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Creating energy futures

A short guide to energy planning

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Publication date:
1983

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Crossley, D., & Sørensen, B. (1983). *Creating energy futures: A short guide to energy planning*. (pp. 1-30). Roskilde Universitet. http://milne.ruc.dk/ImfufaTekster/

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TEKST NR 63 1983

CREATING ENERGY FUTURES:
A SHORT GUIDE TO ENERGY PLANNING

ENERGY SERIES No. 8

af David Crossley & Bent Sørensen

TEKSTER fra

IMFUFA ROSKILDE UNIVERSITETSCENTER
INSTITUT FOR STUDIET AF MATEMATIK OG FYSIK SAMT DERES FUNKTIONER I UNDERVISNING, FORSKNING OG ANVENDELSER

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IMFUFA tekst nr. 63/83, RUC. 30 sider. ISSN 0106-6242

ABSTRACT:

The aim of energy planning should be to develop an energy plan which is appropriate and optimal for achieving specified societal goals. A prerequisite to the planning process is the elaboration of one or more visions of the future. This leads to the first step in energy planning which involves the setting of societal goals in relation to the desired vision of the future.

Seven different types of actors may be involved in substantive energy planning: governments and parliaments; government departments; the energy industry; local governments and their administrations; the scientific community; political parties, labour organisations and other interest groups; and community groups. Each of these actors has a legitimate and specific role to play in the energy planning process. This process consists of translating the desired vision of the future into a list of necessary material processing and service requirements which then may be spelled out in terms of the associated energy demands.

Continuing assessment of energy plans is essential to determine whether the outcomes are indeed the desired ones, to identify any unexpected outcomes or impacts at an early stage, and to modify the energy plan and policy initiatives so as to achieve more closely the desired goals. All important impacts of the chosen energy system should be assessed by means of a process which allows significant and meaningful public participation.

Energy planning should be seen as an iterative process involving continuing cycling through the three stages of planning, implementation and assessment.

CONTENTS

	Page
SUMMARY	2
INTRODUCTION	4
Aims of Energy Planning	4
Society and Societal Goals	4
Societal Structure	7
Creating Energy Futures	7
THE PROCESS OF ENERGY PLANNING	8
Governments and Parliaments	8
Government Departments	8
The Energy Industry	9
Local Governments	9
The Technical/Administrative Elite	10
The Scientific Community	10
Political Parties, Labour Organisations and Other Interest Groups	11
Community Groups	11
Integration of the Planning Process	13
THE METHODOLOGY OF ENERGY PLANNING	15
Specification of Energy Demands	15
The Energy Supply System	15
Optimization of Energy Supply and Use	16
System Aspects	16
Flexibility	17
THE PROCESS OF IMPLEMENTATION	18
Information Instruments	18
Financial Instruments	18
Regulatory Instruments	19
Role of Non-governmental Bodies	19
THE METHODOLOGY OF IMPLEMENTATION	21
Information Instruments	21
Financial Instruments	21
Regulatory Instruments	23
Social Consequences of Policy Implementation	23
THE PROCESS OF ASSESSMENT	25
THE METHODOLOGY OF ASSESSMENT	27
CONCLUSION	30

SUMMARY

The aim of energy planning should be to develop an energy plan which is appropriate and optimal for achieving specified societal goals. A prerequisite to the planning process is the elaboration of one or more visions of the future. This leads to the first step in energy planning which involves the setting of societal goals in relation to the desired vision of the future. Subsequent stages then consist of substantive energy planning, the implementation of the energy plan, and the assessment of the success or otherwise of the implemented plan in achieving the specified goals.

Seven different types of actors may be involved in substantive energy planning: governments and parliaments; government departments; the energy industry; local governments and their administrations; the scientific community; political parties, labour organisations and other interest groups; and community groups. Each of these actors has a legitimate and specific role to play in the energy planning process. This process consists of translating the desired vision of the future into a list of necessary material processing and service requirements which then may be spelled out in terms of the associated energy demands. The major planning effort then consists of finding an optimum path from energy sources to final demands by selection of the most viable set of conversion devices, energy system layout and demand organisation.

