be one explanatory factor. Leach also pointed out that the absolute and relative prices of firewood and kerosene vary widely, both between countries and over time. Government controls influence kerosene prices and hence the relative price of wood and kerosene, but he feels it to be less than obvious that these control strategies focussed on a commercial fuel are the most appropriate for managing biomass demand and supply problems.

Concern was expressed about the appropriate ways of analysing the externality/public good/common property resource aspects of traditional fuel production, collection and use (for example, deforestation resulting from over-exploitation of woodlands, with its consequent chain of environmental effects, such as soil erosion, siltification and flooding, lowering of the water table, and other effects on soil productivity). These problems arise partly because markets fail to convey appropriate signals about the social opportunity costs and benefits of biomass and environmental resources. By analogy, there was some scepticism about the extent to which the models that were focussed principally on commercial energy would appropriately (if at all) reflect the environmental costs and benefits of commercial energy pricing and investment decisions. There was some disagreement about whether these issues could be successfully treated in isolation from each other, either at the analytical or the policy-making levels.

Many of the issues raised at the Workshop could not be said to have been resolved. Nevertheless, the meeting did bring together a variety of energy specialists with diverse backgrounds and special interests and encouraged an exchange of views and areas of concern in a way that should help to stimulate more effective work in the future. It also informed people from different disciplines about substantive findings of current

research and proposed new lines of research, and effectively widened the participants' perspectives on data problems and prospects.





**ENERGY PRICE IMPACTS ON OIL-IMPORTING DEVELOPING COUNTRIES**

**David Pearce and Richard Westoby (University College, London)**

The Pearce-Edwards (1984) model can be used to assess the impact of a change in the world price of oil on selected countries GDP. For the case where internal prices do not adjust to world prices of crude oil and petroleum products and in the case where there is full adjustment of internal prices but no conservation effect the elasticity of output with respect to the world price of oil may be expressed as follows:

$$\frac{E^y}{w} = \frac{b \cdot h \cdot w \cdot EP}{Y} \quad (1)$$

where Y is output, EP is net exported production of oil, and w is the world price of oil. Note that b is the income multiplier and h is a coefficient which allows for the feedback of any change in oil consumption owing to a change in income.

This means of calculating the oil price impact is similar to the cost share approach employed by Pindyck (1979) and calculations for the Indian Economy made by Desai (1979). However, the elasticity derived from the Pearce-Edwards model involves not only the cost share of oil in output but also two parameters, b and h, which are effectively feedback effects from the first round impact on output.

We have used equation (1) as a basis for calculating the impact of changes in the world oil price in the latter half of the seventies on output in

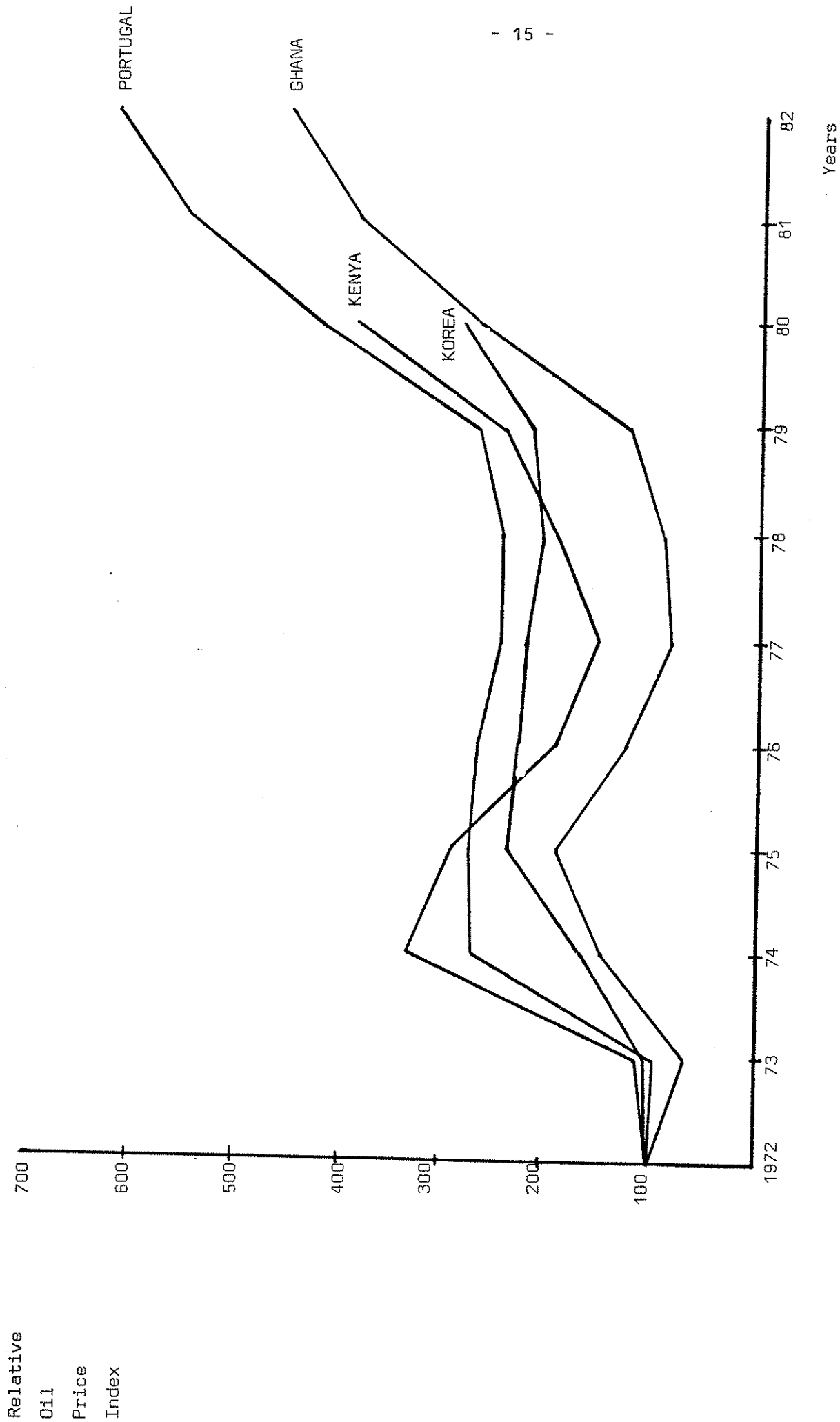
only three per cent. Our calculations suggest that the rise in the relative price of oil can be blamed for some of the decline of growth in this year. However, it should also be noted that non-oil import prices rose twice as fast as non-oil export prices between 1979 and 1980.<sup>1</sup> Thus the non-oil terms of trade exacerbated the problems caused by the oil price rise. It could be argued that the deterioration of Kenya's non-oil terms of trade after 1979 was also in some part attributable to the oil price rise either through an impact on the coffee and tea market and/or via an influence on the price of non-oil imports. Unfortunately such indirect effects are very difficult to quantify.

Of the four countries under consideration, Ghana suffered the worst change in the relative oil price between 1979 and 1970. This was due to the continued decline in the world price of cocoa since 1977, which constitutes 70 per cent of Ghana's exports. However, the cost of net oil imports are only a small proportion of GDP (approximately 2 per cent) so the direct impact of the oil price change is less severe than in Portugal and South Korea. From Ghana's point of view a more serious development between these years was the severe decline in the terms of trade (a fall of over 20 per cent).

The experience of Portugal is a particularly interesting case. In spite of having a relatively high share of net oil imports in GDP (over 7 per cent) the rise in the relative oil price did not prevent the GDP of Portugal raising its rate of growth between 1979 and 1980 although this was at the cost of a huge increase in the balance of payments deficit. The success in maintaining growth over this period may be attributed in part to the large energy conservation programme in Portugal.

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1. 18% and 9% respectively.



Relative  
Oil  
Price  
Index

Years

TABLE I

	Change in relative oil price (%)	Impact on GDP when		
		bh=1	bh=1.5	bh=2
GHANA				
1976	-34.0	0.65	0.97	1.29
1977	-33.5	0.64	0.96	1.27
1978	9.5	-0.18	-0.27	-0.36
1979	35.7	-0.68	-1.02	-1.35
1980	114.4	-2.17	-3.26	-4.35
PORTUGAL				
1976	-2.7	0.21	0.32	0.43
1977	-7.3	0.58	0.88	1.17
1978	-0.2	0.02	0.02	0.03
1979	9.7	-0.78	-1.17	-1.56
1980	57.4	-4.59	-6.88	-9.17
SOUTH KOREA				
1976	-5.1	0.41	0.61	0.81
1977	-2.0	0.16	0.24	0.33
1978	-7.0	0.56	0.84	1.13
1979	6.7	-0.54	-0.81	-1.07
1980	30.1	-2.41	-3.61	-4.81
KENYA				
1976	-33.9	1.02	1.52	2.03
1977	-19.7	0.59	0.88	1.18
1978	25.8	-0.77	-1.16	-1.55
1979	26.5	-0.80	-1.19	-1.59
1980	57.6	-1.73	-2.59	-3.46

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- A.V. Desai "Impact of higher oil prices on India", World Employment Programme, Working Paper 50, September, 1979.
- D. Pearce and R. Edwards "Energy Policy in a Price-Regulated Developing Economy: A Study of Egypt", Journal of Economic Studies, Vol. 11, No. 1, 1984.
- R.S. Pindyck Structure of World Energy Demand, MIT Press, Cambridge, Massachusetts and London, England, 1979.

Discussion

In response to comments suggesting the importance of allowing for substitution and enquiring about the extent of substitution allowed for in the estimation procedures, the authors confirmed that in this paper they were using an initial-impact, no-substitution model (although the mechanism to include conservation effects is discussed in the Pearce and Edwards (1984) paper, referenced above). They argued that their estimates were particularly appropriate in the short-run.

It was suggested that it would be a good idea to deflate the price of oil by a different index, specifically the World Bank index of manufactured imports into LDCs.

A questioner raised the issue of the relevance of analysing price impacts in a situation where, on the one hand, the government runs the commercial energy sectors and can set prices but, on the other hand, has little or no influence on traditional energy prices.

THE INCIDENCE OF FUEL TAXES: A COMPARATIVE STUDY OF THREE DEVELOPING  
COUNTRIES

by G.A Hughes

Faculty of Economics, Cambridge and The World Bank, Washington, DC

Summary

The analysis of the incidence of taxes imposed on goods and services used as intermediate inputs into the production of other goods and services necessarily involves an attempt to estimate the indirect effect of such taxes on the prices paid by consumers and other final users. This is particularly important in the case of fuels both because fuel taxes/subsidies are a major item in the government budgets of most developing countries and because energy prices affect the prices and/or profitability of a wide range of goods and services. To allow for this indirect effect of taxes it is conventional to assume that changes in costs are passed on completely as prices changes and then to use data from an input-output table to estimate the effect of these changes on prices. This approach will be referred to as the 'cost-plus pricing rule'. Provided that a suitable input-output table - or similar source of data concerning the average cost structure of sectors - is available, this approach is relatively straightforward to implement.

