INTEGRATED ENERGY PLANNING FOR WIDENING ACCESS TO BASIC ENERGY SERVICES IN SOUTH AFRICA

A methodology for policy analysis and research

Preface

This monograph provides a conceptual framework for a proposed energy policy research programme and identifies appropriate analytical methods and tools. It does not provide an outline of the programme of work or define subject areas for energy policy analysis and development. It is, rather, primarily a methodological piece which situates *policy research* within an overall analytical framework for *planning* to achieve specified goals. Policy research, analysis and planning are closely linked and the effectiveness of policy research is greatly enhanced by considering integrated planning goals and methods, and by incorporating key policy makers and planners in the process.

The principles outlined in this paper are applicable to energy policy research in general. The focus of the proposed research project, however, is on equity in access to energy services for meeting basic needs and providing development opportunities. Where methodological principles are elaborated or illustrated in this monograph, the examples given are oriented towards this goal.

Introduction

The political transformation of South Africa to a system of universal franchise is heightening the urgency for developing socio-economic policies which will not only maximise growth and opportunity but address directly questions of poverty and historical imbalances in access to health care, education and housing and to basic services such as water and energy. South Africa, with just four per cent of Africa's population, generates a fifth of its GDP and more than half of its electricity. The surprising anomaly, however, is that two-thirds of South Africans still do not have access to electricity and have to use fuelwood for cooking or rely on inconvenient and expensive fuels such as paraffin and coal. There is a need for comprehensive planning to enhance access to affordable and sufficient energy services to meet household needs and development goals. Research is urgently needed into available policy options.

The rationale for integrated energy planning

With the disintegration of the Soviet Union and the collapse of commandist economies in Eastern Europe, it may seem inappropriate to advocate state planning, even if only for the energy sector. The market, however, has failed to provide adequately for the basic needs of the poor, and policies of previous governments in South Africa have specifically disadvantaged black people. Selective intervention and planning to overcome historical imbalances is politically and socially necessary.

It should also be noted that even in Western democracies there has been some degree of centralised state energy planning and policy intervention – although this has been mainly geared to energy security rather than improved access. For example, the USA's national energy strategy states:

> The goals of a healthy environment and reduced dependence on insecure suppliers represent . . . social benefits to which markets are unlikely to give adequate weight. Hence, government must act, alone or in concert with private markets, to incorporate appropriately these considerations. (USA Dept of Energy 1990)

In earlier years state involvement was common in facilitating capital-hungry developments such as large-scale electricity-generation plants or encouraging more extensive electricity distribution. Energy planning, however, was never extensive. It seldom transcended energy or economic sectors, and any goal setting, planning and regulation has, on the whole, evolved separately within the different energy subsectors and within individual enterprises. The nuclear establishment, for example, almost without exception operates autonomously from other energy subsectors and, at times, even outside of energy ministries. Electricity generation is mostly controlled by very large utility companies, and the petroleum and coal sectors by large, independent multinational firms operating within the dictum of internal financial viability and profit.

In the period when energy was cheap, imbalances between demand and supply were dealt with by planned augmentations in supply. The time-lags and large capital investments associated with large-scale energy infrastructure have meant that individual energy sectors and enterprises have undertaken energy forecasting and planning. This ensured the timely and reliable energy supply which is vital for the functioning of a modern economy and the well-being of its citizens. Discussion and analysis of the energy sector was dominated by engineers and generally restricted to technical aspects of supply. In the past this system worked reasonably well and, in South Africa, industry has been well served, though the costs of over-optimistic large-scale energy supply investments (by Eskom, Sasol, Mossgas and the Atomic Energy Corporation) have not fully been counted – neither the cost to the environment nor, most critically, the social cost of ignoring the basic needs of the poor majority.

De Oliveira and Girod (1990) identify the theoretical basis of this traditional supply-oriented approach to energy planning: individual energy subsectors had to adapt to demand induced by the market, both in terms of supplying sufficient energy and by minimising costs. Supply options were optimised by minimising discounted costs of supply, and energy prices were supposed to play a key role in supply/demand adjustment.

The international energy situation changed fundamentally with the end of cheap and predictable oil supplies in the 1970s. Planning for secure energy supplies was subsequently recognised as a national responsibility, but was still mainly confined to separate energy sub-sectors. In the petroleum sector, for example, policies were initiated to expand national reserve stocks and to regulate energy taxes and prices. In countries like South Africa there was massive state investment in the development of local alternatives including the mammoth Sasol oil-from-coal plants and the uneconomic Mossel Bay oil-from-gas development.

As the pervasive impact of rapid changes in energy prices on economic growth, employment and inflation became apparent, however, so too has the potential for national policy initiatives which could facilitate fundamental adjustment towards more energy-efficient production, not only through conservation measures and technical innovation but also through inter-fuel substitution. The focus began to shift from supply planning to an awareness of energy end-uses and the potential of demand management.

The underlying assumption of traditional energy planning was also undermined. Market-induced equilibrium between supply and demand was now recognised to be unpredictable and incapable of guaranteeing desirable developments in the energy system. Unplanned disjunctions in energy prices and supply could undermine the achievement of socio-economic objectives, such as meeting basic needs of consumers and providing development opportunities. Developing countries, in particular, face the twin bind of an ever-increasing foreign exchange burden in petroleum imports, and increasing fuelwood scarcities. Fuel famine for the poor is a serious problem; without a concerted, integrated planning effort it remains hopelessly intractable.

A further factor pointing to the necessity of integrated energy planning is the growing public concern with the environmental problems resulting from current patterns of energy production and consumption. Furthermore, investments in energy infrastructure are typically huge and in some countries can account for 30% or more of gross public investment. In South Africa, Eskom alone accounts for 20% – again underlining the importance of rational integrated energy planning which would improve both economic and energy efficiency and help meet socio-economic objectives.

There has also been a growing awareness of the connections between energy and the economy. Energy is a peculiar thing, not quite like anything else in our physical and social world. It is an element in a physical system subject to the laws of thermodynamics; it is also a component of the economic and social system, although never a desired end in itself. We do not enjoy electricity for its electrons, but rather for what it can accomplish in powering lights, appliances or motors. Its end-use is the linking concept between energy's socio-economic role and its physical dimension. Energy is needed as an input to most other economic sectors and is also a vital on-going component of the final consumption of goods and services. Its pervasive character implies that energy issues cut across most economic sectors, including industry and agriculture. In a sense, the energy system is analogous to the financial system, and all economies employ financial planning and regulation. But energy planning is also very different from financial planning, which is generally short-term, typically less than a year. Energy projects are usually large, and a short-term energy planning horizon is typically ten years. And, unlike money which can be devalued, energy is counted in constant physical units, thus enabling more reliable long-term planning.

