

THE STATUS AND ROLE OF ENERGY ECONOMICS

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1. INTRODUCTION

The pervasive and vital role of energy in national economies indicates that the identification of energy issues, and energy policy analysis and implementation are important areas of study. While the softening of world oil prices which began in 1986 has provided some relief to the economies of oil importing nations, energy related problems still preoccupy the minds of decisionmakers in most developing countries. Thus, the availability of adequate energy resources at a reasonable cost remains a vital precondition for continued economic growth, while most of the key energy issues identified during the past decade persist. Typically, developing country energy investments still account for about 25 percent of total public capital expenditures, while this figure is around 50% in some nations -- particularly in Latin America. Furthermore, oil importers are spending an average of 15-20 percent of export earnings on petroleum imports, and serious fuelwood shortages and deforestation problems continue unabated -- especially in Africa and Asia.

Following the first international oil crisis of 1973, the rapidly increasing costs of all forms of energy, led by the world oil price, stimulated the development of new analytical tools and policies. Indeed, much of this success may be attributed to the discipline of energy economics, and the increasing recognition received by our profession reflects the valuable contributions made by many distinguished researchers and colleagues in the field. It is a privilege to briefly set out in this paper, my views on the progress made in recent years, and its impact on energy decisionmaking and implementation in the developing countries. Unfortunately, limitations of space and time prevent full justice being done to the considerable literature available.

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Central to the success of the energy economics approach has been the concept of economic value of scarce resources. The economic numeraire has provided the basis on which alternative uses of various resources might be evaluated, facilitating the tradeoff between energy and other more traditional inputs such as capital and labour, as well as among the different forms of energy themselves. Furthermore, economic efficiency in both energy supply and use is a practical benchmark. Thus, the economic costs of deviating from efficient policies, to meet sociopolitical and other goals, may be used to assess the desirability of such options.

Several important lessons have been learned by both energy analysts and policymakers, during the last 10-15 years. First the importance of an integrated approach to energy analysis, and more systematic exploration of energy-macroeconomic links, emerged. Furthermore, while policy analysis and formulation at the national level might be centralised, the effective implementation of policy requires the maximum use of decentralised market forces and institutions. Second, the need became apparent, for greater coordination between energy supply and demand options, and better use of demand management and conservation. Third, the more disaggregate analysis of both supply and demand within the energy sector offered greater opportunities for inter-fuel substitution in specific uses. Fourth, the analytical and modeling tools for energy subsector planning became more sophisticated, particularly in their treatment of uncertainty, reliability and supply quality. Fifth, greater practical reliance was placed on economic principles, such as marginal costing and shadow pricing in the developing countries, rather than relying on engineering and financial analysis alone.

II. FRAMEWORK FOR INTEGRATED NATIONAL ENERGY PLANNING (INEP), POLICY ANALYSIS AND IMPLEMENTATION

Energy decisions cannot be made in isolation. The complexity of energy-economic interactions indicate that energy sector investment planning, pricing and management should be

carried out on an integrated basis, e.g., within a integrated national energy planning (INEP) framework which helps analyse the whole range of energy issues and policy options over a long period of time.

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. Planning techniques range from simple manual methods to sophisticated computer modeling. The complexity of energy problems and the enhanced capability of low cost microcomputers, has led to increasing reliance on the latter approach. Energy policy analysis is the systematic investigation of the impact of specific energy policies or policy packages on the economy and society, at all levels. Energy supply and demand management involves the use of a selected set of policies and policy instruments, to achieve desirable national objectives.

An important goal of developing countries must be to upgrade the quality of energy planning, policy analysis and management. However, the word planning, whether applied to the national economy or the energy sector in particular, need not imply some rigid framework along the lines of centralized or fully planned economies. Planning, whether by design or neglect, takes place even in the so-called market economies.

In energy planning and policy analysis, the principal emphasis is on the detailed and comprehensive analysis of the energy sector, its linkages with the rest of the economy, and the main interactions within the various energy subsectors themselves. In the industrialised nations, the complex and intricate relationships between the various economic sectors, and the prevalence of private market decisions, make policy analysis a difficult task. In the developing countries, substantial levels of market distortions, shortages of foreign exchange as well as human and financial resources, larger numbers of poor households whose basic needs have to be met, greater emphasis on rural energy problems, and relative paucity of energy and other data, add to the already complicated problems faced by energy analysts everywhere.