There are, however, two major objections to reliance upon the cost-plus pricing rule:

- (i) It is strictly only valid for marginal changes in the relative prices of inputs, whereas specific taxes designed to collect significant amounts of revenue will almost always involve quite large changes in the relative prices of some inputs.
  
- (ii) For many sectors in developing countries prices may be determined not by costs of production but by the price of competing traded goods - for example, by the landed price of competing imports or by the world market price for exported goods.

Estimating the impact of non-marginal price changes on the cost of production requires detailed information on the cost function for each sector, which is certainly not available for any developing country at a reasonable level of sectoral disaggregation. It might be possible to make use of cost functions estimated for developed countries, but the work involved could only be justified if a simpler analysis suggested that there might be scope for significant cost savings by substitution between inputs in production. Reliance upon input-output data has the merit of overestimating the indirect effect of tax changes, so that it is possible to identify the sectors for which more extensive analysis of the cost function might be justified. Thus, in this paper the conventional approach is modified primarily by allowing a greater variety of pricing rules. The most important of these is the traded goods pricing rule which assumes that the domestic price is determined by the appropriate border price of competing traded goods.

Once the impact of tax changes upon the prices of goods and services supplied by the various sectors has been estimated, the analysis of tax



incidence proceeds by examining their effect upon households, Here, it is essential to use data on individual households from a household budget survey because substantial within-group variation in expenditure pattern means that the use of average expenditures for groups of households will fail to capture horizontal inequities in the incidence of the tax changes. As for the sectoral cost functions, it is very difficult to obtain plausible parameter values for household expenditure functions, so that the analysis of the welfare effects of tax changes is strictly valid only for marginal price changes since it relies upon information concerning the initial composition of household expenditure. Again, the approach followed will overestimate the impact of larger tax changes on households, so that it is possible to identify which categories of household expenditure warrant further investigation.

This method of analysis has been applied to three developing countries with widely differing economic characteristics:

- (a) Indonesia - using input-output data for 1975 and a household budget survey for 1981.
- (b) Thailand - using input-output data for 1975 and a household budget survey for 1975-76.
- (c) Tunisia - using input-output data for 1977 and a household budget survey for 1979-80.

The choice of countries was largely determined by the availability of suitable data, including an input-output table at a high level of disaggregation. For Indonesia and Thailand sectors in the original input-output tables were aggregated to yield tables for each country on

almost identical 73 sector bases, while for Tunisia the original sectoral breakdown was largely retained by working with a 111 sector table. In comparison with the cost-plus pricing model, the numbers of sectors for which non-cost-plus pricing rules were used are:

- (a) Indonesia - 21 traded sectors, of which 11 were imported items, plus 3 government-controlled sectors and 4 sectors with non-traded market pricing.
- (b) Thailand - 23 traded sectors, of which 11 were imported items, plus 4 sectors with non-traded market pricing.
- (c) Tunisia - 43 traded sectors, of which 29 were imported items, plus 5 government-controlled sectors and 8 with non-traded pricing.

These figures show that in Tunisia over a half of the sectors have their prices determined according to exogenous factors rather than on a cost-plus basis, so that the analysis allows considerable scope for differences between the price impacts yielded by the standard approach and the model adopted in this paper.

For each country it was assumed that taxes need to be raised in order to collect net revenues - after allowing for the higher cost of government purchases - amounting to 1% of total final demand. As well as taxes on petroleum products a number of non-fuel taxes have been examined in order to provide the basis for investigating revenue-neutral tax reforms - i.e. by raising some taxes and lowering others. The discussion concentrates upon five alternative methods of collecting the additional revenue; the percentage tax rates for these reforms in each country are:

	Indonesia	Thailand	Tunisia
1. All Petroleum Products	47.3	20.9	70.5
2. Gasoline	108.8	48.8	222.1
3. Other Petroleum Products	83.6	36.5	103.3
4. Import Sales Tax	9.3	8.5	5.4
5. Industrial Sales Tax	3.8	2.4	2.4

The differences in these tax rates across countries reflect variations in their initial levels of petroleum product prices and in their per capita incomes, which, of course, is closely associated with expenditure patterns. The two oil-producing countries - Indonesia and Tunisia - have particularly low prices for certain fuels - notably, kerosene and diesel oil - so that the tax rates on other petroleum products need to be high in order to collect sufficient revenue. Further comparisons are also possible because the effects of 50% tax rates on specific fuels - gasoline, kerosene, diesel oil and fuel oil - have also been examined.

From the perspective of the impact of the tax reforms on the general level of prices, the taxes on fuels lead to a lower increase in both producer and consumer price indices than either the import sales tax or the industrial sales tax. There are also significant differences between the pattern of price increases generated by the pure cost-plus pricing model and by the mixed pricing model adopted in the paper. In terms of the overall price indices, the pure cost-plus model tends to overstate the impact of fuel taxes on indices of producer prices, but the difference between the two models is relatively small for indices of consumer prices, because non-traded goods are much more important in consumption than in output.

If all prices adjust in line with input costs there can be no significant income transfers associated with tax changes. The sole effect on households will be changes in their cost of consumption. However, when some prices are determined on a basis other than cost-plus, changes in relative prices may cause substantial changes in relative factor payments. This was investigated for Thailand and for certain tax reforms - especially taxes imposed on traded goods - the resulting income transfers can be extremely important. There are obvious difficulties in investigating this effect of tax reforms - in particular the lack of good data on sources of income in most household surveys - but it is clear that this aspect deserves more detailed investigation.

Apart from the direct effect of fuel taxes on fuel prices, the relative prices changes associated with the fuel taxes are quite small. There is, therefore, no reason to devote a lot of effort to constructing more elaborate models in which the input coefficients or expenditure patterns depend upon all prices. On the other hand, since the direct effects of the tax reforms on fuel prices are very large, it would be desirable to extend the present model by allowing substitution in production between fuels, value-added and all other material inputs and also between specific fuels in the fuel aggregate. Similar kinds of substitution could also be allowed in consumption. Such a model could be constructed by incorporating appropriate assumptions concerning the separability of cost and expenditure functions.

Comparison of the effects of the fuel taxes and the other taxes on the distribution of real income across households show that, as one would expect for developing countries, the gasoline tax is generally the most

progressive of the five reforms and has the most beneficial impact on measures of inequality. However, none of the reforms has a large impact on overall inequality when compared with tax measures involving the same amount of revenue which are specifically designed to reduce inequality. Horizontal differences in the impact of the tax reforms on households at similar real income levels are most serious for the tax on other petroleum products, largely because of its effects on kerosene and/or LPG whose consumption vary greatly between households. This problem is most serious in Indonesia, where kerosene prices have been heavily subsidised for a considerable time, thus inducing substitution in both consumption and production away from other fuels in favour of kerosene. The implication of this result is that price distortions, if allowed to persist, can become so deeply embedded in economic behaviour that they are exceedingly difficult or painful to correct. In both Indonesia and Tunisia, the dependence of rural households on kerosene for cooking and other fuel requirements is such that the tax on other petroleum products - as well as, of course, the tax on kerosene alone - is regressive in simple terms and worsens the overall indices of inequality. It may be possible to devise tax reforms in which the increase in petroleum product prices experienced by the poor is offset by reductions in the taxes on other key items of consumption - or by income gains due to a reduction in export taxes - so that the net outcome is favourable. However, it has proved difficult to find products whose consumption correlates well with the consumption of kerosene in order to achieve this combination of tax changes.

Thailand has not allowed domestic fuel prices to get grossly out of line with world prices and as a result the quite large fuel taxes have a rather

small impact on both the general level of prices and the distribution of income. This may be interpreted in two ways:

- (i) It can be argued that there is no real basis for using fuel taxes as a method of achieving other social or economic objectives, so that they should be set to achieve efficiency in the use of different sources of energy and in the major energy-consuming sectors such as transport.
- (ii) The second interpretation concentrates on the finding that these taxes have a very limited impact on the economy as a whole. They may thus be seen as a desirable method of raising government revenue with an industrial sales tax being an almost equally attractive alternative.

The choice between these two interpretations depends on the weight given to government revenue relative to the efficiency losses associated with higher fuel prices and taxes. That remains a matter for future research.

#### Discussion

The author confirmed that no substitution of traditional fuels took place in the model when the price of kerosene rose, because no quantity changes were allowed for. In principle a supply-side for fuelwood could be built into the model (although this would not itself deal with the issue of deforestation).

A major disagreement emerged over the extent of price-induced substitution between traditional and commercial fuels. The author suggested that: (i) the traditional and commercial fuel markets were too segmented to allow for much substitution - because of relatively high marginal productivity and hence scarce time, people who normally buy in commercial fuel markets are unlikely to switch to collecting fuelwood unless there are very substantial rises in kerosene prices; (ii) econometric studies in Indonesia indicate cross-price elasticities between traditional and commercial fuels that are much lower than is generally asserted. However, other speakers argued that there is evidence of significant substitution of fuelwood for kerosene in Indonesia and elsewhere as a result of rising kerosene prices. The disagreement turned on the interpretation of the survey evidence and on the selection of appropriate econometric methods.

Concern was expressed that the paper did not deal with the important longer-term issue of deforestation. The author pointed out that, if the political will was there, tax revenue raised from increasing the price of kerosene could, in principle, be used to finance reforestation programmes.

**EQUITY, EFFICIENCY AND THE PRICING OF PETROLEUM PRODUCTS IN ASIA**

**David M.G. Newbery**

**Churchill College, Cambridge**

Summary

Oil products especially transport fuels and kerosene, are subject to a variety of taxes and/or subsidies whose rates differ widely between countries, and have changed significantly in real terms over the past decade. This report examines the theoretical issues involved in energy pricing, the practical constraints encountered in developing countries, and examines some of the options available. It shows how to reach conclusions given the particular circumstances of any given country, and illustrates this for the pricing of transport fuels in Thailand and Indonesia.

Energy pricing is part of energy policy, and Chapter 1 sets out the principles of energy policy more generally. It examines the constraints which limit government actions (and in particular, those which affect oil product pricing and taxation). These constraints depend in turn on the tax structure already in place, and the extent to which the country is an oil producer, and essentially reduce to the difficulty of making changes which are desirable on efficiency grounds but which have significant distributional consequences. These constraints may be more severe in an unstable economic environment, such as the world has experienced since 1973, and hence the differences between energy policy in a stable and unstable environment are examined in sections 1.3 and 1.4.

It is argued that in developed countries the main objective of energy policy is economic efficiency, which is therefore the criterion to use in



assessing oil taxation. The rest of the Chapter assesses how far this objective can be achieved.

Chapter 2 sets out a methodology of tax analysis, and argues that most energy tax analysis has been flawed by failing to allow adequately for the effects of the tax structure as a whole. Chapters 1 and 2 set out the principles to apply in countries with a potent tax system, and as such applicable in some advanced countries. Chapter 3 discusses the modifications required for application in developing countries. It discusses, briefly, the taxation of energy production, and the main topic of consumption taxes. The main difficulties arise when it is impossible to confront consumers and industrial producers with different prices, and it is argued that kerosene is the leading example. The rest of the chapter concentrates on kerosene pricing and the related problem of transport fuel pricing.