The above arguments imply that energy planning should also be integrated with overall economic planning and policy analysis. The arguments for the necessity of promoting *integrated energy planning* are summarised below:

1. Energy is an input to all production sectors and adequate energy supplies are an essential pre-condition for economic development. Decisions affecting energy will thus affect other areas of the economy.
2. Energy is also an essential component of consumption and is vital to people's material well-being. Improving equity in access, as well as planning for sufficient and affordable energy supplies for households, transport and other services, is integral to the meeting of basic needs and to social development.
3. With increased disruptions and uncertainties in energy supply and with rising fuel prices, supply-side planning in individual energy subsectors is no longer adequate. Energy end-uses have to be analysed, and energy planning must encompass demand management and fuel-switching within and across economic sectors in order to maximise economic and energy efficiency as well as to enhance international competitiveness.
4. Many energy supply projects require very large investments, and sectoral decisions can have a major impact on key macro-economic variables for many years ahead.
5. Energy imports can consume a large portion of available foreign exchange, and policies which promote conservation or the development of indigenous supply options can have far-reaching economic implications.
6. Major environmental costs of energy production and use, such as acid rain, global warming and deforestation, are currently not adequately accounted for within individual energy subsectors and have to be incorporated as externalities in the integrated energy planning process.

In integrated energy planning, unlike the traditional approach, demand is no longer seen as a market-given imperative determining energy-supply planning, with prices as the sole mechanism of adjustment. Planning is integrated across sectors and can include a wider range of policy measures to achieve desirable goals. Energy end-use analysis becomes central. It involves an investigation into what people are using and why, as well as an analysis of their needs. This approach leads inevitably to a consideration of energy intensity, conservation and efficiency, technical innovation and diffusion, and to fuel-switching and improved access.

Integrated energy planning in the 1980s

One of the largest international efforts in promoting energy policy analysis and planning in developing countries has been the World Bank and UNDP's Energy Sector Management Assistance Programme (Esmap), supported mainly by the Netherlands, Sweden, Switzerland, Canada and Norway, and a number of other smaller donors. Through assessment and strategy studies in about 70 countries over the past ten years, Esmap has sought to identify the most serious energy problems and to propose remedial action. The programme has also undertaken a number of more detailed pre-investment studies, providing institutional and policy advice. The basic approach taken has been to describe the overall economic, social and energy situation; analyse energy supply and demand; forecast future energy supply and demand; and develop a strategy, a set of recommendations, and final project proposals (Esmap 1990). In the Programme's earlier years there was an emphasis on the household sector, but a recent review of Esmap has shifted attention to energy efficiency, global environmental linkages, and long-term investment planning with an emphasis on the commercial energy sector.

Among the first of the pathbreaking, integrated energy planning studies was the Beijer Institutes's energy and development project in Kenya which commenced in 1980 (O'Keefe et al 1984). Although its focus was mainly on fuelwood problems, it made an explicit effort to link energy planning to development goals and employed an energy end-use perspective.

As the practice of energy planning has become more established in the 1980s, a better understanding of the main policy and methodological issues has developed. A number of energy policy networks have contributed to this work including the African Policy Research Network (Afrepren), the Southern African Development Community (SADC) energy planning network, the Asian and Pacific Energy Planning Network (Apenplan), the Latin American Energy Organisation (OLADE), the European Network on Energy Economics Research (ENER) and the Cooperative Programme on Energy and Development (COPED), a network of two European and a number of developing-country research centres, funded by the Commission of the European Communities. In their first phase of work up till 1985, COPED concentrated on methodological issues, and subsequently have sought to apply the methodology in a number of countries and regions. COPED has also commissioned a number of case studies and has ongoing research programmes on energy policy issues such as prices and tariffs, energy and technology, energy and the environment and forecasting.

Other important contributions to the methodology of energy planning and policy research were the publication in 1985 of the lucid and comprehensive *Integrated energy planning: a manual* by the Asian and Pacific Development Centre (APDC), and the prolific writings of Mohan Munasinghe. This monograph relies in part on these two sources for a basic classification of the key principles of integrated national energy planning.

A framework for integrated energy planning

An integrated approach to energy planning asserts that separate planning for energy subsectors is no longer desirable or acceptable. It seeks instead to understand the links between energy supply and demand sectors and with macro-economic factors and socio-economic objectives – that is, the entire energy system. Greater coordination is sought between supply and demand options including demand management.

Munasinghe defines integrated national energy planning thus:

> Energy planning, broadly interpreted, denotes a series of steps or procedures by which the myriad of interactions involved in the production and use of all forms of energy may be studied and understood within an explicit analytical framework. (1990:2)

Munasinghe makes rather semantic distinctions between energy planning (the analytical process), energy policy analysis (the study of the impact of policies on society and economy) and demand/supply management (the use of policy instruments to achieve desired goals). One might protest that planning involves the development of a strategy and the identification of steps to achieve the goals of the strategy. Munasinghe does, however, make the point that energy planning involves primarily analysis. The implication is that research is fundamental in supporting the planning process.

For the APDC, integrated energy planning means the analysis of all energy issues within a unified policy framework in order to arrive at a set of nationally optimal energy solutions over the long term (APDC 1985),

COPED (1984) prefers the term 'energy diagnosis', denoting a policy-oriented approach to energy planning. Major issues of the energy system in relation to socio-economic development are identified and relevant actions and projects devised. As with much literature on methodology, the language becomes pretty turgid. The 'energy system' including 'energy modules' comprising 'homogeneous consumers' and a set of 'energy chains' are described by an 'integral' rather than a 'basic' energy balance sheet which provides a framework within which data are 'processed' and then 'synthesised', followed by 'energy diagnosis' which is a 'coherent method' of 'structured investigation' aimed at identifying the 'energy system's' most important characteristics through the use of key 'indicators'. These data should be combined with information on key 'elements' of the 'energy system' which must be 'regrouped' into 'coherent sets' which are entered into 'synthesis tables' either in a 'time series' or in 'cross-section diagrams' which allow 'hypotheses' to be formed around which 'future scenarios' may be 'elaborated' as a starting point for 'concrete applications', although results obtained from 'case studies' should also be integrated and these in turn should be placed in a broader framework of a 'socio-economic diagnosis'. Whew!

Perhaps much of this is just poor translation. More simply we could say that integrated energy planning involves detailed and comprehensive *analysis* of the energy sector, interaction between energy subsectors, and linkages with the rest of the economy. More importantly, it also involves formulating and evaluating appropriate *policies* and implementation strategies to manage the demand and supply of energy to achieve desirable objectives.

This requires three layers of analysis:

1. the energy sector in relation to other economic sectors (industry, transport, etc) and the broader economy (such as growth), social welfare (basic needs or equity, for example) and the environment (for example, sustainability);
2. energy subsector links (interactions, competition, conflicts, substitution, for example between rural electrification and a biomass production programme); and
3. within each subsector (for example, end-use analysis, demand forecasts, supply options, investment planning and pricing).

Energy subsectors have been traditionally defined according to individual energy sources such as coal or petroleum, and analysis has followed the energy chain from source, through transformation and distribution to the services the end-user demands. Integrated energy planning, however, starts with the consumer. Through disaggregated end-use analysis, major consumption sectors (such as households, commerce, industry, mining, transport and agriculture) are defined. These sectors are then broken down into subsectors (such as rural or urban households), which are, in turn, divided into end-uses (such as cooking or lighting) and end-user sections disaggregated by fuel type, energy technology used, level of energy intensity and social class of users. Building up each energy end-use from this level of disaggregation allows a clear analysis of policy options from fuel-switching through to technology transfer and energy efficiency, to government strategies for different users.