In order to better understand the nature of decisionmaking in the energy sector, we begin by identifying below, some of the broad goals of energy policy as seen from the national perspective.

National Policy Objectives

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. Energy planning must also be part of, and closely integrated with overall economic planning and policy analysis, to meet many specific, inter-related and frequently conflicting national objectives. Specific goals might include: (a) ensuring economic efficiency in the supply and use of all forms of energy, to maximize growth -- other efficiency related objectives are energy conservation and elimination of wasteful consumption, and saving scarce foreign exchange; (b) raising sufficient revenues from energy sales, to finance sector development; (c) meeting the basic energy needs of the poor, and income redistribution; (d) diversifying supply, reducing dependence on foreign sources, and meeting national security requirements; (e) contributing to development of special regions (particularly rural or remote areas), and priority sectors of the economy; (f) price stability; (g) preserving the environment; and so on.

Scope of INEP

The scope of integrated national energy planning (INEP), policy analysis, and supply-demand management may be clarified by examining the hierarchical framework depicted in Figure 1. At the highest and most aggregate level, it is clearly recognized that energy is but one sector of the whole economy. Therefore, energy planning requires analysis of the links between the energy sector and the rest of the economy. The range of macroeconomic policy options from long term structural adjustments to short term stabilisation programs, will have significant impacts on the energy decisions. More specific links between the energy sector and the rest of the economy include energy sector inputs such as capital, labour, raw material and environmental resources (eg. clean air, water or space), as well as energy outputs such as

electricity, petroleum products, or wood fuel, and the impact on the economy of various energy policies.

The second conceptual level of INEP treats the energy sector as a separate entity composed of sub-sectors such as electricity, petroleum products and so on. This permits detailed analysis, with special emphasis on interactions among the different energy sub-sectors, substitution possibilities, and the resolution of any resulting policy conflicts such as competition between natural gas, oil and coal for electricity production; woodfuel and kerosene for cooking; or diesel and gasoline for transportation.

The third and most disaggregate level pertains to planning within each of the energy sub-sectors. Thus, for example, the electricity subsector must determine its own demand forecast and long-term investment programs; the woodfuel sub-sector its consumption projections and detailed plans for reforestation, harvesting of timber, and so on. It is at this lowest hierarchical level that most of the detailed formulation, planning, and implementation of energy schemes are carried out.

In practice, the three levels of INEP merge and overlap considerably. Furthermore, regional disaggregation may also be required, especially in large or diverse countries. The INEP process should result in the development of a flexible and constantly updated energy strategy which can meet the national goals discussed earlier. Such a national energy strategy, of which the optimal investment program and pricing policy are important elements, may be implemented through a set of energy supply and demand management policies and programs. While the policy analysis and formulation may require centralised coordination, policy implementation is most effectively carried out using decentralised mechanisms and market forces, as discussed below.

In the recent past, analytical advances have been made in implementing hierarchical modeling with a policy focus. Earlier energy models sought to encompass the entire scope of energy planning within a single framework. However, recent work has been based on a modular hierarchical system along the lines of the INEP concept. The efficacy of this analytical approach has been proven in recent applications.

Policy Instruments

To achieve the desired national goals the policy instruments available to third world governments, for optimal energy management include; (a) physical controls; (b) technical methods; (c) direct investments or investment-inducing policies; (d) education and promotion; (e) pricing, taxes, subsidies and other financial incentives; and (f) reforms in market organization, regulatory framework and institutional structure. Since these tools are interrelated, their use should be closely coordinated for maximum effect.

Physical controls are most useful in the short-run when there are unforeseen shortages of energy. All methods of limiting consumption by physical means such as load shedding, or rotating power cuts in the electricity sub-sector, reducing or rationing the supply of gasoline or banning the use of motor cars during specified periods, are included in this category. Use of physical controls as long-run policy tools, however, is generally undesirable because of severe economic consequences. Technical means are used to manage both the supply of and demand for energy, and include determination of the most efficient means of producing a given form of energy (e.g., choice of the least-cost or cheapest mix of fuels for supplying power) and disseminating higher efficiency energy conversion devices.