Chapter 4 discusses two derivations of the efficient price of fuel needed for taxing energy production and setting prices to non-energy producers. The particular problems of gas and electricity pricing are discussed, as well as petroleum product pricing.

Chapter 5 describes the methodology for assessing the distributional and inflationary impact of fuel price changes, illustrated for Thailand.

Discussion

In response to a comment suggesting that the demand for fuel can be affected in a variety of ways apart from price changes, and that energy policy is more a matter of institutional methods of policy implementation, the author emphasised that he wanted to take a broader view than that of the energy specialist. In particular, he was not aiming at minimising energy consumption but was concerned, as an economist, with maximising the welfare of society.

The interpretation of low cross-price elasticities between traditional and commercial fuels was discussed. It was suggested that the interpretation of the implications of a particular elasticity figure (though not the figure itself) would depend on whether the underlying quantities were measured in physical units of weight or in terms of thermal equivalents.

The political difficulties in raising fuel prices (especially kerosene prices) were discussed at some length. It was suggested that although there is resistance to increasing fuel prices, there are many instances where governments can and do change fuel prices (kerosene prices in Indonesia were quoted as an example). The degree of openness was thought to be relevant: where people are exposed to world prices they are used to exogenously changed prices - this is not so where governments have accepted responsibility for energy prices independently of world prices.

The issue of "second-best" optimal pricing was raised. Do you, for example, try to calculate optimal, distortion compensating oil prices? It was suggested that if the energy planner thinks that everyone else is trying to remove distortions then it makes sense to go for removing distortions in the energy area. However, even if this position is

accepted the calculation of the right distortion-offsetting price of oil turns out to be problematic. If others are not trying to remove distortions it is questionable whether oil prices should be used to attempt to compensate.

Several questioners felt that it was very important to explore the distributional consequences of fuel price changes on the income side as well as on the consumption side. It was accepted that this was desirable (and some attempt had been made to do this for Thailand - although it was asserted that these effects only really operate in the area of the effects on producers of exportable crops, e.g. rice, and it was claimed that in Thailand the changes on the expenditure side dominate those on the income side). The data difficulties involved in tracking income changes experienced by different income groups were stressed, but despite this several participants felt it to be worth pursuing where feasible.

## RURAL ENERGY PLANNING IN DEVELOPING COUNTRIES

### Summary

Gerald Foley, Energy Information Programme, Earthscan, London

Many of the programmes devoted to improving rural energy supplies in the developing world have been failures. Far too frequently, devices which would not meet the minimum standards of safety effectiveness and durability required of consumer products in the developing world were optimistically offered to peasants of developing countries as a means of solving their energy problems.

Many of these lessons have now been learned. The need for effective technology is now understood. But this is only part of the battle. The crucial factor, if a substantial impact is to be made, is whether a particular innovation will be self-disseminating. If new energy sources or improvements in energy efficiency are to have a significant impact, they must be capable of spreading rapidly and with a minimum of external assistance.

Rural energy planning must therefore be based on an awareness of the structure of the energy economy in any particular rural area. Figure 1 proposes a simple schematic division between the different energy-sectors in a typical poor developing economy. Each sector has its own particular characteristics which determine whether a particular energy innovation will be appropriate or not within it.

For example, biogas has been proposed as a solution to the firewood problem of the subsistence domestic sector. But because it requires a substantial capital investment it is beyond the reach of subsistence fuel users. If people are given a biogas system, their neighbours will be unable to

acquire one except as a donation. Biogas is more likely to find applications in the lower reaches of the cash economy.

Similarly, the types of fuel-saving cooking stoves which can be introduced into an area depend on the category into which fuel users fall. Those in the subsistence sector who obtain their fuel by collecting it from their surroundings will be able or willing to pay little if anything for a stove. In the upper levels of the cash economy they may be willing to pay a considerable amount for a durable and sophisticated device.

Other examples can be chosen, but the fundamental point is that it is essential to locate energy initiatives at their appropriate level and in the relevant sector of the rural fuel economy if they are to have a possibility of becoming integrated and self-sustaining measures for easing rural energy problems. This is not a matter of creating a hierarchy of actions, or making mutually exclusive choices. Rather, the objective is to devise a method of selecting a range of effective and complementary energy initiatives for different rural areas.

#### Further Reading

A number of the issues discussed here are examined further in:

Foley, G. (1984) "Outside the oil economy - rural energy in developing countries", in Policy and Development of Energy Resources, Shaw, T.L., Lennard, D.E. and Jones, P.M.S. (eds.), Wiley. Copies of the article are obtainable on application to the author.

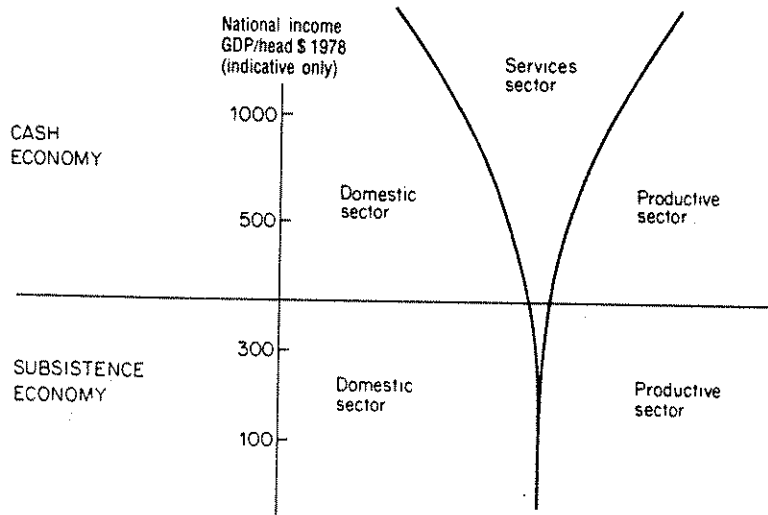


Figure 1. Schematic division between energy-using sectors in the rural fuel economy in the developing countries

Discussion

1. A case was made that with appropriate technology many of the mismatches would not occur and that appliance subsidies would help overcome the dissemination problem resulting from low income. However it was emphasised several times in the discussion that people had to want the appliance otherwise its dissemination would simply not happen. Furthermore, it was pointed out that consumers' choice may not necessarily produce the expected result. An example cited was the case where housewives adopt stoves which use much more energy but save scarce labour time. Thus it was argued that a 'systems' approach was needed, with emphasis upon who makes the decision on appliances.

2. Much criticism was forthcoming of aid projects designed to develop and promote appliances. Some argued the market was more effective and that often aid constrained the direction and nature of the projects selected - there are structural rigidities in the way resources are distributed; people do not want to provide money to rural users in the form of general loans to enable them to select the appliance of their choice - ministries prefer to produce or promote specific devices and this often results in technical mismatches.

**RURAL ENERGY SURVEYS IN THE THIRD WORLD:  
A CRITICAL REVIEW OF ISSUES AND METHODS<sup>1</sup>**

**A summary of recently completed work**

**Michael Howes**

**Institute of Development Studies, University of Sussex**

A large number of rural energy surveys have been completed in the last decade. This report starts by looking at the issues which have been explored and the methods which have been employed; before going on to raise additional questions which have generally been overlooked, and to show how these, in turn, might be investigated. Following the definition of energy implicitly adopted by the great majority of surveys, the scope of the enquiry is limited to biomass fuels. No reference is made to the extensive Indian literature, which is the subject of a companion volume produced by Ashok Desai.

The report deals first with problems of fuel consumption, since these have been central to nearly all of the surveys which have been carried out. Two major problems are identified. One is the wide-spread tendency for researchers to present highly aggregated data, which fail to distinguish between the different end uses to which fuels may be put. The other is for inadequate account to be taken of the cyclical variations in consumption occurring through shorter and longer periods of time. Individual studies which overcome both of these limitations are explored, and the basis for a more satisfactory overall approach to consumption is outlined.

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1. Report to the IDRC, January 1984. To appear in IDRC Manuscripts series, 1984, forthcoming.



The next section addresses itself to the much less frequently investigated problems of biomass fuel supply. Methods of assessing sustainable productivity under three representative types of land use/fuel extraction regime are explored; followed by a discussion of the symptoms which may arise when consumption outstrips supply, and of the ways in which these may be interpreted.

A further major section is then devoted to the broader economic and social contexts within which fuel use and supply take place; which like supply itself, have been neglected by all but a small minority of studies. The unsuitability of average levels of consumption, as a means of identifying fuel needs, is pointed out; and the utility of a number of alternative means of categorising rural populations are explored. It is also suggested that a capacity to differentiate, and an understanding of relations between different groups and classes, provides an essential pre-condition for identifying the political interest which will often be critical in determining whether or not it will be possible for specific forms of intervention to achieve their intended effects. A corresponding attempt is then made to dis-aggregate the household, and to show how changes in fuel supply can interact with the existing division of labour between women.

The reader's attention is next directed towards the forces transforming rural society, and to the influence which these can exercise, in more or less direct ways, upon the supply of fuel. Particular emphasis is given to urbanisation, and the effect which this can have upon the availability of fuel in surrounding rural areas. The less obvious impact of trade in changing land use patterns, and hence the supply of fuel; as well as in transforming rural social relations; including those governing access to fuel, is also pointed out.

The report concludes with an attempt to take stock of the issues arising in relation to consumption, supply, and social context, and to show how each of these different aspects of biomass fuel may be investigated in relation to each other within a unified framework of research.

### Discussion

The importance of consultation with the villagers was stressed. While this was accepted it was also pointed out that this alone may not provide answers to energy problems because we cannot cope with energy problems in isolation.

The time-consuming nature of such studies was accepted but with experience the time input could be reduced. Also while the approach was very general it was argued that it does help identify relevant questions and so assists in developing more effective ways of getting useful data from large-scale surveys.

## ENERGY DEMAND STRUCTURES IN LDCs

Gerald Leach

International Institute for Environment and Development, London

This two year project (Jan 83 - Jan 85) is funded by the European Commission under the title: 'A comparative analysis of energy demand structures of countries at different levels of economic development'. It is a collaborative study between IIED and ATW, University of Regensburg, Fed. Rep. of Germany. A workshop with 10 LDC participants was held at IIED in December 1983 to help define the second phase of the study in terms of LDC planning needs. All data collection and analysis is now complete. A few key findings will be presented.

The basic objective is to assist energy (and economic) planning in LDCs by making comparisons between a wide range of countries and over time, at a disaggregated level, of (1) the structure of the economy, (2) final and primary energy use in relation to this structure, and (3) energy prices. Our assumption is that the planners must move - and be helped to move - from a supply side view to considering the levels and dynamics of final energy use and how these are founded in the activities, needs and 'wants' of a society, modified by available technologies as well as prices and policies: in short, a disaggregated 'bottom-up' view.