Integrated energy planning permits the development of a coherent set of policies which meets the needs of many interrelated (and sometimes conflicting) national objectives. Munasinghe argues that:

> The broad rationale underlying all national level planning and policymaking is the need to ensure the best use of scarce resources, in order to further

> socio-economic development efforts and improve the quality of life of citizens. (1990: 3)

Primarily, countries would want to determine the energy needs of the economy to achieve growth, environment and socio-economic development targets, and to choose the mix of energy sources to meet these energy requirements in the cheapest way possible. Increasingly, attention is being given to sustainable energy development which meets present needs without destroying the development possibilities of future generations. More specific objectives might include:

- maximising growth through economic efficiency in supply and use of energy;
- energy conservation and efficiency ;
- equity in access to affordable and sufficient energy supplies;
- development goals such as meeting basic needs of the poor or income redistribution;
- increasing the energy security of the poor;
- development of a sustainable energy economy;
- maximising use of renewable energy resources;
- environmental protection;
- enhancing regional development or particular economic sectors;
- self financing through revenue sales (in some energy sectors);
- saving scarce foreign exchange and reducing trade deficits;
- national security through diversification of supply; and
- investing in research and development (R&D), technology transfer and education to widen future energy choices.

Most of the literature on energy policy is a discussion of preferred goals. For example:

> The building of energy policies in Africa must be based on a development trajectory which strives towards growth which is sustainable in environmental and economic terms and takes account of constraints imposed by an unfavourable economic climate and environmental resource limits.
> (ETC 1989: 2)

Energy efficiency should always be a key goal, as it impacts favourably on a number of other goals. Greater energy efficiency can reduce energy costs to consumers, enhance environmental quality and living standards, increase energy security, and promote a competitive economy.

Munasinghe (1990) argues that the ideal aim is to produce and use energy more efficiently, thereby maximising net output and growth. Integrated national energy planning, in contrast to traditional approaches, should include not just engineering and financial analysis but also broader economic principles of marginal costing and shadow pricing. Key economic concepts employed would be opportunity costs and economic value with the objective of economic efficiency. The aim is:

- efficient *production* of energy, by ensuring the least-cost supply mix through the optimisation of investment planning and energy system operation; and
- efficient *consumption* of energy by providing efficient price signals that ensure optimal energy use and resource allocation (Munasinghe 1990:5).

Energy and economic efficiency are linked but distinct concepts. Economic efficiency is a higher value of net output (value of economic outputs minus the total costs of all inputs) produced. Energy efficiency is higher value of net output per unit of energy used. Munasinghe recognises that, while economic efficiency provides a useful starting point, it may have to be balanced with other goals and objectives, such as meeting basic needs.

Equity in access to energy services to meet basic needs and widening development opportunities is one of many, possibly conflicting, goals. While national security concerns in South Africa diminish in importance, goals of economic efficiency and growth cannot be discounted. On the other hand, the balance of payments is unlikely to be much affected by programmes aimed at widening energy access, given the overcapacity of current electricity generating plant in South Africa and the smallness of the potential energy demand of underdeveloped residential areas in relation to industrial and mining energy consumption. However, large investments in electricity distribution or afforestation, for example, might compete for capital required for other services or production. Demands to meet basic energy needs also have to be weighed against the urgency of investing in energy conservation and environmental protection. Integrated energy planning thus provides a framework for systematic and rational prioritisation of goals.

Once policy objectives have been defined, a range of policy instruments exist to achieve them (Munasinghe 1990):

- physical controls (for example, rationing supplies – usually short term);
- technical methods (for example, selecting a least-cost mix of efficient technologies and initiating appropriate R&D);
- investment policies;
- education and promotion;
- pricing, taxes, subsidies and other financial incentives;
- reforms in market organisation, regulatory framework, and institutional structures.

A broad framework for integrated energy planning has been established. We now need to look at the practical steps of how one sets about an integrated energy planning exercise.

The process of integrated energy planning

The essential components of integrated energy planning are described below. The list derives from a synthesis of the literature on integrated energy planning but does not follow any one author or publication. The component steps may be undertaken sequentially, although it is frequently necessary to return to previous steps as the data or analyses improve and deepen.

Definition of goals and scope

1. National (or regional) and sectoral development *goals* need to be defined, and relevant macro-economic or socio-economic variables whereby these goals may be measured need to be identified, including GNP growth-rate targets, adequate energy for basic needs and development, regional development balance, and desired energy intensity.
2. The *scope* and planning horizon have to be defined: national or regional; all or specific energy subsectors, short or medium term. In the first iteration the national energy system should always be surveyed, before looking at specific regions or energy subsectors. The scope or system constraints will often follow from stated objectives and goals.

Database development / description of energy system

The current and past energy systems should be described through data collection and appropriate presentation. In other words, a database needs to be developed through identifying data needs, and collecting and assembling data.

3. Various *elements* of the *energy system* and their links with major economic production and consumption sectors have to be *identified*. This involves the identification of energy consumption or demand sectors (disaggregated by

energy end-use, consumer category and fuel type) as well as energy supply sectors, including the energy chain of primary production, final energy and useful energy. Consumption sectors can follow Standard Industrial Classification (SIC) tables and should include household and informal sectors. If the scope has been limited to particular regions or subsectors, then an understanding is first needed of how these link with the energy system as a whole. The specific data needs of the study also need to be identified (for demand analysis, resource assessment and technology evaluation).

4. *Data collation* and, where necessary, *data collection*, needs to be done for the consumption (disaggregated by end-use) and production of energy (resource and technology), historically and currently, within identified energy subsectors. Data must also be collected on linked macro-economic and socio-economic variables relevant to understanding determinants of energy demand and supply or the achievement of goals.
5. *Data presentation* can be in the form of energy balances or an energy system network. *Balances* of energy supply and demand are constructed by assigning specific energy sources to corresponding uses to form a matrix including losses in production, processing, distribution and end-use. A useful framework for integral energy balances, which describes systematically the total energy chain from resources to final uses, including useful energy, has been developed by COPED (1984). A more standard format is provided by the IEA or the UN Statistical Office. Energy balances serve as both accounting and analytical tools. An alternative approach is the reference energy system. This is an energy accounting system indicating estimated energy demands, energy conversion technologies, fuel mixes, and the resources required to satisfy those demands.

Demand analysis and projections

6. Past and present energy demand (disaggregated by end-use) is then analysed – relative to prices, incomes, level of economic activity, supply constraints, stocks of energy using equipment and other relevant variables – in order to project future demand. It may be necessary to supplement quantitative consumption data with further qualitative data which would help to explain determinants of energy use as well as possible future changes in demand. Future demand scenarios which take into account shifting patterns in past and current determinants and future goals are constructed with the assistance of models.

Supply analysis

7. Primarily, supply analysis involves *resource assessment* and *technology evaluation*. Collated data on past and present levels of energy resources, production, imports and distribution, (including finance and personnel requirements), costs and output prices, together with development plans, application of new technologies and non-conventional sources, are analysed. All possible future options are investigated, disaggregated by energy subsector.