Investment policies have a major effect on both energy supply and consumption patterns in the long run. The electrification of new areas, extension of natural gas distribution networks, and building of new power plants based on more readily available fuels such as coal, are some examples of such policies. The policy tool of education and promotion can help to improve the energy supply situation through efforts to make citizens aware of cost-effective ways to reduce energy consumption, the energy use implications of specific appliances or vehicles, and the scope for economically beneficial tradeoffs between savings on recurrent energy costs and capital expenditures required to realise such savings.

Pricing is politically sensitive, but a most effective means of demand management and in view of its importance, pricing policy is discussed in more detail in the next section. Taxation and subsidies are useful policy inst-

ments that can also profoundly affect energy consumption patterns in the long run. For example, the imposition of duties or taxes on oil powered motors and the subsidization of electric motors may cause a significant shift from petroleum-based products to electricity, where such a substitution is desirable from the national perspective.

Finally, the potential for policy reforms to improve market organization and promote greater efficiency in the energy sector, is the subject of increasing scrutiny in many third world countries, as well as the development community. This theme is also more fully developed later.

We conclude this section by noting that the chief constraints which limit effective policy formulation and implementation are: (a) poor institutional framework; (b) insufficient manpower and other resources; (c) weak analytical tools; (d) inadequate policy instruments; (e) lack of political will; and (f) other constraints such as low incomes, and economic distortions.

The foregoing discussion has helped to establish the wider basis for energy analysis. As noted earlier, it is the concept of economic value of scarce resources that ties the analysis together, and permits the decisionmaker to focus on policy alternatives, involving tradeoffs arising from the deployment and use of otherwise non-comparable sets of inputs and outputs. Next, we examine how energy economics has contributed to the determination of specific energy policies, within this wider framework.

It is convenient to begin by recalling that the objective of economic efficiency requires both:

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

III. PRICING POLICY

In the past, energy prices in most countries were determined mainly on the basis of socio-political considerations, and financial or accounting criteria such as earning suffic-

ient sales revenues to meet operating and investment costs. More recently however, there has been increasing emphasis on the use of economic principles in order to encourage more efficient consumption and production of energy.

While economic efficiency is a useful starting point for price setting, a number of other national goals (indicated earlier) must be also met. Since these criteria are often in conflict with one another, an effective integrated energy pricing policy should be flexible enough to accommodate tradeoffs among them. Thus in the first stage, a set of prices based on the marginal opportunity costs (MOC) of supply, is determined, to meet the strict economic efficiency objective. In practice, it is easier to begin the optimal pricing procedure from MOC, because supply costs are generally well defined (using techno-economic considerations). In the second stage of price setting, the MOC based efficient prices are adjusted to meet the other goals of pricing policy.

Strictly Efficient Energy Prices

For a typical nontraded form of energy like electricity, MOC is the long run marginal cost (LRMC) of supply from the power system. LRMC is estimated using the economic opportunity costs or shadow prices for inputs to the power sector (like capital, labor, and fuel), instead of purely financial costs. This approach facilitates efficient utilization of capacity to meet peak demands, with price structures that vary with the marginal costs of serving demands: by different consumer categories; in different seasons; at different hours of the day; by different voltage levels; and in different geographical areas. In particular, with an appropriate choice of the peak period, structuring the LRMC-based tariffs by time-of-day generally leads to the conclusion that peak consumers should pay both capacity and energy costs, whereas off-peak consumers need to pay only the energy costs. Similarly, analysis of LRMC by voltage level usually indicates that the lower the service voltage, the greater the costs imposed on the system by consumers.

Contemporary ideas in electric power pricing, such as spot pricing, take account of the dynamics of instantaneous, and the fact that the MOC also changes dynamically as the generation mix is adjusted to meet shifts in

demand. These concepts have great potential for improving economic efficiency, particularly in the case of large power consumers, though formidable implementation constraints remain.