One aim of the work is to establish how much (expensive if reliable) data are needed for sound energy planning and forecasting on such a viewpoint. Single number (e.g., aggregate energy/GDP) models are obviously inappropriate although still used. Multi-sector models demanding

excellent statistics are equally inappropriate. Where is the best compromise for a 'minimum data/maximum reliability' planning and forecasting tool?

A second aim is to provide comparative data, on such things as sectoral energy intensities and prices, to planners who simply for lack of time and information cannot relate their country's 'performance' to that of any other. For this reason a wide range of countries and a 13-year time base (1970-82) has been used. Data collection and assembly using a consistent methodology has been a key feature of the work, usually by extensive country visits to look beyond and beneath national statistics. In each of IIED's countries this process has revealed substantial errors in the energy and economic statistics of organisations such as OECD, UNSO, the World Bank and the IMF.

In outline, the project data coverage is as follows:

Countries            5 industrialised (USA\*, UK\*, FRG, France, Japan);  
                          4 semi-industrial (Brazil, Chile, Portugal, Philippines\*);  
                          4 agrarian (India, Pakistan\*, Kenya, Sri Lanka\*).

IIED countries are starred. Non-industrial countries were chosen by data availability as much as geographic or income spread. Lack of resources unfortunately prevented greater coverage of such countries.

Years                    3 for the full disaggregated analysis, chosen by data availability and to span the 1973 and 1979 oil price shocks; namely, 1970-72 period, 1976-77 period, post-1979.

1970-82 for energy prices (11 fuels x sectors), GDP structure, trade, commodities such as steel, cement, fertilizers, transport activities, tractors, etc.

Dissaggregation 20 energy types, including 5 biomass; primary to net supply conversion matrix ('energy balance') plus sectoral breakdown of final energy;

56 sectors, including sector totals and unallocated amounts;  
43 when these are excluded.

Special emphasis was given to sectors that are either large or energy intensive (or both) in LDCs: eg, urban/rural residential, cement, fertilizers, sugar refining, tobacco.

#### Analysis

Countries are compared with each other, and over time, mostly by plotting quantities against GDP per capita in 1975 US\$, using market exchange rates or purchasing power parity as appropriate. Time series are also used.

Clear distinctions are made between (1) biomass and non-biomass fuels, and (2) the production and consumption sectors of the economy and energy use.

The quantities plotted include GDP and energy shares, energy intensities with total GDP as the denominator, intensities with sectoral GDP (or some other measure of activity level) as the denominator, and GDP or energy intensities per capita.

#### How good are the data?

Obviously, with such an ambitious target of disaggregation, there are holes in the data base for many sub-sectors, countries and years. In some cases estimates had to be used even for consumption by main sectors, such as agriculture. This was true of commercial energy sources as much as for biomass fuels. It was also true of industrialised countries as much as for LDCs. Indeed, in some key sectors or sub-sectors - eg, agriculture, irrigation - the data are often better in LDCs than in industrialised countries. Generally the most difficult sectors to complete in LDCs were the residential (unless there had been a decent-sized household energy survey), commercial and institutional, and road transport.

#### What results?

Since the project has produced well over 60 plots, most of them a rich seam for wonder, bemusement and curious introspection, no attempt is made here to summarise them. A selection was presented at the Workshop to illustrate some of the main findings.

## HOUSEHOLD ENERGY IN LDCs

Gerald Leach

International Institute for Environment and Development, London

Household energy use in LDCs is the subject of international concern, largely because of the linked issues of poverty, the 'firewood crisis' and competition between food and bio-energy production for land.

While exploring future areas for project work and preparing some chapters for a World Bank 'handbook' on LDC household energy use, I have been digging through some 150-200 LDC household energy surveys. Workshop participants may be interested in some key thoughts and findings that have emerged, even though these are at best part-baked. Some are surprising and will be illustrated.

### Variability

In developed countries families vary in their energy use by a factor of 3 or 4 even on the same housing estate. But because most energy use is metered, it is relatively easy to examine and predict the behaviour of large (even national) samples with respect to income, price, etc.

In LDCs the variability seems to be no less: within a village, between villages, or in different ecological/climatic zones. Most energy use is not metered and can be discovered, reliably, only by painstaking 'micro-surveys'. Naturally there are few of these, and virtually no time

series for the same location. Nevertheless, their results are frequently extrapolated into estimates of national consumption, possibly with very large errors. These are then compounded with equally large uncertainties over the rates and stocks of biomass fuels to produce sometime ludicrous conclusions. There are also extraordinary variations in peoples' attitudes to scarcity and willingness to respond. In Sierra Leone the rural poor will gather fuel up to a radius of several kilometres before they switch to part purchasing firewood or buying kerosene. In one city the urban poor will not walk more than 50 metres to buy wood.

In this situation one has to fall back on large sample, nationally representative surveys based on respondent recall. These too may be inaccurate and may miss important features such as the effects of land ownership, variations in fuel availability and prices, or climatic difference, etc. Again, there are few of these; and almost no time series.

There is an urgent need for a marriage between the virtues of micro-surveys and those of macro-surveys in LDCs. An exploration of both types should help distill which virtues should be preserved and which sins should be rejected.

### Fuel Poverty

There is undoubtedly much fuel hardship in LDCs. Scores of papers report that people must spend many hours a week gathering fuel or large fractions of the family budget buying it. Expenditure shares of 15-20% or more for the poorest are quoted with alarm.

These budget shares are generally lower than in developed countries. For example, in the USA in 1982 families with incomes below \$5,000 (\$1980) and oil heating spent 35% of their income on fuel. Furthermore, in LDCs the budget shares fall rapidly with higher incomes, mainly because of a switch to more efficient 'commercial' fuels and possibly a saturation in end-use needs. In developed countries they fall slowly, probably due to space heating needs. In other words, the cross-sectional energy-income elasticity is much lower in LDCs than in developed countries (although it may be much higher for commercial fuels alone).

This has important implications for national policy. The wealthy urban elites may be insensitive to higher fuel prices and hence to conservation. The energy intensity of the household sector should fall rapidly with increased incomes, taking pressure off biomass supplies but putting them on commercial fuels. However, the true dynamics of demand cannot be understood until there are more consistent surveys over a decent time period in which income and energy prices have changed appreciably.

#### Biomass for the rich

This point is underlined by the next observation. In several countries, contrary to most expectations, biomass fuels such as firewood and dungcake are used in substantial amounts by the highest income households, even in urban areas. For example, in Pakistan there is a 5-fold increase in biomass use in rural households, and a negligible decline in urban households, across a 30-fold range of household income. Perhaps more surprising, the use of dungcake as fuel shows almost exactly the same pattern, which can also be seen in the two other countries where energy-income surveys have been analysed: India and Sri Lanka. Why this persistence of inconvenient, low status fuels at high incomes? Is it due to cultural factors: the smoke-grilled chapati? Or relative prices? Or



because in all three countries household size increases sharply with income - from an average of 3 to 12 persons in the case of rural Pakistan - so that there are several low status family members (or servants) who can be told to collect free fuels? Is this pattern found in other countries?

#### Fuel prices

These questions are important because of their bearing on future pressures on biomass fuel supplies and commercial fuels; and attempts to control these by pricing policies, etc. Unfortunately, there is very little but scattered anecdotal evidence in LDCs on the effects of price on consumption, on whether fuels are gathered or purchased, or on fuel switching; eg, from firewood to kerosene or LPG for cooking, or vice versa.

However, one thing is clear. Both the absolute levels and time trends of the prices for the major (substitutable) household fuels - firewood and kerosene - vary very widely between countries. Equally, the relative prices of firewood and kerosene show quite different time developments. For example, in Pakistan, Bangladesh, Philippines and Sri Lanka kerosene was within 1.0 to 1.5 times the price of firewood, on a calorific basis, in 1970. By 1982 the ratio was still only 1.5 in Pakistan but was 5:1 in Sri Lanka, where there has been a substantial switch back from kerosene to firewood for cooking, despite widespread concerns about depleting wood supplies.

While governments can do little in the short term to control the prices of firewood or other biomass fuels, they can and do control kerosene prices. However, it is not at all obvious that these control strategies are the best ones for managing biomass consumption and pressures on biomass supplies.

#### Discussion

Much emphasis was placed upon the divergences between countries.

NETWORK ON RURAL ENERGY TECHNOLOGY ASSESSMENT AND INNOVATION

Background paper prepared by Andrew Barnett  
(Science Policy Research Unit, University of Sussex)

for the  
SECOND INFORMAL MEETING OF ENERGY RESEARCH DONORS

17-18 September 1984

to be held at IDRC, Ottawa, Canada.

August 1984

A. The Problem

- (1) Over ten years and many millions of dollars have now been spent in seeking solutions to the energy problems of rural areas of developing countries. But despite this effort, and the undoubted advances that have been achieved, many of the simplest questions posed by policy makers still cannot be answered. One such set of questions concerns the choice of energy conversion devices suitable for rural areas: it is not yet possible to provide anything but the broadest advice about which technical options are most suited for a particular purpose and location. The aim of this network is to address this set of issues concerned with meeting policy makers' requirements concerning the selection, development and introduction of new or conventional rural energy technologies.
- (2) From a position of almost total ignorance in 1970, patchy evidence is now available about energy use and supply in a relatively small sample

of rural communities; and the methods for such research are much improved. But by comparison more is now known about the physical characteristics of conversion devices for use in rural areas. Recent state of the art reviews (by the World Bank, IDRC and others) are generally regarded as being significantly better than anything which had appeared before. But despite the competence of each report, as a group they serve to illustrate the major limitations of current knowledge:

- the lack of comparative evaluations under field conditions of the various technologies that can meet a particular need, using similar assumptions and within a single analytic framework;
- the under-emphasis of an understanding of the needs of the potential users of the technology and the consequences of low levels of "effective demand";
- the relative weakness of the financial, economic and other social science analyses of the technology choice (relative to the physical and engineering aspects);
- the lack of knowledge about the mechanisms for the commercialisation and other forms of diffusion of the technology.

(3) Successful attempts are being made to build a consensus between practitioners about the issues to be considered and the means of measuring the physical characteristics of individual 'non-conventional' devices operating in the field. Most notably this has been achieved with photovoltaics, woodstove, windmills and biogas plants. But there has been little attempt so far to generate such a consensus on the issues and means of comparing the social and economic consequences of particular energy conversion devices whether 'new and renewable' or conventional. No consensus has been built on how to assess the needs of the potential users of the technology, or on how to introduce the technology by commercial or non-commercial means. In addition, policy makers are not yet able to base their choices on the consideration of how the technologies and their operating

environments might change over time (all rural energy conversion devices have a potential for technical change and the direction and speed of such change is to some extent a function of policy within individual or groups of countries). The proposed network is seen as providing the policy dimension to complement the existing networks which focus on specific technologies.