Balancing supply and demand and constructing future scenarios

8. Past and current integral energy *balances of supply and demand* are analysed to explain the past evolution of the system, to describe its successes and shortcomings and to evaluate its effects on the development process or the way development patterns have themselves constrained energy supply and demand. This is particularly relevant for underdeveloped sectors. Supplementary data on energy demand and supply determinants are also analysed, including the impact of past policies. This is the heart of the 'energy diagnosis' process defined by COPED (De Oliveira & Girod 1990). The present situation is explained by an analysis of the past, but the process is also oriented towards

the future in terms of identifying factors which will help one achieve desirable goals.

9. Taking into account existing and projected demand, resource constraints, technology developments, supply plans, projected macro-economic variables and desired socio-economic goals, future energy balances are then developed, preferably with the assistance of a microcomputer-based model. Energy flows have to be traced from each end-use, through conversion technologies to energy source. Before constructing alternative scenarios it may be useful first to forecast a base case (business-as-usual), which involves no policy interventions, to reveal the nature, timing and scale of demand/supply problems.

Policy options

10. Policies to manage desired supply and demand are then formulated in order to achieve a desired balance, using identified policy instruments for the energy system as a whole and for energy subsectors. These will include demand management and the configuration of supply options in terms of fuels, technologies, and (as the process becomes more detailed) costs and capital investment plans.

Impact analysis

11. Potential impacts of various policies on the environment, macro-economic indicators, and socio-economic objectives are analysed, and forecasts and policies adjusted as necessary.

Iteration

12. As the process unfolds and understanding of the energy system increases, it will be necessary to return to earlier steps to modify goals, redefine or add elements, collect new data or refine data, analyses, projections and policy options.

In essence, these steps should determine levels of energy demand and supply to achieve economic and social goals. The optimum supply mix is established to meet desired demand within defined constraints.

Any attempt to develop a plan for addressing historical inequalities in access to energy resources would first need to proceed through these steps for the overall energy system (even if cursorily). The exercise would have to be repeated in much more detail according to the specific objective of equity in access to energy services which meet basic needs and provide development opportunities. Specific demand and supply categories would be re-analysed within constraints and with reference to linkages identified in the first level analysis.[1]

Integrated energy planning is not easy. Available data is often inadequate and difficult to use in the face of a bewildering array of analytical tools and computational techniques. Linkages with economic plans can be contrived. There are also the problems of insufficient trained personnel, weak institional capacity and a lack of continuity in updating policy research and planning. A number of these issues are dealt with below through a more detailed examination of some of the processes involved in intregrated energy planning.

COPED researchers De Oliviera and Girod (1990) introduce the notion of decision nodes as depicting those parts of the energy system which have strong links with the main structural and development problems of the country. Only these need detailed representation and analysis.

The steps in more detail

Setting goals

A key problem area within the energy sector, and the most urgent energy policy issue to tackle, is widening the access of poorer households to basic energy services.

Equity is an issue in any society, but is a particularly severe problem in South Africa with its highly skewed income distribution, spatial development and access to services. While industry, commerce and nearly all 'white' households have adequate energy services, the majority of black households in urban and rural areas do not.

Investment in energy distribution will not only improve living standards but will stimulate development opportunities for new consumers. Economic development will also be promoted through backward and forward economic linkages including supply of electrical equipment, employment creation and sales of new appliances.

Data base development

Energy planning requires large sets of data in order to describe and analyse the energy system. Much of the data can become superfluous unless it is collected within a well understood framework of presentation and analysis. Models also require data, and care should be taken to ensure that the model represents local reality, rather than a set of assumptions developed elsewhere and with the possibility of an irrelevant set of data requirements.

At the outset, then, data needs should be closely specified. Data is required for energy demand analysis (factors affecting demand as well as data on actual energy consumption) and energy supply analysis (energy resource assessment and technology evaluation).

The following matrix represents the current status of information on the energy system:

	Modem fuels	*Traditional fuels*
Supply	very good	very poor
Demand	reasonable	poor

FIGURE 1 Status of energy information

Relatively good data exists on the supply and consumption of commercial fuels like coal, petroleum products and electricity, although not always for all end-uses and seldom in sufficient detail for low-income households[1] or subsistence agriculture, the two sectors on which a programme oriented towards basic energy needs of the poor will focus. Very little information exists on non-commercial biomass fuels, although there have been selective surveys of consumption in particular areas. This data needs to be systematically collated and combined with census data to provide a coherent national and regional picture. New data collection systems need to be established for fuelwood, crop residues, animal waste, biogas, solar, wind, and animal and human energy. Where necessary additional surveys (statistically representative, if possible) need to be commissioned to fill information gaps.

Although the database serves as an input to demand and supply analysis, its development does not necessarily precede the analysis stage. Usually database development and analysis are carried out simultaneously, with considerable iteration between them.

1. A recent study by Borchers and Eberhard (1990) goes some way towards filling this information gap in South Africa.

Even if the initial data set is incomplete and simple it allows a consistent and comprehensive approach to analysing national energy problems which is superior to the traditional uncoordinated planning by subsector. Planners and researchers can start identifying areas where data is poor and where further research and data collection is necessary. It should be remembered that the importance of database development does not lie in its sophistication but in the extent to which it is useful for energy planning.

Energy demand analysis

While analysis of energy supply options is a fairly well-established practice, analysis of demand is still a relatively underdeveloped science. It is, however, central to the process of integrated energy planning. Planners and policy makers need to have a good understanding of the factors affecting growth and patterns of energy demand before they can make demand projections or devise appropriate demand and supply management policies. This applies at both the macro-economic level and within particular energy sub-sectors or consumption categories.

At the outset, the term 'demand' should be used with caution, as consumers or potential consumers may not be able to express their social needs adequately through the market. The notion of demand, as used in neo-classical economics, typically expresses a relationship between price and quantity in a 'free market': the quantities that will be purchased at a given price. Simple relationships such as these can be of limited value, because of imperfect market conditions and also because they cannot easily account for the role of technological change or inter-factor or inter-fuel substitution. Once the purchase has been made, we refer to consumption rather than demand. But actual consumption may obscure unfulfilled demand, particularly where there have been constraints in the supply market such as restricted electricity distribution. In compilations of historical data the equivalence of demand and consumption is often assumed, and surveys to uncover unfulfilled demand are rare. When forecasting energy demand, it may be more appropriate to talk of energy requirements, as demand may need to be managed or regulated according to social, economic or environmental objectives.

The notion of energy needs and useful energy should also be clarified. The concept of energy needs addresses the fact that energy is not consumed for itself, but always for another purpose – for production of goods and services, for lighting, cooking or for obtaining desired thermal comfort levels. Energy needs, and hence demand, may shift according to new technology, or changing consumer tastes. Useful energy, is the actual energy delivered by end-use devices such as stoves, lights, and motors. The difference between overall and useful energy consumption is the energy lost in the transformation/conversion process. This difference reflects the energy efficiency of the end-use devices. Accounting for useful energy needs or requirements enables energy demand and energy efficiency policies to be explored.