Implementation of energy plans is carried out by governments acting to set the parameters within which energy production and use takes place. Governments have available three main categories of policy instruments with which they can influence energy production and use: information instruments, financial instruments and regulatory instruments.

Continuing assessment of energy plans is essential to determine whether the outcomes are indeed the desired ones, to identify any unexpected outcomes or impacts at an early stage, and to modify the energy plan and policy initiatives so as to achieve more closely the desired goals. All important impacts of the chosen energy system should be assessed by means of a process which allows significant and meaningful public participation.

Energy planning should be seen as an iterative process involving continuing cycling through the three stages of planning, implementation and assessment. Successful energy planning will require the continuous formulation, implementation and assessment of new policy initiatives as conditions and societal and group value systems change.

INTRODUCTION

This short paper is intended to be a modest and preliminary guide to energy planners in government and the civil service, as well as to those who want to check the appropriateness of official energy planning and perhaps suggest alternatives.

Aims of Energy Planning

In broad terms, the main aim of energy planning is to develop a working energy system compatible with the general goals of society. This usually involves a process of optimization because more than one appropriate solution can often be identified. Thus criteria have to be devised to assess which of the solutions bests fulfills the goals of society. Also, as there are societies with different goals, there will be different energy systems best serving different societies. This is often overlooked in energy studies aiming at finding the "right" energy solution for the North and the South, the East and the West. Rather, the aim of energy planning should be to develop an energy plan which is appropriate and optimal for achieving specified societal goals.

When different energy solutions are being pursued in different societies, questions of their cross-national compatibility must also be considered, e.g. potential conflicts arising over access to global resources.

Society and Societal Goals

A society is often defined as a nation within political boundaries. However, we also consider local communities which, due to cultural or geographical links, function like an entity, a local society. Furthermore, there may be situations where population groups across national borders consider themselves as a common society, again for reasons such as common cultural background or widely common interests.

A society aims to provide good living conditions for its members. There is broad (but not universal) consensus that this means satisfying primary needs for everyone and creating conditions that will allow individual members of society, as well as groups within society, to fulfill many of their aspirations and desires. We adopt this goal definition and distinguish between primary goals which are indisputable and secondary goals, which are varying and sometimes mutually conflicting. In relation to secondary goals, society must debate and agree on those ideals that cannot be pursued independent of competing ones, while leaving freedom for pluralistic priority setting with respect to wishes that do not preclude other members of society from pursuing different wishes.

We have tacitly assumed that societies have goals. In many present societies, no process of goal setting has been established, and societal goals are diffuse or unformulated. There may still be individuals and groups within society, who have given some thought to goal setting and who may actually have formulated coherent sets of goals. Such proposed goals may form the basis for a process of defining national goals in a political context, including ways of changing (secondary) goals with time. Once a society possesses a set of accepted goals, it can address the problem of moving towards a future with satisfaction of its goals in order of their priority.

Deciding on the societal goals which are to be pursued through the implementation of policy is an essential first step in policy formulation. However, many policymakers ignore this first step and move immediately to detailed consideration of possible policy instruments. Ignoring goal setting frequently results in policy which is unacceptable to certain groups in society whose goals are different from the implicit goals of the policymakers. Another likely consequence of ignoring goal setting is the development of policy instruments which have outcomes and impacts which were unforeseen and unintended by the policymakers.

The policy formulation process may commence by identifying the goals which are currently broadly accepted in society and those which are held only by certain groups. On this basis, the policymakers should then propose goals which they wish to promote through the policy instruments being formulated. In relation to energy policy, these goals are likely to be concerned with such issues as centralisation versus decentralisation of society, materialist versus non-materialist lifestyles, and future prospects for employment. Identification of such goals will facilitate a meaningful public debate about the appropriateness and optimality