- (4) The initial problem can be conceived as one of evaluating the current state of the knowledge involved in considering rural energy technology options. While in practice there may be much controversy about the accuracy, level of detail and range of participants required to make decisions about technology, the chain of reasoning required is in principle fairly straight forward. In some form or another the process starts by consideration of what is known about the energy problems facing specific social groups; it considers what options there are for meeting these problems both now and in the future; it appraises the relative merit of the options from the point of view of the various parties both directly and indirectly involved and considers what needs to be done to effectively plan, implement, evaluate (and subsequently modify) the chosen option at local and other levels. At each point the costs and relative merit of obtaining more knowledge have to be weighed against the chances and consequences of delay and inappropriate decisions.
- (5) It is an hypothesis of this network that the necessary knowledge is available at many points along this chain; but that the strength of the whole chain is currently weakened by specific missing links. The strongest links appear to involve knowledge of the physical nature of the environment and energy conversion technologies; the weakest links involve the identification of user needs, the comparative evaluation

of devices, social and economic analyses in general and the mechanisms to affect technical change.

#### The Research Network

- (6) The IDRC proposes to provide financial and other support to researchers in developing countries wishing to form such a network concerned with the comparative evaluation and innovation of energy conversion technologies which are suitable for rural application. The participation in the network of other research donors and other researchers not funded by IDRC will be encouraged.
- (7) The precise objectives, methods and institutional arrangements for the proposed network are to be decided by a group of researchers at a Project Identification Meeting to be held in Ottawa from 30 October to 1 November 1984. Some 10 teams are involved already and it is hoped that other researchers not supported by IDRC will join the network at a later date as full or associate members (see Annex for list of teams already involved in negotiations).

#### B. Objectives

- (8) The objectives of the network will be to improve the quality of social and economic advice given to policy makers concerning:
- (a) the comparative social, economic and technical merit of energy conversion devices for use in meeting the needs of rural people in developing countries;

(b) the methods for effecting the introduction of such devices through both commercial and non-commercial channels;

(c) the actions required to improve the relative merit of the most relevant energy conversion devices over time by means of research, development and other aspects of technology policy.

C. Activities

(9) Four types of activity are envisaged:

- research
- literature collection, synthesis and exchange
- training
- sharing of experience through international meetings

The research activity will be of two forms: research that consolidates existing knowledge and research that generates entirely new knowledge predominantly from primary data collection in the field.

Consolidation

(10) In some countries the necessary knowledge is well established and the primary research needed to fill in the gaps is clearly identified. But it is a premise of this research that in most countries this is not the case. Here energy problems and the needs of the potential users of new technology are not well understood; research is well advanced on some technologies while others are neglected without reason.

(11) It is therefore expected that a number of teams will wish to undertake research which clarifies what is known (both inside and outside their country) and what still needs to be researched. This will involve surveys of literature, local opinion (for instance the opinions of researchers, technology suppliers, policy makers) and the assembly and re-analysis of data already collected for other purposes.

(12) A 'consolidating' research strategy does not necessarily imply delaying action nor should the proposed chain of reasoning behind technology choice be perceived as a 'maximalist approach' of an ideal world. Research can clearly take place alongside action; some actions are so obvious as to require no preliminary research; and the chain of reasoning should rather be considered as the minimum knowledge required to formulate and execute action.

(13) Research topics that might be included under the heading of consolidation might include:

- (i) the elaboration of the minimum knowledge required to make choices about rural energy technology;
- (ii) the compilation and critical review of the current state of knowledge both inside and outside the country on:
  - the energy use and supply situation in rural areas and their likely change over time; what surveys have been completed, how valuable are they; how general are their conclusions;
  - the need and effective demand for energy related technical change by specific sections of the rural population;
  - the range of both technical and non-technical options for meeting the identified need;
  - the comparative evaluation of the technical and non-technical options.

- (iii) review and analysis of energy technology field testing sites (their location, size, range of technologies included, types of social, economic and technical data collected);
- (iv) review and analysis of attempts to monitor the introduction of energy related technical change. A useful distinction may be made here between attempts to introduce technical change within the monetized parts of the energy sector where there is 'effective demand' and technical change in the non-monetized sector, where poverty and a delicate ecological balance reduce the room for manoeuvre;
- (v) review and analysis of energy related research and development (resource allocation, range of research activities, range of technologies, resource allocation criteria, research output, research effectiveness);
- (vi) review and analysis of the structure of the decision making process in the various stages of rural energy technology policy formulation and implementation in both the public and private sectors. Special emphasis might be placed on the research needs of the policy makers so identified.

#### Primary Research

- (15) It is expected that some research teams already have identified the most pressing needs for research and that original primary data will need to be generated. Such research might include:



- (i) gap filling rural energy use and supply surveys;
- (ii) "need and/or "market assessments for particular devices or for particular end-uses;
- (iii) the development and implementation of techniques to simplify market and need assessment surveys;
- (iv) social, technical and economic analyses of new or existing field testing and demonstration programmes which attempt to evaluate energy conversion devices on a comparative basis;
- (v) the addition of particular devices to existing field test sites to increase the range of comparison;
- (vi) setting up and monitoring attempts at innovation through commercial and/or public mechanisms;
- (vii) the design and implementation of studies to examine the range and effectiveness of rural energy R&D, and procedures for the search and selection of imported technology;
- (viii) studies to assess the effectiveness of local and foreign consulting firms in the planning and execution of rural energy policy.

**It should be stressed that it is clearly not likely that any research team will research all the issues listed.**

D. Network Participants

- (16) It is expected that the core of the network will be between 3-5 teams working full time on research funded at least in part by IDRC. However, some teams who are already well established in programmes of related research or have access to local funds, may wish to contribute their experience to the research network even though their research is not financed by IDRC.

While the network will be essentially involved with the technological aspects of rural energy and will doubtless involve many engineers and scientists, the network is concerned primarily with policy research and is therefore likely to incorporate the approach and techniques of social science (particularly of finance, economics and sociology).

E. Output

- (17) The main output of the network will be authoritative research results in written form which will enable policy makers within government and aid agencies to make choices concerning energy technologies for application in the rural areas of developing countries.

The network is also likely to increase the skill and experience of the participating researchers both as a result of direct training but also through contact with the other members of the network.

F. Co-ordination

The possibility exists for the network to be supported by a co-ordination team. The precise role of co-ordination will be determined in discussion with the researchers. Possible tasks include:

- (i) administration of the network, circulation of work in progress, organising training programmes and work in progress discussions;
- (ii) in response to requests from researchers, provide intellectual input to the research designs and methods and provide critical comments on work in progress;
- (iii) find, review and where necessary provide relevant books and articles to the researchers;
- (iv) as required, provide synthesis and other reports on the research.

Annex 1

Professor Ramesh Bhatia  
Institute of Economic Growth  
University of Enclave  
Delhi 110007, INDIA  
Cable: GROWTH  
Tel: 222221

Professor Amulya Reddy  
School of Engineering/Applied Science  
Centre for Energy & Environmental Studies  
The Engineering Quadrangle  
Princeton  
New Jersey 08544, USA  
Tel: 609 452-5448  
Telex: 499-1258

Dr Mark Mwandosya  
School of Engineering/Applied Science  
Centre for Energy & Environmental Studies  
The Engineering Quadrangle  
Princeton  
New Jersey 08544, USA  
Tel: 609 452-5448  
Telex: 499-1258

Dr Kilayko  
C/O Dr Ibarra Cruz  
Energy Research & Development Centre  
Don Mariano Marcos Avenue  
Diliman  
Quezon City, PHILIPPINES  
Tel: 85-90-61 or  
Tel: 85-88-56  
Telex:

Dr Alvaro F Umana  
P O Box 1660  
San Jose 1000, COSTA RICA  
Tel: 38-29-73  
Telex: 2160 ALUMA-CR

Mr Nithianandan  
Agrarian Research & Training Institute  
P O Box 1522  
114 Wijerama Mawatha  
Colombo, SRI LANKA  
Cable: AGRATI  
Tel: 596981/598541

Mr Barney  
Institute de Economia Energetica  
24 de Septiembre 178  
Casilla de Correo 138  
8400 Bariloche - Rio Negro, ARGENTINA  
Tel: 01-33-1649  
Tel: 01-30-4717  
54 944 25755

Dr Jose Zapp  
Cbs Gaviotas  
Paseo Bolivar 2090  
Bogota, COLOMBIA  
Tel: 2811729  
2811535  
2811705  
2419967

Annex 1 (continued)

Dr H D Panggebeacn  
Director, Energy Conversion and Conversion Technology  
Agency for Assessment and Application of Technology (BPPTO)  
Jalan M.H. Thamrin 8  
15 Floor  
Jakarta, **INDONESIA**  
Telex: 44331 ATP-JKT or  
45321 BPPT

Dr Russell de Lucia  
Meta Systems Inc.  
10 Holworthy Street  
Cambridge, Mass. 02138, **USA**  
Tel: (617) 868-8660  
Telex: 951280  
METASYSTEM CAM

Dr Ashok Desai  
IDRC  
P O Box 8500  
Ottawa  
Ontario K1G 3H9, **CANADA**  
Tel: (613) 236-6163  
Telex: 053 3753

Dr Schwember  
Applied Renewable Energies Ltd.  
35 Dollis Hill Lane  
London NW3 6JH  
Tel: 01-452-3937  
Telex: 27291 G

Stephen Klein  
Energy Department  
World Bank  
1818 H Street NW  
Washington DC 20433, **USA**  
Tel: (202) 477-1234  
Telex: 89650

Discussion

It was suggested there was a strong need to look at the use of established older technologies, in particular where there existed local skills to maintain the equipment. This argument was agreed with and by way of example it was pointed out that there was no credible economic data on the performance of small pumping sets.

In response to a question about planning for adequate biomass supply, it was suggested that the donor agencies had recently accepted the need to put funds into research on fuelwood.

**SOME PROBLEMS OF ENERGY FORECASTING IN LDCs**

**Summary of Work in Progress**

**Peter Pearson & Paul Stevens**

**Surrey Energy Economics Centre**

**University of Surrey**

Introduction

Our work is intended to contribute to the development of integrated energy forecasting and policy-making methods that take account of the interrelations between commercial energy (CE) and traditional energy (TE) in Less-Developed Countries (LDCs).

We have argued elsewhere (Pearson and Stevens, 1984) that the development of energy policies that integrate CE and TE (see appendix for definitions of TE and CE) is clearly important for the efficient and equitable allocation of resources in LDCs, with all that this implies for the development prospects of these countries. However, this is a neglected area whose exploration is long overdue. LDC government energy policies, explicitly or implicitly, have been focussed on influencing CE. As a result, the TE sector has been neglected by policy-makers, although where links exist between the sectors policy has had an indirect and often unintended impact on the traditional sector. In turn this has fed back upon the effectiveness of CE policy. Thus government policy has been orientated to influence the supply of and demand for commercial fuels while

largely ignoring traditional fuels. Effective energy policy-making requires not only a proper appreciation of the current energy situation but also the ability to forecast future trends and their susceptibility to policy decisions. Ignorance of the TE situation and of the links between TE and CE is one of the major reasons why energy forecasting and policy can go astray, especially in a period of rapid technological and social change.