For tradable fuels like crude oil, and fuels that are substitutes for tradables at the margin, the international or border prices (c.i.f. price of imports or f.o.b. price of exports) are appropriate indicators of MOC. Fuels such as gas or coal could be treated as tradables or nontradables, depending on the specific circumstances. The MOC of depletable, nontraded energy sources will include an economic rent or "user cost", in addition to the marginal costs of production. Generally, MOC of depletables will depend on demand conditions, stock of resources, and opportunities for substitution or trade, all of which could vary with time. The economic value of traditional fuels (like biomass) are the most difficult to determine, because in many cases the relevant markets are not well defined. However, they may be valued indirectly, in terms of savings on alternative commercial fuels like kerosene, the opportunity cost of labour for gathering fuelwood, or the external costs of deforestation and erosion.

In summary, the efficient price for nontraded energy is the opportunity cost of inputs used to produce it plus a user cost where relevant, while MOC for traded fuels is the import or export price. Thus strictly efficient prices will signal to the consumer, the economic costs of resources used or alternative benefits foregone, resulting from increased energy use. MOC may need to be modified because of second-best considerations on the demand side, if prices elsewhere in the economy do not reflect marginal costs -- especially when this applies to close energy substitutes or complements in specific applications. The rather simplified marginal cost rule also needs to be adapted, to accommodate the dynamics of shifts in supply and demand over time, capital indivisibilities, uncertainty and reliability considerations.

Adjustments to Meet Nonefficiency Criteria

In this section, we examine how strictly efficient energy prices need to be modified to arrive at a practically implementable price structure that also meets the nonefficiency objectives mentioned earlier.

The purely financial goals most often encountered relate to meeting the revenue requirements of the sector, and are often embodied in criteria such as some target financial rate of return on assets, or an acceptable contribution toward the future investment program. In principle, for state-owned energy suppliers, the most efficient solution would be to set the price at the efficient level, and to rely on government to subsidize losses or tax away surpluses. In practice, some measure of financial autonomy and self-sufficiency is an important institutional goal. Because of the premium that is placed on public funds, a pricing policy that results in continual failure to achieve minimum financial targets would rarely be acceptable. The converse case, where efficient pricing would result in financial surpluses well in excess of traditional revenue targets, may be politically unpopular, especially for a public enterprise. In either circumstance, changes in revenues have to be achieved by adjusting the efficient prices.

It is intuitively clear that discriminating between the various consumer categories, so that the greatest divergence from the marginal opportunity cost-based price occurs for the consumer group with the lowest price elasticity of demand, and vice versa, will result in the smallest deviations from the "optimal" levels of consumption consistent with a strict efficiency pricing regime. In many countries the necessary data for the analysis of demand by consumer categories is rarely available, so rule-of-thumb methods of determining the appropriate tariff structure have to be adopted. However, if marginal costs are greater than average costs, the fiscal implications should be exploited to the full. Thus, electric power tariffs (especially in a developing country) constitute a practical means of raising public revenues in a manner that is generally consistent with the economic efficiency objective, at least for the bulk of the consumers who are not subsidized; at the same time they help supply basic energy needs to low-income groups. Cross subsidization is often used also in the petroleum subsector, where high prices for gasoline, based on efficiency, externality, and conservation considerations, may be used to finance subsidies on kerosene for poor households or diesel for transport.

Next, we consider the income distributional objective. Sociopolitical or

equity arguments are often advanced in favor of subsidized prices or "lifeline" rates for energy, especially where the costs of energy consumption are high relative to the incomes of poor households. Economic reasoning based on externality effects may also be used to support subsidies; for example, cheap kerosene to reduce excessive firewood use and prevent deforestation, erosion, and so on. To prevent leakages and abuse of such subsidies, energy suppliers must act as discriminating monopolists. Targeting specific consumer classes such as poor households, and limiting the cheap price only to a minimum block of consumption, are easiest to implement, for metered forms of energy like gas or electricity. Other means of discrimination, such as rationing, licensing, etc., may also be required, but are difficult to apply effectively.

In practice, the magnitude of the minimum consumption has to be carefully determined, to avoid subsidizing relatively affluent consumers; it should be based on acceptable criteria for identifying "low-income" groups and reasonable estimates of their basic energy requirements. The subsidized price level relative to the efficient price may be determined on the basis of the poor consumer's income level in relation to some critical consumption level or poverty threshold. The financial requirements of the energy sector would also be considered in determining the magnitude of the subsidy.