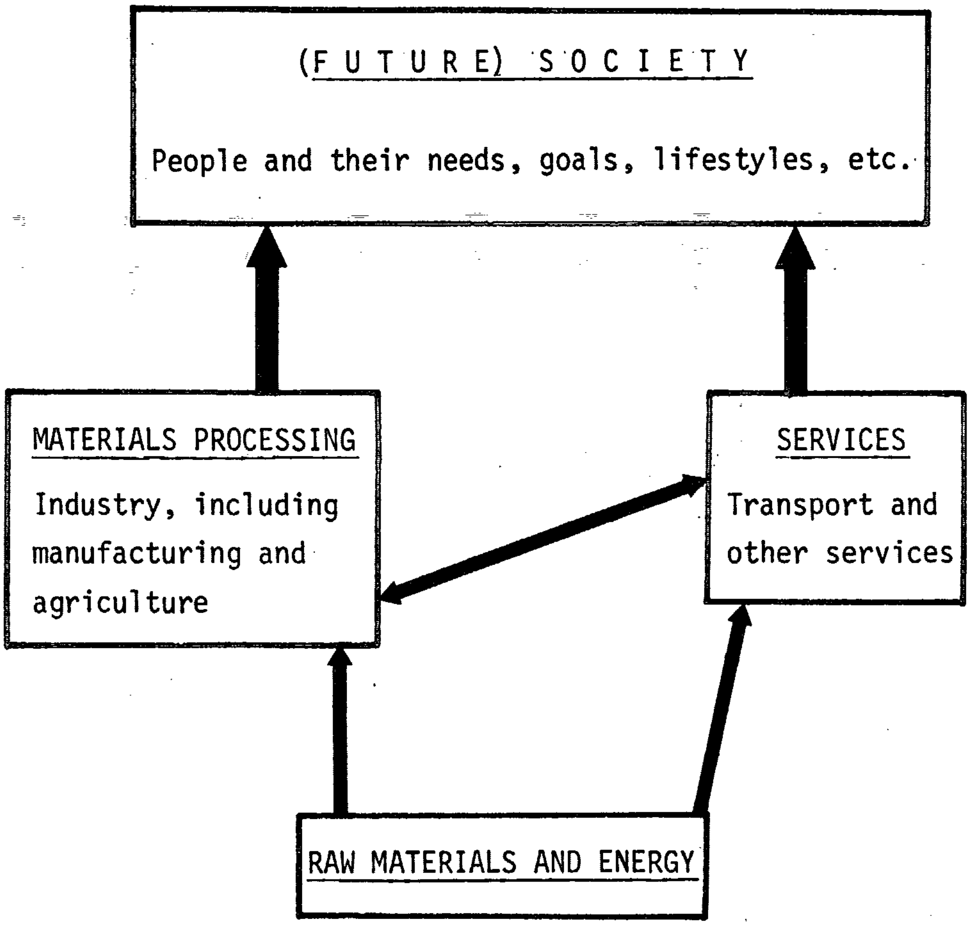


FIG. 1. Relationships between social needs and energy use.

of the chosen policy instruments.

Societal Structure

As illustrated in Fig. 1, the satisfaction of the primary (often termed "basic") and secondary needs involves both materials processing (manufacturing industries and agriculture), and services (transportation, health and social institutions, etc.). The processing sector further requires certain services, e.g. for distributing goods, and both the processing and service sector demand inputs of certain raw materials and of energy. Most materials are used in the processing sector and indirectly carried to the service sector, and to people as consumers of products and services, whereas energy is used (better "converted") in all sectors.

This picture of society is helpful in exhibiting structural possibilities. From Fig. 1, it is evident that the processing, service and energy/raw materials sectors are only means to achieve goals, and that they can be changed in any way that helps improve goal achievement. Thus, it is not essential for the wellbeing of a society that, for example, its industry expands by a certain annual rate, but rather the optimal goal achievement could involve contraction of both the processing and service sectors, thereby reducing energy use. Such structural changes are as important to the optimization process as are simple increases in efficiency in each sector without structural changes.

Creating Energy Futures

In the following, we view the effort of creating energy futures from three angles; energy planning, implementation of an energy plan, and assessment of whether both the aims of the plan and societal goals are being achieved. These can be seen as successive steps but, as we will argue, they are in fact part of an iterative process in which both energy plans and their implementation are regularly being assessed and modified as a result of new insights. For each of the steps, we discuss both the processes involved and the methodology available for use in energy planning, both representing of course our input to the reflection, discussion and action through which every society should become involved in creating their own energy futures.