There are four major problems here. They are:

- (i) There are serious difficulties involved in collecting and analysing data on TE in general and on the linkages between TE and CE in particular (Barnett, Bell and Hoffman, 1982, pp. 10-17; Hall, Barnard and Moss, 1982, p.13; World Bank, 1979, p.34). Because of this it is important to economise on data collection and analysis.
- (ii) The nature of TE's 'importance' is rarely explored in any depth beyond measuring its magnitude at national, regional or local level. Although much more data on TE has begun to be available, as yet little is known about the process of substitution within TE (for example between woodfuel, dung and charcoal) and between TE and CE (for example, between woodfuel and kerosene, LPG and electricity) in either the short or the long run.
- (iii) Little is known about the functioning of local energy markets, especially in situations where people are choosing between TE and CE fuels and appliances.
- (iv) A fourth difficulty is that the nature and quality of data on TE and CE are very different; while CE exhibits a high degree of physical homogeneity and is relatively easily measured in both physical and value units, the same cannot be said of TE. Consequently it is difficult to integrate these two types of data in forecasting models. While a number of commentators have stressed the importance of trying to do this, there remains a disturbing gulf between the prescription and the achievement.



It is important that integrated energy policies should be devised in ways that avoid wasting resources. Therefore, it matters to identify the crucial areas where extra data are worthwhile and not to waste resources on data that yield little, either because the area itself is quantitatively insignificant or because it is unlikely to be responsive to policy intervention. It is clearly not sensible to try to go out and measure everything that burns or moves. Nevertheless, we do need appropriate survey data that can lead to the elucidation of generalisable results. Such data should provide not only information about levels and rates of change of energy production and consumption but also about the factors influencing enterprise, farm and household decisions to switch between fuels and appliances.

Our work has three interrelated objectives:

- a) The ultimate objective is to improve the quality of forecasting and, therefore, planning methods. However, before this can be attempted two other objectives must be achieved.
- b) To identify the variables which influence the size and nature of the linkages between CE and TE, especially those elements which would be influenced by energy policies.
- c) To obtain some quantitative estimates of the orders of magnitude of the various substitution/complementarity linkages, both currently and historically.

Forecasting at the macro level

We argue that by concentrating on CE and excluding TE or including TE and ignoring the interlinking with CE, the present methodology of forecasting which is invariably based on past relationships will be wrong.

Energy forecasting for the LDCs is a relatively recent phenomenon. Application of forecasting techniques did not emerge until after the first oil shock of 1973, for much the same reasons as the growth of interest in LDC energy in general and TE in particular (Pearson and Stevens, 1984). Apart from individual country forecasts, usually carried out by the relevant government, there have also been a number of global studies covering all the LDCs (WAES, 1977) and regional areas (Asian Development Bank, 1982; OAPEC, 1982). In general, the approaches of these forecasts have followed the techniques used in energy forecasting in the industrialized countries, subject to the constraints imposed by the limitations of data. This has meant the use of relatively simplistic extrapolation techniques with a limited amount of sensitivity analysis on the energy/GDP coefficients, population growth and GDP forecasts. Lack of time series data has precluded the use of most econometric techniques although some attempt to use cross-section data has been used in the regional studies (OAPEC, 1982).

The existence of TE has caused two fundamental problems in these forecasting exercises. The first is that in many cases TE has been excluded from the analysis altogether with only CE sources being included. This means that the starting base supply and energy demand figures are both understated. Inevitably, the forecast is therefore also understated. If there is no change in the structure of energy demand and supply between TE and CE this may not matter in terms of some of the macro economic

implications of the forecast (for example, in the calculation of balance of payments implications). However, given the existence of linkages, together with the uncertainty over supply for traditional and commercial fuels, an unchanged energy structure in the future is extremely unlikely. Furthermore, the extrapolation or estimation is based upon past data. In many cases the past energy structure changed significantly after 1973 as the decline in TE use was reversed. A similar discontinuity would also be expected following the second oil shock of 1979-80, although at present there is very limited data to support this assertion. Thus extrapolation from the past or the use of estimated equations faces a discontinuity which concentration on CE would miss. Unless this element of substitutability and general linkage is considered in the forecast little reliability can be placed upon the forecasting result. Put simplistically, it is like forecasting the demand for butter while ignoring the price of margarine in a situation where the availability and therefore the price of margarine is expected to change.

The second forecasting problem concerns the implicit input of policy into the forecasts. Any forecast involves making some assumption about the impact of policy on the forecasted variables, even if it is only to assume more of the same. In many forecasts, the policy element often tends to be neglected because it is difficult to forecast how policy might change. At best, past forecasts have involved some assumption that energy policy will encourage a decline in the energy/GDP ratio although the mechanism is left vague. However, as previously emphasised, the effectiveness of energy policy in influencing energy in general and CE in particular depends upon the extent to which the linkages between TE and CE cause policy to produce unintended results which feed between the sectors. To some extent the divergence between energy policy targets and achieved targets is a function of the size and nature of the linkages which exist. This will clearly

influence the accuracy of the forecasts. For example, a policy of higher energy prices to encourage a reduction in the energy/GDP ratio may well simply encourage substitution to TE rather than genuine conservation. Initially this would mean the forecast (i.e. less CE consumption relatively) would be fulfilled. However, if the TE resource base were limited then it might be expected that suddenly and apparently inexplicably, CE consumption would rise very rapidly, diverging from the forecast. The longer the forecasting period the greater the divergence. However, before these elements can be incorporated into the forecast/policy exercise, it is essential to analyse in more detail the nature of the linkages between CE and TE and the variables which will cause the linkages to change.

#### Analysis at the micro level

We begin with domestic energy use. TE is the most commonly used source of fuel for cooking and heating in rural areas and also among the urban poor and middle income groups. Moreover, in rural areas most energy use is for domestic purposes, rather than for directly productive activities (Foley and van Buren, 1982). The household demand function for any given fuel  $x$  can be generally specified as:

$$x = f(p,s,y,t,z,w,v,a)$$

where:  $p$  is the own price, explicit for traded fuels and implicit for non-commercial fuels;  $s$  is a vector of explicit or implicit prices of substitute and complementary fuels;  $y$  is the household income level;  $t$  is a vector of tastes, which change over time, often towards more commercial fuels and newer appliances;  $z$  is a vector of characteristics - these include the characteristics of the fuel and of the appliance, which determine the nature of the services yielded by the fuel and the appliance;

$w$  is a vector of household characteristics, such as household age-sex composition;  $v$  is a vector of other influencing variables, such as season and temperature; and  $a$  is a vector indicating the stock of appliances, fixed in the short run and variable in the long run.

We have expressed the household's demand for energy in the form of a single function. However, energy demand is best decomposed into two components, by interpreting it in terms of a household production process in which the household combines the services of a durable good, the appliance (stove, lamp, etc.), with fuel inputs to produce services that contribute to the household's utility. Then energy demand is the outcome of both a capital stock decision and a final services or stock-utilisation decision. The services yielded by the appliance will be a function of its design and the available technology, while its actual utilisation will depend on a variety of factors, such as fuel costs, season and household income level. In the short run, with the capital stock fixed, only demand for final services will change but in the long run the appliance can be changed to the extent that technology, availability and household resources permit. Here there are likely to be trade-offs between capital cost and running costs (with the latter including time taken in cooking and in obtaining fuel). And even in the short run there may be trade-offs between the opportunity costs of using scarce time to collect the fuel and purchasing the fuel in the market (Pachauri, 1983).

This separation of demand into two components is important not just for a good conceptual understanding of the decision-making processes involved, but also for estimation. As Hausman observes, "If an econometric model of energy demand is to be successful, it must allow for the different nature of the adjustment of the two components of household energy demand. Econometric models which do not differentiate the capital stock decision

from the utilization decision cannot capture the interplay of technological change and consumer choice in determining final energy demand" (Hausman, 1979, p.34). Before discussing estimation any further, however, we will consider in a little more detail some of the factors influencing the capital stock and final services decisions.

We begin with income. Cross-section evidence suggests (Alam et al., 1983) that as household income rises the basic TE fuels become inferior and people switch to charcoal, kerosene and LPG, with the move being dependent on the acquisition of the appropriate appliances. Charcoal tends to remain popular for cooking even at high income levels and also tends to be widely used in restaurants in many urban areas.

Changes in relative prices of fuel and appliances exert income and substitution effects on domestic fuel demand. For the non-commercial fuels of course, what changes is not an explicit relative price but relative opportunity cost relating to the costs of collection and possible alternative uses (e.g. dung and crop residues can be used as fuels or to improve soil quality). For empirical work the lack of explicit prices and the non-homogeneity of the fuels makes work on the pricing aspect of substitution behaviour particularly problematic. However, on the one hand, it may be possible to derive useful results about the non-pricing aspects, and on the other hand, significant amounts of wood and charcoal are traded and so some price data do exist.

When incomes fall or prices rise domestic users can usually switch down-market; for example, it is relatively easy to move from kerosene and LPG to woodfuel because the 'three stone fireplace' is relatively easy to acquire. However, in the short run it is not easy for people to respond to a fall in, say kerosene or LPG prices, because of the necessity to

acquire relatively costly appliances. Thus the responses to income and price changes are likely to be asymmetrical in the short run.

The response to price changes can be complex and the consequences far-reaching. As an example, consider the possible impact of an increase in the price of kerosene. The demand curves for TE substitutes for kerosene would shift to the right and their explicit and implicit prices would rise. There would be: reduced quantities of kerosene and increased quantities of substitutes demanded; extra use of human and animal energy to collect traditional fuels; earlier cutting of open-access woodlands, reducing their present value and possibly exacerbating problems of erosion, siltification and flooding; increasing commercial exploitation of wood, including the enclosure of previously open woodland, leading to problems for poorer households in scavenging for fuel; and substitution of dung and crop residues in place of kerosene and woodfuel, leading to a deterioration in soil quality. Thus the rise in price of one commercial fuel can trigger a series of adjustments some of which have potentially serious external effects. Consider, on the other hand, the effects of a fall in the price of kerosene, possibly the result of a subsidy intended to make kerosene more available for the poor and to take the pressure off limited supplies of traditional fuels. One unintended side-effect here could be the diversion of subsidised kerosene intended for domestic use by mixing it with diesel fuel and using it to power diesel engines.

It has almost become conventional wisdom that the fuel efficiencies of TE stoves are exceedingly low (5-10 per cent is often quoted) and could, therefore, easily be improved; moreover, it is often suggested that the introduction of more efficient stoves would reduce overall fuel consumption. Both of these contentions need to be treated with caution. It seems that fuel efficiency may not in practice be usually as low as is

often claimed (Gill, 1983) and that it can be very difficult both to improve it and also to introduce new stove designs. In any case, as theory would suggest (Dobbs and Hill, 1984), improved efficiency does not necessarily imply lower overall fuel use; consumers may take the benefits in other ways (for example, you can cook more dishes and/or faster). The impact of improved technology on both TE and CE needs to be more carefully investigated, since it will be a major determinant of future energy demand.