As indicated earlier, there are several additional political, and social considerations that may be adequate justification for departing from a strict efficient pricing policy. The decision to provide commercial energy like kerosene or electricity in a remote rural area (which often entails subsidies), could be made on completely noneconomic grounds. Typical reasons of a general sociopolitical nature include maintaining a viable regional industrial or agricultural base, stemming rural to urban migration, or alleviating local political discontent. Similarly, uniform nationwide energy prices are a political necessity in many countries, although this policy may, for example, imply subsidization of consumers in remote rural areas (where supply costs are high) by energy users in urban centers. However, the full economic benefits of such a course of action may sometimes be greater than the apparent

costs of the divergence between actual and efficient price levels. Again this possibility is likely to be much more significant in a developing country than in a developed one, not only because of the high cost of energy relative to incomes in the former, but also because the available administrative or fiscal machinery to redistribute incomes is frequently ineffective.

The conservation objective (to reduce dependence on imported energy, improve the trade balance, and so on) usually runs counter to subsidy arguments. Therefore, it may be necessary to restrict cheap energy to productive economic sectors that need to be strengthened while in the case of the basic energy needs of households, the energy price could be sharply increased for consumption beyond appropriate minimum levels. In other cases, conservation and subsidized energy prices may be consistent. For example, cheap kerosene might be required, especially in rural areas, to reduce excessive fuelwood consumption and thus prevent deforestation and erosion.

It is particularly difficult to raise prices to anywhere near the efficient levels where low incomes and a tradition of subsidized energy have increased consumer resistance. In practice, price changes have to be gradual, in view of the costs that may be imposed on those who have already incurred expenditures on energy using equipment and made other decisions, while expecting little or no change in traditional energy pricing policies. At the same time, a steady price rise will prepare consumers for high future energy prices.

Finally, owing to the practical difficulties of metering, price discrimination, and billing, and the need to avoid confusing consumers, the pricing structure may have to be simplified. Thus, the number of customer categories, rating periods, consumption blocks, and so on, will have to be limited. Electricity and gas offer the greatest possibilities for structuring. The degree of sophistication of metering depends among other things, on the net benefits of metering and on problems of installation and maintenance. For electricity or gas, different charges for various consumption blocks may be effectively applied with conventional metering. However, for liquid fuels like kerosene, subsidized or

discriminatory pricing would usually require schemes involving rationing and coupons, and could lead to leakage and abuses.

IV. SUPPLY EFFICIENCY

We recall that efficient energy pricing based on marginal costs assumes that the energy supply system is already optimally planned and operated. This makes good sense from even a purely practical point of view -- thus an inefficient supplier that is routinely permitted to pass on excessively high costs to consumers, under the umbrella of marginal cost pricing, will have very little incentive to reduce costs and produce more efficiently. There are also solid analytical reasons for insisting on supply efficiency as a prerequisite to efficient pricing. We begin by discussing the power subsector, where the analysis is particularly sophisticated, and then generalise the results to other energy subsectors.

Optimal Reliability and Traditional Least Cost Planning

Recent theoretical work has emphasized that the optimal conditions for price and capacity levels must be simultaneously satisfied to maximize the net social benefits of electricity consumption. In this context, determining the optimal capacity level is equivalent to establishing the optimal level of reliability, since capacity additions do improve the reliability level. We may summarize simply, the complex analysis underlying the joint optimality conditions, as follows. The optimal price is the marginal cost of supply. Simultaneously, the optimal reliability (capacity) level is defined by the point at which the marginal cost of increasing reliability is exactly equal to the corresponding increase in marginal benefits to consumers because of improved supply quality.

In brief, this approach indicates that for a given price structure, an optimal long-run investment plan and a corresponding range of reliability levels may be determined which maximize net social benefits of energy consumption, and thus reflect the national viewpoint. This reliability (or capacity) optimization model subsumes rather than replaces the conventional least cost criterion. In the conventional approach to power system design and planning, costs are minimized subj-

ect to supplying the load at some (arbitrarily) given reliability level. Since the forecast demand is assumed to be fixed in this case, consumption benefits are also constant. Therefore, cost minimization (or the least cost criterion) is equivalent to maximization of net benefits. With the new approach, it is possible to determine, rather than assume the optimal reliability level, by explicitly maximizing the net benefits of energy use. A social cost-benefit model is used to evaluate the inherent trade-off between the increase in energy system supply costs required to achieve a higher level of reliability, and the corresponding increase in consumer benefits, including the cost savings due to reduced supply shortages. It is possible to then design the supply system to meet the forecast load, subject to the new reliability requirement, using the traditional least-cost planning techniques. This would permit the application of existing sophisticated least cost system planning models and techniques.