Energy demand analysis requires an understanding of the relationship between energy demand and various variables at two different levels of data:

- macro-economic and demographic data as used in national economic planning; and
- sector and subsector data for each end-use, consumption sector and fuel, including fuel price. Other important data are the cost of alternative fuels, their availability, connection or access charges, reliability of supply, uniformity of quality, convenience of use, technical and economic characteristics of energy using equipment and appliances, availability of credit, income, rate of urbanisation, social preferences, acceptability, and knowledge of potential users.

Ideally one would want to develop short- and long-term elasticities of demand in relation to identifiable variables such as fuel price. This is sometimes possible in established commercial sectors but in the household sector energy consumption is often a function of a host of not easily quantifiable variables. Data collection and analysis should try to incorporate qualitative information which could facilitate a better understanding of factors which influence energy demand.

The analysis of demand must also include an understanding of why consumers shift from one fuel to another. The process of energy transition from biomass to paraffin to LPG and electricity is widespread amongst households in developing countries. An understanding of multiple fuel use is essential for integrated energy planning.

The outputs of demand analysis (projections and scenarios) are inputs to policy analysis, including demand management and energy conservation – the starting point for additional energy supply.

Energy models

Data presentation and analysis can be facilitated with the use of micro-computer models which can act as an accounting system (constructing energy balances), enable energy projections and the evaluation of various policy options. A number of reviews of available micro-computer models exist.[1] Models need to be assessed according to their ability to incorporate the methodological framework outlined above, particularly the links between energy sectors and macro-economic variables, energy balances, end-use analysis, scenario building and the evaluation of alternative policy options.

One of the more controversial uses of energy modelling is forecasting. Different forecasting methods can result in very different results and it is important to understand the basic methodology upon which these models are based. The following classification looks at some of the advantages and disadvantages of different approaches.

1. *Trend analysis* involves simple extrapolation of past growth trends. The obvious disadvantage of this methodology is that the future is decreasingly like the past – the very reason sophisticated integrated planning is needed. Trend analysis cannot model structural change and does not allow for any energy-economy feed-back.
2. *Multiple correlation forecasting*, where past energy demand is correlated with other variables such as prices and incomes, and future energy demand, is related to predicted trends in these variables. This method could be nothing more than a sophisticated version of trend analysis depending on the forecasting methods used for the separate variables. Munasinghe concludes that:

    > most of these . . . studies of energy demand aggregates are probably of limited value in industrialised countries and practically useless for developing nations. More specific studies, of clearly defined subsectors such as urban residential energy demand by city size and income, for example, may be more promising and useful, even if the required disaggregation reduces the more mechanical aspects of statistical significance. (1990:157)

3. *Econometric, macro-economic and supply-demand based energy forecasting* models are often additions to existing multi-purpose macro-economic models, although some have been constructed specifically to examine energy supply and demand relationships. Empirical relationships between energy variables (such as energy consumption or prices for various energy end-uses) and driving variables (such as consumer income or production costs) are modelled, yielding a great number of econometric equations which enable future demand and supply relationships to be estimated against various policy assumptions. The data requirements, however, are considerable and might be unrealistic for many developing countries. A major problem with

1. See, for example: Bogasch Associates (1984), Fenham (1986), ETC (1987), Esmap (1991).

econometric models, as with trend analysis, multiple correlations and elasticities of demand, is that relationships between variables are mostly obtained by regression analysis and curve-fitting of historical data which may not be relevant for future situations. The main advantage of econometric/energy methods is that a serious attempt is made to model the relationships between the economy and the energy system.

4. *Input-output analysis* is a standard tool of quantitative analysis of economic sectors and can be extended and refined to model energy flows. Input-output analysis can be incorporated into econometric or simulation models, but the data requirements are considerable.
5. *Process analysis* describes energy flows from primary sources of supply through to final demand, including transformation and conversion efficiencies. Energy flows are recorded in physical units, and process analysis thus provides a basic accounting framework, compatible with reference energy systems and similar to energy balances. Its advantages are that it can describe different technology alternatives, enables optimisation of supply options, accommodates traditional fuels, and has relatively simple computing requirements. It has traditionally been used for supply modelling, but it has important demand-side applications such as inter-fuel substitution. Its main disadvantage is that energy-economy relationships and price and income demand elasticities are not integral to the model. It is, essentially, a static model, providing a series of snap-shots of the energy system. Detailed end-uses can be incorporated, however, and a demand model which links energy demand to macro-economic and other variables can be added on. An example of this approach is the LEAP model. Although not a forecasting model, various scenarios can be explored.

Supply analysis

Supply analysis involves:

1. identifying and describing the energy supply system from resource through transformation to end-use;
2. assessing domestic supply resources and related conversion technologies;
3. identifying supply gaps;
4. evaluating the availability and prices of energy imports;
5. evaluating resource alternatives;
6. evaluating energy supply technology alternatives; and
7. analysing impacts of increases in energy supply on the energy system and the rest of the economy.

A study of supply options for improving access to energy which meet basic needs and increase development opportunities will not cover all energy resources or supply technologies. It will focus on those supply options which have been neglected or ignored for urban and rural households, and those appropriate for supporting rural development and small-scale agriculture.

Institutional issues

Integrated energy planning will only be possible with adequate institutional support, sufficient trained personnel, and the political will to employ policy instruments to achieve set goals. In a period of political transition in South Africa, these may seem unrealistic requirements. Yet there exists much common ground and even consensus around the need to alleviate poverty and to meet basic needs. A great deal of thought and research, however, has to be directed to the creation of appropriate institutional structures and the provision of adequate trained personnel if these goals are to be realised.

Commenting on a series of reviews of energy planning experience in different countries, Witbanks (1987) points out that energy analysis and planning – no matter how well done – are seldom linked effectively with energy decision-making and energy actions. His sobering conclusion is that formal comprehensive planning has seldom made much of a difference in important energy decisions. In his view, institutional limitations have probably been more significant than methodological shortcomings. The challenge is to link policy-makers more closely with planners and researchers. Ideally, policy-makers should themselves participate in the research process.

De Oliveira and Girod (1990) argue that energy planning in developing countries is very much more complex than in industrialised countries because of the inadequate integration of underdeveloped sectors into the national economy and the large inequalities in access to modern and efficient energy forms which can improve productivity. In this respect, South Africa ranks as a developing country. In most developing countries demand cannot be met in the short term. De Oliveira and Girod introduce the notion of energy actors, and discuss possible areas of conflict and the mediation/policy roles of government. In the South African situation there is growing conflict between consumers, suppliers and the state in energy provision as evidenced by electricity boycotts and growing demand for new and better electricity services in townships. Any research on policy options for meeting basic needs has to connect with key energy actors such as civic and political organisations, suppliers, and local and central government (energy, agriculture, transport and macro-economic planners).

Ideally, energy planning institutions should:

- be open to multi-sectoral perspectives and cooperation;
- allow participation of energy users, suppliers and development organisations in the planning process, both centrally and regionally; and
- establish interactive links with researchers.