It is clear that the level and patterns of use of TE vary extensively within and between countries in response to a wide variety of factors influencing demand and supply, including tastes, fuel-use practices, the stock of energy-using appliances, relative prices and availability of both CE and TE, location, season, income level and property ownership, fuel-gathering rights, privileges and practices, and the division of labour within the family. Moreover, given the diversity of consumption patterns it is evidently most unlikely that the current and future patterns of TE and CE demand, supply and use can be successfully explained or forecast on the basis of a few broad generalisations.

The re-analysis of existing data, however, will throw more light on the decision-making processes involved. By viewing energy demand as part of the household's production process (Becker, 1965; Pollak and Wachter, 1975; Gronau, 1977; Pachauri, 1983) and separating it into appliance acquisition and utilization decisions, we intend to illuminate the factors that influence decisions about fuel and appliance use and substitution and determine the long-run transition to CE sources. An important aspect of this approach is the intention to use qualitative choice (or discrete choice) modelling. These methods can be used to analyse the factors influencing the probability of a decision unit choosing a particular appliance from a set of appliances in a situation where the variables are



discrete rather than continuous (although continuous independent variables are not necessarily ruled out). As Hausman (1979, p.35) puts it, "The qualitative choice model is a disaggregate model of individual behaviour which specifies the determinants of individual choice in terms of the characteristics or attributes of the different possible alternatives". Qualitative choice modelling is briefly presented in Chow (1983) and surveyed in more detail by Amemiya (1981) and Hensher and Johnson (1981). Applications to the choice of energy-using appliances include Hausman (1979) and Hawdon (1982).

We have already referred to the use of human and animal energy in agriculture and transportation. Clearly it is important to investigate the factors that influence mechanisation and survey data can be used here. Both demand and supply of CE are important to investigate. These areas require major investigation in their own right and have already been studied to some extent by others. Thus although we do not plan any new work here we do intend to use existing studies to examine current trends and to see how these trends might be susceptible to energy policy decisions; in particular we want to see how this knowledge can be integrated into forecasting.

TE finds important uses in a variety of industrial and processing applications, many of them small-scale, but a number of them on a larger scale (e.g. steel-making in Brazil). The rises in oil prices in the 1970s appear to have stimulated greater interest in using TE fuels in these sorts of applications and evidence suggests that entrepreneurs are willing to collect and use crop residues, wood and charcoal from considerable distances. However, recent work (de Lucia and Poole, 1984) suggests that more extensive use of biomass, especially wood, maybe being hindered by the lack of formation of appropriate markets to bring suppliers and demanders

of appliances (such as fuel-efficient wood boilers) together. Here the existence of transaction costs that inhibit the formation of markets may suggest that government intervention could aid the development of appropriate markets (some work on woodfuel markets is now slowly beginning to develop, including the IIED Woodfuel Commercialisation Project and the work reported in Alam et al. (1983). This potential substitution of TE for CE, and indeed the commercialisation of TE, could be very important and merits further examination. In the past energy policy has tended to pay too little attention to the development of effective markets for TE, with the result that the non-commercial element of TE has been larger than it might otherwise have been. This may well have hindered the development process through failing to facilitate the use of available or potentially available energy inputs. This is not to imply that the development of markets is a panacea; rather it is to suggest that the absence of markets carries important implications for resource allocation.

#### Conclusion

Energy forecasting and policy-making methods need to be developed in ways that take proper account of the role of TE and of the linkages between CE and TE, especially of those linkages influenced directly or indirectly by energy policy decisions. Failure to do this, and the consequent tendency to make incorrect assumptions about the impact of policy decisions on forecasted variables, limits the effectiveness of many current forecasts. It is important that the linkages should be explored in ways that avoid wasting resources, either through a concentration on insignificant linkages or through a failure to get the kind of data that permit understanding and forecasting of the underlying decision processes. At the micro level we intend to investigate the factors influencing the levels of use and substitution between fuels and appliances. The re-analysis of existing

data with appropriate methods will also produce valuable clues about what minimum types and amount of data it will be most worth collecting in order to improve forecasting and policy-making.

Appendix: definitions of commercial and traditional energy

It is important to be clear about the distinction between CE and TE. Commercial energy has at least two significant characteristics. It moves in corporately controlled markets - in most LDCs the corporation is state owned - and it involves a gross foreign exchange input. Essentially CE covers coal, petroleum and electricity. TE on the other hand is either traded in small local markets or moves in no markets at all, in the sense that it is not traded and has no money price, although it does have an implicit opportunity cost. That part of TE which is not traded is also called 'non-commercial energy' (NCE). TE's other characteristic is that it involves no direct foreign exchange input. TE, therefore, covers woodfuel, charcoal and crop and animal residues. There is a further dimension to TE: animate energy. In LDCs much physical work, including transportation, that in more developed areas or countries would be done by machines powered by CE, is performed by humans and animals. Statistics on TE often do not include animate energy, although for a number of purposes (for example, energy forecasting, comparisons of energy-intensities and assessments of levels of living) it is important that they should (Desai, 1978, 1980, Sankar, 1977). As development proceeds, increasing mechanisation will lead to significant increases in the absolute level and relative share of CE in the total energy situation.

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#### Discussion

Doubts were raised as to whether the data is likely to be available. In response it was pointed out that the actual formulation of the model was intrinsically useful since it helps formulate questions and a clearer specification of data requirements. Data is too often collected indiscriminately, without a clear idea of what it may be used for. Also it was suggested there is already some data available which might allow the work to begin. Support was given to the idea that too little is known of what makes consumers switch from CE to TE and studies were needed on this, although it was questioned whether the results would arrive in time.

**RENEWABLE ENERGY POLICY IN LDCS**

**A report on work recently completed**

**David C. Stuckey**

**Chemical Engineering Department, Imperial College, London**

Due to the sharp rise in oil prices in the last decade, many developing countries are facing severe balance of payments problems and in a number of these countries the whole process of raising living standards in both urban and rural areas is being threatened. In addition, due to increasing population pressures and poor land management, many developing countries are facing the dual threat of severely depleted sources of "non-commercial" fuel such as firewood and agricultural residues. It is with these factors in mind that most developing countries are looking closely at sustainable energy yields from renewable energy technologies (RETs) based on indigenous energy sources such as wind, solar and biomass.

In the last five years much effort and money has been expended by developing country governments and multi and bilateral aid agencies on investigating the various RETS available, and on setting up demonstration units. Most of this work has had a "supply side" or technical orientation, and in many cases has not been an unqualified success. Recently this lack of success in implementing RETs has led a number of people working in the field to strongly question the emphasis on the "supply side" approach. Instead they have pointed out that the real aim of developing renewable energy sources is to satisfy a variety of end uses, e.g., cooking, lighting, stationary and motive power. Hence, the primary

emphasis in work on renewable energy should be to take a demand side approach. In many ways this approach appears to complicate matters still further since understanding the factors affecting energy demand brings in many other factors besides purely technical considerations. However, if renewable energy is to make a significant contribution to the energy supplies of developing countries in the foreseeable future, it is essential that rational policies be formulated to match energy supplies with energy demand, both in terms of quantity and quality, and in terms of technique. In addition, governments should be aware of the resources required to implement such a policy, and have a clear idea on the degree of self-reliance they are aiming for and how to achieve it.

The objective of this work was to outline a general methodology for formulating a renewable energy policy based on satisfying specific end-uses, and to examine the ramifications of implementing such a policy in developing countries.

The rational formulation of a renewable energy policy involves a sequential series of steps concerned with data acquisition, evaluation and explicit decisions on national priorities. These steps, although laid out sequentially, are highly interactive, and are as follows:-

- 1) Assessment of energy demand - since the emphasis in this work is on meeting specific energy end-uses it is essential to have a clear picture of energy demand in the country, not only in terms of sectorial end-use, but also the forms of energy required, and the consequences of energy use (or lack thereof). With this information, governments can make explicit decisions on priority areas in which energy policy should be oriented by "ranking" end-uses.

- 2) Evaluations of renewable energy base - data on solar radiation, rainfall, wind velocities and ambient temperature should be collated, together with their seasonal variation. In addition, data (or estimates) on the production of agricultural residues, organic wastes, animal manure and sustainable annual yields from forest resources need to be obtained to estimate the annual biomass production. From this an estimate can be obtained for the substitutability of renewable energy for present energy sources.
  
- 3) RETs - the third step is to assess the RETs available including: techniques and their inputs and outputs; thermodynamic efficiencies; capital and operating costs, and, technical constraints. From this it should then be possible to draw up a list of ultimate end-uses, and the sources and techniques which are able to satisfy them most efficiently.
  
- 4) Socio-cultural constraints - many technologies have limited success in developing countries due to the nature of the societies in which they are implemented. Hence in order to diffuse RETs it is extremely important to understand the societies in which they will be used, and how this will impose constraints on certain RETs.
  
- 5) Economics - in addition to technical and social considerations, the economics of RETs are also extremely important because if the use of a specific technique is not financially viable (CB analysis) to its owner, or economically viable in terms of the country's broader criteria (SCB analysis), then obviously it is not sensible to try and diffuse it.



- 6) Institutional - the final area that is important to consider in the formulation of policy is infrastructure. This general term covers such things as: R and D capacity; a network to diffuse the technique and provide technical back-up; the provision and training of skilled manpower; the capacity of the local capital goods sector; and the availability of finance.

Based on the data collected and evaluated in these areas the energy planner should now be able to formulate a relatively cohesive renewable energy policy to meet specific end-uses. However, in order to actually implement this policy governments should have a clear idea of the resources required, the degree of self-reliance aimed for, and the channels available for establishing an RET programme.

The resources required for implementation consist of a "core" sequence of technological activities, some or all of which will be required in certain circumstances. This core consists of: creation of technical knowledge (formal and informal R and D); pre-investment and feasibility studies drawing on existing knowledge; production of designs and specifications for technical systems; transformation of designs into concrete elements of an operating system; communication of technical knowledge and information; and finally, an over-riding management function. Obviously, depending on the degree of self-reliance aimed for, provision of these capabilities will, in most instances, require some degree of skill build-up, not necessarily in the area of R and D alone.

The degree of self-reliance will undoubtedly vary between the various core functions depending on the technique, e.g. wood stoves vs. large scale ethanol. In addition, the degree of self-reliance need not be static, but could build up over time. Finally, it will be influenced by social

development objectives such as: generation of local employment; "appropriateness", local knowledge acquisition and economies of scale.

At a macro level, governments lastly need to be aware of the needs for: access to information, technical cooperation amongst developing countries (TCDC), and access and bargaining competence in the international market for certain RETs.

In conclusion, the formulation of a cohesive and rational renewable energy policy should be rooted in a sound understanding of energy end-uses, and match available sources to meet these end-uses in the most technically and economically efficient manner while being cognisant of social and institutional constraints. Implementation of such a policy requires governments to be aware of resource requirements, and to make explicit decisions on the degree of self-reliance required.

#### Discussion

Questions of doubt were raised at the prospect of the use of thermodynamic efficiency as the only criterion. A further point emphasised was that often for a project to be undertaken it must have prestige and top-level commitment.