The contemporary ideas of reliability differentiation and priority service, though related more to the demand side, take these concepts a step further by recognising that customers differ in their willingness-to-pay for reliability. Thus, welfare could be increased by supplying customers (and charging them) according to the reliability level they desire, rather than using a universal reliability level as at present. However, practical implementation is subject to the same constraints that apply to spot pricing.

We note that reliability optimization may be generalized for application in other energy subsectors. For example, in oil and gas investment planning, the costs due to gasoline queues, lack of furnace oil, or gas for domestic and industrial use may be traded off against the supply costs of augmenting storage capacity or delivery capability. Clearly, these additional considerations would modify the marginal costs of energy supply and thus affect optimal pricing policies.

Because of greater uncertainties in the present global scene, including unforeseen changes in energy demand, fuel prices, technology, interest rates, and trade and economic conditions, minimizing risk is playing a more important role in modeling. Thus, decisionmakers in developing countries are now paying

increasing attention to risk diversifying energy policy options that are robust over a wide range of exogenous scenarios, rather than adopting purely cost minimizing, deterministic but risky solutions that were more appropriate for the narrower band of possibilities which existed in the past.

Finally, we note that supply efficiency requires optimal operation of energy systems (in addition to optimal investment planning), which in turn implies that plant performance, loss levels, etc. are also optimised.

Efficient Operation of Enterprises

Unfortunately, the performance of energy supplying institutions in many developing countries has deteriorated drastically in the past few years. Problems that have plagued these institutions include: the inability to raise prices to meet revenue requirements, weak planning, inefficient operation and inadequate maintenance, high losses, low supply quality and frequent shortages, poor management, excessive staffing and low salaries, poor staff morale and performance, excessive government interference, etc. Concurrently, there has been a shift towards large monolithic state owned energy enterprises in the developing countries. This trend has been based on reasons such as: scale economies, improved coordination, reduced reserve margins, nationalisation and elimination of foreign ownership. Although some of this rationale is still valid, new options for improving enterprise efficiency are being increasingly explored.

Of the difficulties plaguing developing country energy enterprises, undue government interference in organizational and operational matters may be the most pervasive. Such interference, which has resulted in loss of management autonomy, is at least partly responsible for the other problems mentioned above. In order to address these difficulties, an important principle must be recognised -- that given the complexity of energy problems and the scarcity of resources and managerial talent in developing countries, each set of issues should be dealt with by that level of decisionmaking and management best suited to analyzing the difficulty and implementing the solution. This hierarchical approach corresponds closely to the INEP concept developed earlier.

Thus, political decisionmakers, senior government officials and ministry level staff would do better by focusing on critical macro-economic and energy sector strategy and policy, in order to determine global expectations of energy sector performance. The senior management of the enterprise, appropriately buffered by an independent board of directors, could then conduct their daily operations free from government interference, to meet the overall national policy objectives and targets within regulatory guidelines. As far as possible, the enterprise management should be assured of continuity at the top, even in the face of political changes. Decisionmakers should discuss with the power enterprise management, any relevant national goals, especially the extent to which government finds it necessary to trade off efficient pricing and investment policies against broader sociopolitical objectives. While the enterprise is provided wider autonomy, it would now become more accountable in terms of performance measured against an agreed set of specific objectives and monitored indicators.

Major changes in enterprise management may be required, to mirror changes in the external environment discussed above. The enterprise's organizational structure may be inadequate. Administrative and financial controls might be loose. Management can be timid and lacking in objectives. There should be sufficiently comprehensive management reporting and information systems which address each level of management and ensure accountability. Long range planning and economic analysis responsibilities need to be clearly defined and assigned. Commercial forms of accounting must be instituted to help in assessing performance and making decisions. Billing and collection of receivables often need to be improved. Finally, decentralisation of administration, and technical, operational, and commercial activity must keep pace with the increasing size of the enterprise.