Integrated energy planning cannot end merely with a set of policy options but has also to research how these policies might be enacted.

Policy research

It should be stressed that the development of an integrated energy plan requires a great deal of *research*. It requires the collecting and analysing of requisite data, developing an understanding of the linkages between energy use and social and economic needs, evaluating supply possibilities, analysing policy options in a systematic way and investigating the potential impact of energy policies on the economy and society. These are important areas of study by governments, development agencies, and research institutions. The Energy Research Group (ERG), a distinguished panel of international experts brought together by the International Development Research Centre in Ottawa in 1983, argues that competent policy research requires, in the first instance, the establishment of professional research institutions which are, preferably, independent but supported by the government.

What distinguishes university research institutions from research facilities in business or government is their potential to bring greater breadth and depth of knowledge to bear on problem issues. The quality of research often depends on researchers' experience, which accumulates from sustained application to meticulous research in an environment of peer review. University researchers are usually supported by superior facilities such as libraries and computing facilities, and have established contact with international literature and researchers. They act as repositories of knowledge and the skills necessary for advances in knowledge. They should be capable of giving independent advice which widens policy options and reduces decision-making risks.

Government departments often have a use-orientated and short-term approach to knowledge. If they fund research, it is usually project-orientated and neglects the basic infrastructure and management support so essential for continuity of research experience and quality. Funding research only at its marginal cost orients researchers towards a series of unrelated short-term projects and prevents them from developing depth. Captive research institutions or consultants are often forced to forego quality because of the pressures of being responsive to immediate demands. There is less time for new research. Available knowledge is skimmed and the result is often repetitive or derivative work perhaps best described as 'professional shallowness'.

In its review of energy research needs in developing countries, the ERG (1986) advises against proliferation of small new research units. Established multi-disciplinary institutes should, rather, be encouraged to grow by accretion of new programmes designed to meet new demands. Institutions should be given basic infrastructural support and long-term programme funds, as an investment in physical and personnel resources which can manage and supervise additionally funded, urgent, goal directed projects. The direction and management of programmes and projects should be as decentralised and autonomous as possible.

The ERG argues, however, that research will only be effective if there are informed buyers or users and if there is informed direction. The latter involves translating the demands of the external environment into well-defined research programmes. The former involves personnel in government and other user-groups who have been professionally trained in the field of energy, are familiar with energy research and are able to judge its quality and usefulness. Ideally there should be periodic exchanges between research and user organisations, re-emphasising the point made in the previous section.

Successful integrated national energy planning thus requires an investment in research, to develop the capacity to advance knowledge which acts as a resource for policy making. The above methodological outline provides the basis for undertaking this research.

References

Asian and Pacific Development Centre (1985). *Integrated energy planning: a manual.* 3 Volumes. Kuala Lumpur: APDC.

Bogasch Associates (1984). Review of accounting and planning models for use in developing countries. Report prepared for IDRC, Ottawa.

Borchers, M & Eberhard, A A (1990). Household energy supply and price trends in South Africa. EDRC Report No 5. Energy for Development Research Centre, University of Cape Town.

COPED (1984). Energy and development: what challenges? which methods? Report prepared for the Commission of the European Communities, Director-General for Energy. Boston: Lavoisier.

De Oliveira, A & Girod, J (1990). Energy diagnosis: towards a policy oriented approach for energy planning in developing countries. *World development*, 18 (4): 529-38.

Energy Research Group (1986). *Energy research: directions and issues for developing countries.* Ottawa: IDRC.

ETC (1987). The LEAP model. Report for the Wood Energy Development Project, SADCC, ETC Foundation, Leusden, Netherlands.

ETC (1989). Formulating African energy policy: a discussion document. ETC (UK) report, Newcastle.

Esmap (1990). Information and status report: September 1990. Washington: World Bank.

Esmap (1991). *Assessment of personal computer models for energy planning in developing countries.* Washington: World Bank.

Fenham, J (1987). Evaluation of the LEAP model. Report for SADCC by Energy Systems Group, Riso National Laboratory, Roskilde, Denmark.

MacKerron, G (1987). Energy pricing: industrialised country practices versus criteria for developing countries. Paper presented to the Third World Energy Policy Study Group, King's College, London

Munasinghe, M (1990). Energy analysis and policy – selected works. London: Butterworths.

O'Keefe, P, Raskin, P & Bernow, S (1984). *Energy and development in Kenya: opportunities and constraints.* Stockholm and Uppsala: Beijer Institute and Scandinavian Institute of African Studies.

Raskin, P D (1985). Integrated energy planning in developing countries: the role of computer systems. *Ambio*, 14 (4-5): 210-13.

United States Department of Energy (1990). *National energy strategy: powerful ideas for America.* Washington: Department of Energy. Available from NTIS, USA Dept of Commerce, Springfield, Virginia.

Witbanks, T J (1987). Lessons from the national energy planning experience in developing countries. *The energy journal*, 8: 169-82.

APPENDIX I
An annotated bibliography of energy planning and policy analysis in South Africa

The published literature on energy planning in South Africa is not extensive and comprises:

- a limited number of academic papers discussing key issues characterising the South African energy system or advocating particular supply strategies;
- a government white paper on energy policy and a subsequent monograph on energy strategy for developing areas;
- a number of regional studies on household energy which have provided a snap-shot pictures of existing energy consumption patterns in a particular area and have evaluated and recommended a range of supply options, but with very little analysis of the range of policy instruments to manage demand and supply.

There is a fairly extensive local literature on energy supply technologies, on the one hand, and a smaller literature on energy consumption or demand studies, on the other, but these have not dealt explicitly with energy planning. Discussion of energy planning methodology has largely been absent from this literature.

Documents are listed below according to their date of publication.

❑ **Dutkiewicz, R K (1980). Energy policy options for South Africa. Energy Research Institute Report, University of Cape Town.**

Apart from a number of reports in the mid-1970s from the old Department of Planning and the Environment which discussed the energy situation in South Africa in broad terms, this is the first document to explore energy policy options in some detail. Each of the energy sectors is looked at separately from a supply perspective and available resources, and potential technologies are evaluated.

❑ **Dutkiewicz, R K (1985). Energy planning in South Africa – problems and challenges. In Garnett, H M (ed) *Critical resources – use and abuse*. Senate Special Lectures 1985. University of the Witwatersrand, 18-21.**

Prof Dutkiewicz notes that 'up to now, Energy Policy in South Africa has been a question of putting out fires as they arise without any consideration of the long-term effects, or a general direction'. The paper discusses, in broad outline, policy options from a supply perspective, looking separately at coal, nuclear, transport fuels and renewables.

❑ **Department of Mineral and Energy Affairs (1986). *White paper on the energy policy of the Republic of South Africa*, Government Printer, Pretoria.**

The Department of Mineral and Energy Affairs (with an Energy Branch) was established in 1980. Its first White Paper in 1986 aimed at setting guidelines for a more structured and coordinated approach to energy policy formulation, the objective of such a policy being 'to ensure, by means of an appropriate energy management plan, both the adequate and uninterrupted provision of energy and its efficient utilisation in order to promote the optimum economic and social development of the Republic of South Africa'. The long-term plan would establish a national strategy that would ensure an adequate and uninterrupted supply of energy; promote a market-oriented and economically sound energy industry with a minimum of government control and involvement; constructively involve the private sector in the formulation of energy strategies by the creation of an Energy Advisory Council, and provide for the organisational structures and funds necessary for the formulation and efficient implementation of appropriate energy strategies. These strategies were conceived essentially in terms of energy resources and supply sectors, with the exception of separate strategies in energy efficiency and research and development.