WORKSHOP ON THE ECONOMICS OF ENERGY IN LDCs

FRIDAY, 28 SEPTEMBER 1984

**PARTICIPANTS' NAMES AND INTERESTS**

**Andrew Barnett**, Science Policy Research Unit, University of Sussex  
Falmer, BRIGHTON BN1 9RF  
0273-686758

**Interests:** Choice of energy technology, with particular reference to rural areas. Diffusion of energy technology. Rural energy demand and needs assessment. Resource allocation to R&D and technical change in the energy sector.

**Dr Lesley Brattle**, 67 Penlands Vale, Steyning, Sussex BN4 3PL  
0903-812794

**Interests:** Social forestry; wood and charcoal stoves, hay boxes; energy surveys (firewood).

**Ariane van Buren**, IIED, 3 Endsleigh Street, LONDON WC1H 0DD  
01-388 2117

**Interests:** Strategic planning; land use; fuel substitution & pricing. Wood fuel markets; premium uses of wood fuel in industry, social sectors; land clearance & sources of commercial wood fuel; alternative land use; alternative fuels.

**Joy Clancy**, Dept. of Engineering, The University, Whiteknights, READING  
RG6 2AY  
0734-875123 Ext. 7328

**Interests:** Biomass conversion technologies for use in rural areas with particular interest in alternative fuels for engines.

**Lyndon Driscoll**, Energy Policy, Butterworth Scientific Ltd., P.O. Box 63, Westbury House, Bury Street, Guildford, Surrey GU2 5BH  
0483-31261

**Prof. Walter Elkan**, Dept. of Economics, Brunel University, Uxbridge, Middlesex UB8 3PH  
0895-56461

**Interests:** Participated in a World Bank assessment of energy supply and demand and policy in Zambia. Became especially interested in policy relating to supply of charcoal.

**Bahira El-Mougy**, S.E.E.C., University of Surrey, Guildford GU2 5XH  
0483-571281 Ext. 890

**Interests:** Analysis and planning of commercial energy within the framework of macroeconomic requirements, using a variety of modelling approaches.

**PARTICIPANTS' NAMES AND INTERESTS**

**Gerald Foley**, Earthscan, 3 Endsleigh Street, LONDON WC1H ODD  
01-388 9541

**Interests:** Recent reports on: biomass gasification; improved cooking stoves; farm and community forestry. Currently working on charcoal and on the transition from fuelwood to commercial fuels.

**Jas Gill**, Energy Research Group, Open University, Walton Hall, Milton Keynes, Bucks, MK7 6AA  
0908-653336

**Interests:** The rural firewood 'problem' and intervention strategies aimed at reducing fuel demand including the introduction of 'improved' cooking stoves (this has entailed taking a multi-disciplinary approach).

**Prof. David Hall**, King's College London, University of London, 68 Half Moon Lane, LONDON SE24 9JF  
01-733 5666

**Interests:** Biomass and the productivity of plants. The food vs. fuel problem in developed and developing countries.

**Danny Hann**, S.E.E.C., University of Surrey, Guildford GU2 5XH  
0483-571281 Ext. 890

**Interests:** The development of government energy policies and the role of national oil companies.

**Graeme Harris**, BH 26 23, Corporate Planning Dept., British Petroleum, Britannic House, Moor Lane, LONDON EC2Y 9BU  
01-920 6191

**Interests:** Forecasting energy demand and supply in LDC's as part of BP's long range environmental analysis. Has been involved recently in a forecasting exercise covering global energy balances to the year 2000. His part in this was coverage of the Latin America and Carribean region.

**David Hawdon**, S.E.E.C., University of Surrey, Guildford GU2 5XH  
0483-571281 Ext. 851

**Interests:** Energy demand modelling. The economics of energy transport. The economies of the gas industry.

**J D L Harrison**, Energy Adviser, Room E323, Overseas Development Administration, Eland House, Stag Place, LONDON SW1E 5DH  
01-213 4889

**Interests:** Utilization of renewable energy sources; rural energy supplies; appraisal/planning of energy supply options at national level.

**PARTICIPANTS' NAMES AND INTERESTS**

**Irene Himona**, S.E.E.C., University of Surrey, Guildford GU2 5XH  
0483-571281 Ext. 890

**Interests:** Modelling and forecasting of world oil prices.

**Dr Michael Howes**, Institute of Development Studies, University of Sussex  
Falmer, BRIGHTON BN1 9RF  
0273-606261 Ext. 254

**Interests:** Framework for the comparative evaluation of alternative techniques in specific third world environments. Rural energy R&D and dissemination processes (particularly stoves and photovoltaics).

**Dr Gordon Hughes**, Faculty of Economics, Sidgwick Avenue, CAMBRIDGE  
CB3 9DD  
0223-58944

**Interests:** Pricing & taxation of energy products. Demand Studies: consumers, transport, industry. Natural gas: investment decisions & traded/non-traded problems.

**Christopher Hurst**, Department of Management Science, Imperial College,  
Prince Consort Road, LONDON SW7 2BX  
01-589 5111 Ext. 2829

**Interests:** Energy modelling, rural energy/alternative technology for irrigation and petroleum refining/pricing.

**Richard Johnson**, ERL, 79 Baker Street, LONDON W1N 1AJ  
01-486 8277

**Interests:** All aspects of energy planning, rural energy demand forecasting, firewood use and supply, woodlot developments, renewable energy sources and conservation.

**Arlene Jones**, Minerals Strategy & Economics Research Group, British Geological Survey, Exhibition Road, South Kensington, LONDON SW7 2DE  
01-589 3444 Ext. 382

**Interests:** Oil/gas/coal and the interaction between fuel and non-fuel minerals.

**Richard Krigsman**, Petroleum Intelligence Weekly, 8 Bouverie St., LONDON  
EC4  
01-353 4581

**Gerald Leach**, IIED, 3 Endsleigh Street, LONDON WC1H 0DD  
01-388 9541

**Interests:** Rural & urban household, demand/supply issues. Medium & long term strategies for biomass fuel & food production. Structure of demand, conservation & national energy planning.

**PARTICIPANTS' NAMES AND INTERESTS**

**A J Meyrick**, Department of Energy, Thames House South, Millbank, LONDON  
SW1P 4QJ  
01-211 4120

**Interests:** Assembly of up to date assessments of total LDC oil demand. Projections of primary energy demand and supply over the medium and longer term.

**Dr Ravindra Nath**, Visiting Fellow, I.D.S., University of Sussex, Falmer,  
BRIGHTON BN1 9RF  
0273-606261 Ext. 255

**Interests:** Rural energy problems. Energy and the ecosystem.

**Dr David Newbery**, Churchill College, CAMBRIDGE CB3 0DS  
0223-61200

**Interests:** Energy pricing & taxation especially of transport fuels and gas.

**Sheila Page**, Overseas Development Institute, 10-11 Percy Street, LONDON  
W1P 0JB  
01-580 7683

**Interests:** Future supply of and demand for fuels, and consequences for trade balances and trade patterns, especially oil and coal and Latin America.

**Prof. David Pearce**, Dept. of Political Economy, University College,  
Gower Street, LONDON WC1E 6BT  
01-387 7050 Ext. 628

**Interests:** Domestic pricing of energy. Energy policy and planning. Exogenous energy price shocks. Benefits of electrification.

**Peter Pearson**, S.E.E.C., University of Surrey, Guildford GU2 5XH  
0483-571281 Ext. 784

**Interests:** Energy policy formulation; household energy demand and supply; environmental consequences of energy production and use.

**Dr Leo Pyle**, Department of Chemical Eng., Imperial College, Prince  
Consort Road, LONDON SW7 2BY  
01-589 5111 Ext. 1909

**Interests:** Technology & policy in relation to biomass as an energy source. Also includes resource recovery from wastes, use of biomass in rural areas of LDCs. Viability of small scale processing & production units.

**PARTICIPANTS' NAMES AND INTERESTS**

**Jacqueline Read**, S.E.E.C., University of Surrey, Guildford GU2 5XH  
0483-571281 Ext. 890

**Interests:** Modelling energy demand using econometric techniques, in particular energy demand by the industrial sector - substitution between factors of production and inter-fuel substitution.

**Prof. Colin Robinson**, S.E.E.C., University of Surrey, Guildford GU2 5XH  
0483-571281 Ext. 479

**Interests:** Energy demand forecasting and energy policy.

**Dr Ricardo Santiago**, Visiting Fellow, Dept. of Political Economy,  
University College, Gower Street, LONDON WC1E 6BT  
01-387 7050

**Dr Adam K Selby**, Dept. of Economics & Politics, School of Oriental &  
African Studies, University of London, Malet Street, LONDON  
01-637 2388 Ext. 369

**Interests:** Policies determining the development of energy supply and demand in LDCs, how international economic policies can encourage the countries most seriously affected by the energy crisis to rationalise their energy policies: what LDCs can learn from each other about coping with the energy crisis.

**Dr John Soussan**, Department of Geography, The University, Whiteknights,  
READING RG6 2AB  
0734-875123 Ext. 7839

**Interests:** Energy in rural areas and problems associated with biomass fuels, especially in the Asian region.

**Dr Paul Stevens**, S.E.E.C., University of Surrey, Guildford GU2 5XH  
0483-571281 Ext. 831

**Interests:** Energy policy in LDC's, its formulation and effectiveness.

**Dr David Stuckey**, Dept. of Chemical Engineering & Chemical Technology,  
Imperial College, Prince Consort Road, LONDON SW7 2BY  
01-589 5111 Ext. 1927.

**Interests:** Renewable energy technologies, specifically biogas, power alcohol (ethanol) gasifiers. Diffusion of RETs with respect to economies, social-cultural aspects and infrastructure. Technology transfer of RETs. Policy formulation for the use of RETS.

**PARTICIPANTS' NAMES AND INTERESTS**

**Dr R Tomkins**, Department of Management Science, Imperial College, Prince Consort Road, LONDON SW7 2BY  
01-589 5111 Ext. 2825

**Interests:** Energy modelling - demand & supply models for energy planning. All aspects of renewable energy - special interest in solar refrigeration.

**T. Hama Uzu**, Visiting Fellow, School of Oriental and African Studies, University of London, Malet Street, LONDON  
01-637 2388

**(Institute of Developing Country Studies, Japan)**

**Dr Kirit Vaidya**, University of Aston Management Centre, Nelson Building, Gosta Green, BIRMINGHAM B4 7DU  
021-359 3611 Ext. 5051

**Interests:** Energy policy and energy modelling in general and impact of oil/gas discoveries on LDC economies in particular.

**P E Velho**, Visiting Fellow, I.D.S., University of Sussex, Falmer, BRIGHTON BN1 9RF  
0273-606261 Ext. 231

**Interests:** Potential for LDCs in adopting alternative technologies, especially ethanol.

**Dr Richard Westoby**, Dept. of Political Economy, University College, Gower Street, LONDON WC1E 6BT  
01-387 7050

**Interests:** The impact of changes in oil prices on economic activity. Forecasting energy demand.