Once again, the fundamental principle that will help to address these problems is delegation of authority. Very often, in developing country power utilities, the senior management attempts to deal with all problems, and trivial issues often get more attention than critical ones. Provided that middle-level managers could be adequately trained and made accountable, senior managers could (by appropriate delegation of tasks) free themselves to deal with higher level policy. This process

would then be repeated down to the lowest working levels. Obviously, staff training and education, and performance incentives at all levels and stages of career would play a critical role in ensuring the success of such an approach.

V. SECTOR ORGANIZATION AND FINANCING

The natural monopoly characteristics of some energy enterprise functions, as well as the perceived national interest to use these companies as a general policy tool, are in many countries accepted as sufficient reasons for maintaining large public sector monopoly organisations. Nevertheless, the observed problems inherent in stimulating management of developing country monopoly enterprises to be cost conscious, innovative, and responsive to consumer needs, indicates a need for more fundamental change. It could be worthwhile to consider trading off some of the perceived economies of scale in some energy enterprises for other organisational and regulatory structures which provide a greater inherent incentives for management efficiency and consumer responsiveness.

Decentralization Options

The options for decentralization, variations in ownership and corresponding regulatory changes, are numerous. Options for private and cooperative ownership of energy enterprises could include both local and foreign participation as well as joint ventures. As long as a given regulatory framework prevails, it can be argued that the form of ownership alone (private or public) may not necessarily affect operating efficiency. The main point is that, to the extent possible, the introduction of competitive market forces should be encouraged such as by full or partial divestiture of some government owned enterprises. A first step could be for government-owned energy enterprises to competitively contract out activities or functions better handled by others. Obvious areas which many companies already subcontract on the basis of competitive bidding, include civil works and plant construction. Some energy companies have even subcontracted on a competitive basis, the development of local retail and distribution networks, reaping benefits such as lower costs and greater programming flexibility (brought about partly by a reduction in problems associated with public sector labor unions, work rules and general 'featherbedding').

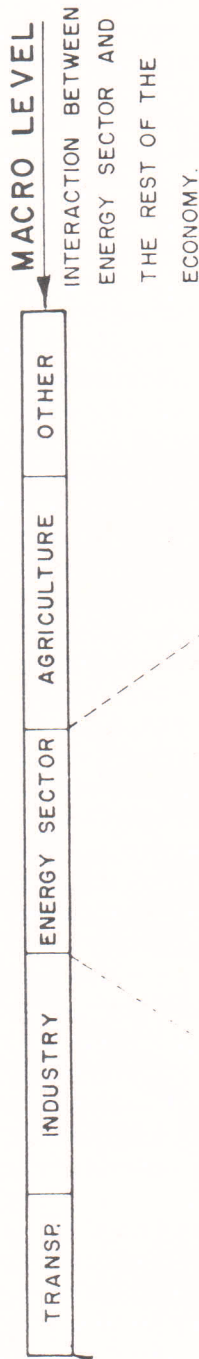
There are also opportunities for decentralization on a spatial basis. For example, larger countries can, and sometimes do, choose to have independent regional power grids. Power or gas distribution companies could be separated by municipality, with perhaps limited overlap in some fringe franchise areas, and have the right to purchase from various suppliers, when feasible. If private participation were allowed, one advantage might be that at least the large energy consumers could also be legitimate shareholders who would be concerned not only with service efficiency but also with the financial viability of the company.

Power generation also has potential for efficiency improvements through divestiture. While the bulk power transmission and distribution functions might be regarded as having more natural monopoly carrier type characteristics in most developing countries, this is not so with generation. In fact, there is substantial scope for competition in power generation with independent (perhaps foreign-owned enclave) producers (or cogenerators) selling to a central grid (or common carrier), as in the case of large industrial cogeneration. For example, in the USA the Public Utilities Regulatory Policies Act of 1978 (PURPA) specifically encourages small privately owned suppliers to generate electricity in various ways for sale to the public grid. As a result there are now a large number of small companies producing and selling electricity presumably at costs below those incurred by some large utilities through conventional generation. Similar laws have been passed elsewhere and are beginning to impact.