The White Paper envisaged the creation of a national energy planning system to construct a thirty-year plan along with continually updatable five-year plans. An Energy Advisory Council was to oversee the process and the first plan was due to be published in 1986/7. Instead, a statutory body – the National Energy Council – was established through the Energy Act (No 42 of 1987) to coordinate energy regulation, policy and research, but no plan has yet been published.

❑ **The Energy Act (No 42 of 1987); The abolition of the National Energy Council Act (No 95 of 1991).**

❑ **National Energy Council Annual Reports 1988/89; 1989/90; 1990/91.**

Effectively, the Energy Act of 1987 transferred nearly all functions of the Energy Branch of the Department of Mineral and Energy Affairs to the National Energy Council (which included private sector involvement). However, the Act did not mention any energy planning function. Rather the objects of the Council were:

(a) to ensure that the energy resources of the Republic, and also those resources that may become available to the Republic from time to time, are exploited, developed and utilised in the best interest of the country, including research with regard to such exploitation, development and utilisation;

(b) to promote the sound development of energy undertakings in the Republic; and

(c) to advise the Minister on methods by which the objects . . . can best be achieved.

The National Energy Council, however, developed a mission statement:

> to formulate energy policy options and to develop and implement long-term energy strategies in partnership with the private and public sectors in order to promote the productivity and economic wellbeing of South Africa in particular and the Southern African region in general.

This was to be made possible by 'an organisational structure designed to promote a coordinated and integrated approach to energy planning'. However, apart from some very general reports on Energy Futures, no Energy Plans have been published. Their last annual report called for a new White Paper on Energy. The most developed statement on energy policy is an internal document on a draft energy strategy for developing areas (see below).

The first chairperson of the Council stated in the first annual report that 'privatisation figured prominently in the minds of the legislators when the Council was established'. It is ironic, then, that the Council was abolished through an Act of Parliament in 1991 in the state's attempt to reduce the scale and role of government. The funding base of the Council was earmarked levies on fuels and future budgets would only be financed from the national budget. The functions and personnel of the Council have reverted to the Department of Mineral and Energy Affairs and it is not clear how state-led energy planning will proceed in future.

- **Eberhard, A A & Dickson, B J (1987). Energy consumption patterns and supply options in Bophuthatswana. Energy Research Institute, University of Cape Town.**

- **Eberhard, A A (1990). Energy consumption patterns and supply problems in underdeveloped areas in South Africa, *Development Southern Africa*, 7 (3): 335-46.**

- **Borchers, M, Eberhard, A A & Archer (1990). Energy consumption patterns and supply options in the Namaqualand Reserves. Energy Research Institute, University of Cape Town.**

These three studies take a standard approach by undertaking energy consumption surveys to determine demand, and then evaluating a range of supply options. Their methodology becomes more rigorous by the third report with carefully designed surveys and detailed costing and discounted financial assessments of supply options. But none of them take an integrated approach to energy planning and macro-economic factors are not taken into account.

- **Gandar, M V (1988). Integrated energy planning for Natal/Kwazulu: a position paper. Prepared for the Natal Town and Regional Planning Commission, Pietermaritzburg.**

This was one of the first papers to discuss integrated energy planning (IEP) in South Africa, although a different notion of IEP is advanced. The term 'integrated' is mostly interpreted as 'holistic' – the full range of energy supply options should be considered and special emphasis should be given to ecologically sound exploitation of resources. The paper recognises that IEP must be located within the development context and that broader linkages between energy-use patterns and 'political-ecology' should be understood, and a set of key principles is defined: sufficient energy for all at affordable prices, sustainability through maximum use of renewable energy resources and protection of the environment, diversity of supply options, optimisation of resource use, energy system efficiency through the utilisation of waste, conservation and energy efficient pathways, and spatial balance between supply and demand. Preferred goals of energy planning are thus defined, rather than the methodology of IEP, or how one sets about IEP. An overview is given of energy consumption patterns and energy resources in Natal and Kwazulu, which are discussed in the context of these preferred goals.

- **Rivett-Carnac, J L (1990). Integrated energy planning: a study of the greater Mariannhill Area. Prepared for the Natal Town and Regional Planning Commission, Pietermaritzburg.**

The notion of 'integrated' is applied mainly to an integrated analysis of supply options to meet identified needs, rather than linking energy planning to broader development objectives or even specific goals such as energy efficiency. The standard approach is taken of mapping the study area, stratifying the sample of households, undertaking questionnaire surveys to determine energy consumption and expenditure patterns as well as preferred demand, and then evaluating available energy supply options – mostly on the basis of existing energy prices, but also in terms of energy needs, tasks and conversion devices.

- **National Energy Council (1990). An energy strategy for the developing areas of South Africa. Unpublished monograph, Pretoria: NEC, 39 pp.**

The governing paradigm of the strategy proposed here is 'the provision of adequate energy for the developing areas from a balanced least-cost mix of available energy sources to satisfy the basic energy needs of communities and to contribute to the improvement of quality of life'. Developing areas are defined as 'those areas inhabited with populations with low incomes who have limited access to basic services, who have fertility and mortality rates higher than the national average and who are relatively unmodernised'. Emphasis is given to the spatial dimensions of underdevelopment and the process of transition between rural and urban and further, between traditional and modern.

A key to the implementation of the strategy is seen to be an integrated energy planning methodology which incorporates the governing paradigm, takes due cognisance of social aspects and avoids technology-led solutions. It is argued that the strategy should ideally be part of 'a wider development effort to provide for the basic needs and to improve the quality of life of the populations'. The strategy has five interrelated elements: energy planning (at regional and local levels); information management (to fill data gaps and to provide tools in support of energy planning methodology); technology assessment and development; private sector involvement; and demonstration and communication.

The principle of energy planning is thus recognised, but no detailed methodology is spelt out to accomplish this, except the ranking of expected benefits and the determination of the costs of supply options. The weighting of the various elements of the strategy is uneven. The distinction between them is not always clear and there is some overlap, such as assessment of technical supply options which appears to be given more emphasis than demand analysis. There is also little mention of the use of appropriate policy instruments (such as pricing) by the central state.

❑ **Neethling, DC, Bredell, J H & Basson, J A (1991).** ***An integrated approach to energy supply and demand: the role of nuclear energy in Southern Africa.***
The importance of an integrated approach to the development of an electricity strategy for Southern Africa is emphasised in view of the numerous options and initiatives that are available for supply- and demand-side management. Apart from present uncertainties concerning future electricity demand, other factors such as the availability of coal and uranium and the comparative costs of nuclear and coal basaed electricity are seen as important parameters.

❑ **Spies, P H (1991). Testing assumptions in strategic energy plannning: applications of environmental scanning, issue analysis and scenario planning. ROC-RSA Energy Conference, Paper No 2, 17pp. Pretoria: National Energy Council.**
The paper focuses on ways of managing the complexity of long-term energy planning and forecasating. It explains the use and application of environmental scanning and scenario-planning in energy policy-making as developed by the Institute for Futures Research in its Energy Futures Project.

❑ **Stewart, T J (1991). Is rational energy modelling for South Africa practicable? or, from modelling to decision support in energy policy planning. ROC-RSA Energy Conference, Paper No 3, 9pp. Pretoria: National Energy Council.**
The author discusses the use of energy-economy models for energy planning and the construction of an energy policy planning decision support system (DSS), based partly on the concepts of multiple-criteria decision-making. He proposes that the DSS start with few policy options and scenarios, and on very simple models.

❑ **Viljoen, R P (1991). Energy strategies for Southern Africa. Paper delivered at the Energy Southern African Options Conference. Johannesburg: Institute of Energy.**
The South African energy sector is analysed in the conventional manner before a different categorisation in terms of fuel group characteristics is suggested, namely modern, transitional and traditional. Energy options and strategies are discussed for these demand categories.

APPENDIX II
Bibliography of energy planning and policy studies in Southern and Eastern Africa

Beijer Institute (1985). *Policy options for energy and development in Zimbabwe*. Stockholm: Beijer Institute.

Environmental Resources Limited (1985). A study of energy utilisation and requirements in the rural sector of Botswana: final report. London: ERL/ODA.

ETC (1987). Wood energy development: policy issues. A study of the SADCC region. SADCC energy development fuelwood study. Leusden: ETC.

ETC (1987). Wood energy development: a planning approach. SADCC energy development fuelwood study. Leusden: ETC.

GTZ (1991). Lesotho Energy Masterplan: Update.

Hosier, R H et al (1986). *Zimbabwe: energy planning for national development*. Scandinavian Institute of African Studies, Uppsala.

Millington, A & Townsend, J (1988). *Biomass assessment: a study of the SADCC Region*. London: Earthscan.

Botswana Ministry of Mineral Resources and Water Affairs (1986). *Botswana energy masterplan*. Gaborone.

O'Keefe, P & Munslow, B (1984). *Energy and development in Southern Africa. SADCC country studies* (2 vols). Uppsala: Beijer Institute and Scandinavian Institute of African Studies.

O'Keefe, P, Raskin, P & Bernow, S (eds) (1984). Energy and development in Kenya: opportunities and constraints. Uppsala: Beijer Institute and Scandinavian Institute of African Studies.

Simoes, J C T (ed) (1984). *SADCC energy and development to the year 2000*. Uppsala: Beijer Institute and Scandinavian Institute of African Studies.

UNDP/World Bank (1982). Kenya: issues and options in the energy sector. Report No. 3800-KE. Washington: World Bank.

UNDP/World Bank (1982). Malawi: issues and options in the energy sector. Report No. 3903-MAL. Washington: World Bank.

UNDP/World Bank (1983). Zambia: issues and options in the energy sector. Report No 4110-ZA. Washington: World Bank.

UNDP/World Bank (1983). Uganda: issues and options in the energy sector. Report No. 4453-UG. Washington: World Bank.

UNDP/World Bank (1984). Tanzania: issues and options in the energy sector. Report No. 4969-TA. Washington: World Bank.

UNDP/World Bank (1984). Lesotho: issues and options in the energy sector. Report No. 4676-LSO. Washington: World Bank.

UNDP/World Bank (1984). Botswana: issues and options in the energy sector. Report No 4998-BT, Washington: World Bank.

UNDP/World Bank (1986). Zaire: issues and options in the energy sector. Report No 5837-ZR. Washington: World Bank.

UNDP/World Bank (1987). Mozambique: issues and options in the energy sector. Report No. 6128-MOZ. Washington: World Bank.

UNDP/World Bank (1987). Swaziland: issues and options in the energy sector. Report No. 6262-SW. Washington: World Bank.

UNDP/World Bank (1988). Botswana: household energy issues study. Washington: World Bank.

UNDP/World Bank (1989). Angola: issues and options in the energy sector. Report No. 4708-ANG. Washington: World Bank.

UNDP/World Bank (1991). Botswana: Urban Household Energy Strategy Study. Washington: World Bank.

UNDP/World Bank (1989). Zambia: energy strategy study. Report No. 094/88. Washington: World Bank.

UNDP/World Bank (1990). Zambia: urban household energy strategy study. Report No. 121/90. Washington: World Bank.

UNDP/World Bank (1982). Zimbabwe: issues and options in the energy sector. Report No. 3765-ZIM. Washington: World Bank.

UNDP/World Bank (1991). Zimbabwe: energy strategy evaluation. Washington: World Bank.

UNDP/World Bank (1991). Zimbabwe: energy strategy for low-income communities. Washington: World Bank.

PD UCT

PAPER Nº 2

Integrated energy planning:

A methodology for policy analysis and research

Anton Eberhard

SOUTH
AFRICAN
ENERGY
POLICY
RESEARCH
AND
TRAINING
PROJECT

widening access to basic energy services for the urban and rural poor

ENERGY FOR DEVELOPMENT RESEARCH CENTRE
University of Cape Town

PROJECT DESCRIPTION

A major two year research project was launched by the Energy for Development Research Centre in April 1992. It aims to investigate policy options for widening access to basic energy services for the urban and rural poor in South Africa. Research papers are being produced in the following areas:

Background papers
Research outline
Integrated energy planning: a methodology for policy analysis and research
Development context for energy planning in South Africa
Background on South African energy system

Energy demand analysis
Energy demand in underdeveloped urban and rural areas

Rural areas
Energy for rural development: an introduction and overview
Energy and small-scale agriculture
Rural household energy supply options
Afforestation and woodland management
Remote area power generation options

Urban areas
Household energy supply in formal and informal urban settlements
Energy and informal sector production

Ancillary sector
Energy and mass transportation*

Key supply sector
Electricity distribution sector*

Cross-sectorial studies
Energy efficiency and conservation*
Energy and environment*
Southern Africa linkages*
Investment requirements and financing mechanisms*
Pricing policy*
Institutional analysis*

Policy options
A concluding document will draw together key policy conclusions
** The scope of these studies is restricted to energy issues concerning the urban and rural poor.*

EDRC

The Energy for Development Research Centre is located at the University of Cape Town. Its objectives are to study energy related problems of developing areas in Southern Africa, and possible ways to address them.

EDRC seeks to achieve its objectives by:

- undertaking research projects;
- running a specialist postgraduate programme to support research projects and to train personnel to contribute to this field;
- transferring relevant information to user groups by offering consulting services and running workshops, and through publishing books, journal papers, reports, leaflets and design and user manuals.

Energy for Development Research Centre
Energy Research Institute
University of Cape Town
Private Bag
Rondebosch 7700
South Africa

Contact persons: Dr Anton Eberhard / Paul Theron
Tel: (021) 650 3230 *Fax:* (021) 650 2830