In fact, with appropriate legislation allowing the break up of national or regional power monopolies and with innovative contractual arrangements, greater scope for cogeneration and free generation might be encouraged. The advantage to the power company would be a de-emphasis on large lumpy capital-intensive projects together with the fact that the cogeneration and free generation companies would put up all or part of the capital and be paid only out of revenues from power sold at guaranteed prices. For larger enclave generation facilities (perhaps peat, coal, or nuclear), the concept would be that a foreign investor put up the plant, mobilise equity and other financing, operate and maintain the plant for an agreed period, and be repaid out of power sold at guaranteed prices convertible

FIGURE 1 - Integrated National Energy Planning Framework

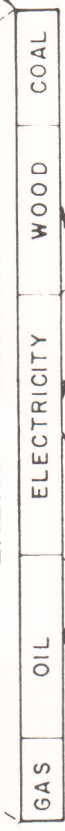
MACROECONOMY



RESOURCE REQUIREMENTS
ENERGY OUTPUTS
ENERGY SECTOR CONSTRAINTS

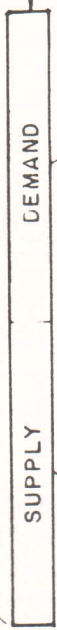
(RESOURCE AVAILABILITY
(INPUTS K, L, M, ...))
ENERGY DEMAND
(DISAGGREGATE)
NATIONAL OBJECTIVES
AND CONSTRAINTS

ENERGY SECTOR



INTERMEDIATE LEVEL
ENERGY SUBSECTOR
INTERACTIONS.

ELECTRICITY SUBSECTOR



MICRO LEVEL
SUBSECTOR PLANNING
AND MANAGEMENT.

- INVESTMENT PLANNING
- OPERATIONS
- LOSS OPTIMISATION
- RELIABILITY OPTIMISATION

- PRICING POLICY (LR)
- PHYSICAL CONTROLS (SR)
- TECHNOLOGICAL METHODS
- EDUCATION AND PROPAGANDA

in foreign currency.

Financial Options

Developing countries are turning increasingly to more innovative financing options, most of which have been used in the industrialised countries. Some of the financial instruments that are now being studied in third world nations, include:

- 1) Non-recourse and limited recourse financing (or project specific financing);
- 2) Leasing of individual pieces of equipment or whole plants, by local or foreign investors;
- 3) Private ownership or operation of energy producing or distributing facilities;
- 4) Counter trade, involving barter type exchange of specific export goods for energy imports;
- 5) Developing financial instruments to finance local costs, often involving the creation of new financial intermediaries;
- 6) Revenue bonds, with yields tied to enterprise profitability;
- 7) Tax-exempt bonds; and
- 8) Sale of energy futures, that encourage large users to seek more stable longer term price contracts.

The Multilateral Investment Guarantee Agency (MIGA), recently created by the World Bank, could also play a key role in the future. It will seek to promote the flow of international capital to developing countries, by providing guarantees (on a fee basis), against the following non-commercial forms of risk:

- 1) Transfer risk, arising from host

government restrictions against convertibility and transfer of foreign exchange;

- 2) Loss risk, resulting from legislative or administrative action (or omission) of the host government that leads to loss of ownership, control, or benefits;
- 3) Contract repudiation risk, when the outside investor has no recourse to an adequate forum, faces undue delays, or is unable to enforce a favourable judgment; and
- 4) War and civil disturbance risk.

VI. CONCLUSIONS

We see that our understanding of energy problems, both from the analytical and practical points of view, have improved significantly since the early 1970's. Energy economics has developed from a fledgling discipline to a well recognised one during this same period, and in the process continues to make a valuable contribution to the management of energy problems, especially in the developing countries. The central concepts of opportunity costs and economic value have provided the numeraire on the basis of which integrated national energy policies could be developed, and alternative options concerning the use of scarce resources might be traded off. The objective of economic efficiency is the practical benchmark against which other goals and objectives can be conveniently evaluated.

At the same time, important energy issues still await resolution, and the tools of energy economics will continue to help us analyse, understand and address these problems.