THE PROCESS OF ENERGY PLANNING

It is essential to consider the process whereby energy planning is carried out because this process can have profound effects both on the detailed content of the plan eventually produced and on the feasibility of its implementation. This section will discuss the process of energy planning by examining the roles of the various actors who may be involved. Seven different types of actors can be identified :

1. Governments and parliaments
2. Government departments
3. The energy industry
4. Local governments and their administrations
5. The scientific community
6. Political parties, labour organisations and other interest groups
7. Community groups and popular movements.

Governments and Parliaments

Governments and parliaments are in principle capable of leading a meaningful public debate on goal setting, and priorities in energy planning. Governments may use their departments as instruments for providing factual imput to such discussions. However, governments and parliamentary committees are often unable to see through the mix of factual and value-based material presented by departments, and government energy planning will then suffer from the same problems as any administratively organised effort, cf. the points raised below.

Government Departments

Usually one government department is given the major responsibility for energy planning. In some cases, this may be a department which is only concerned with energy matters, but in other cases the department may have other responsibilities such as control of mining, or of economic development, or of environmental matters. Whatever the type of department which is responsible for energy planning, there are bound to be other departments which have an interest in energy planning such as the transport department, the industry department, and so on. Any government energy plan will be the result of much discussion and argument between departments with each department trying to protect what it sees as its own territory and making sure that its interests are not compromised. The outcome of such a process therefore may not be the most optimal plan for achieving societal goals.

Another factor which works against the production of an optimal energy plan is that planning within government departments usually takes place in an environment relatively isolated from the everyday reality of energy use by large sections of society. Energy planners in departments are members of a technical/administrative elite who mutually share the same perceptions and value systems in relation to energy production and use. Members of this elite receive continual confirmation and reinforcement of their perceptions and value systems, but these may be at variance from those values expressed in policy-related societal goals. Departmental energy plans therefore are unlikely to be appropriate or optimal, unless they are formed through a process involving thorough public debate with inputs from actors familiar with the goal setting political process.

The Energy Industry

Energy producers and suppliers whether publicly or privately owned, have as their major responsibility the success of their commercial operations. In the case of private companies the motivation is profit, whereas public utilities seek the survival and expansion of their organisation. Energy producers and suppliers have a major role in energy planning because it is their operations which, to a large extent, determine the nature of energy system. However, because of their paramount concern with commercial success, and their frequent involvement with only one energy form, the planning carried out by or influenced by energy producers and suppliers is unlikely to be optimal for achieving societal goals.

Local Governments

The involvement of local governments in energy planning varies greatly from country to country. At one extreme, local governments can be involved in the preparation of detailed energy plans for their area, whereas at the opposite extreme, they may have no involvement with energy matters at all. Local governments, in fact, have great potential for optimal energy planning since they have detailed knowledge of their area and some also have close contact with local residents. Knowledge, expertise and skill in energy matters may well be lacking at the local government level, but this can be an advantage when local government people are willing to learn about energy since they have the potential for introducing innovative ideas and procedures into energy planning. On the other hand, local administrations may suffer from the same problems as central departments, and often local governments assemble irregularly, while their technical staff is on full-time duty.

The Technical/Administrative Elite

Energy planning at present in many countries is dominated by a particular identifiable group of people who are technical experts in various aspects of energy production and use, and/or administrators in government departments or the energy industry. Studies of this technical/administrative elite* have shown that these people tend to share perceptions and value systems about society and societal goals, characterised by beliefs that the future will consist of a simple extrapolation of the present, combined with an indiscriminate technological optimism. The energy plans which are produced by such people, and the de facto planning they carry out in the absence of an elaborated plan, therefore tend to be based on this relatively simple perception of the future which does not allow for much innovation. Such energy planning is unlikely to be optimal for societies with a pluralistic range of societal goals.

The Scientific Community

Members of the scientific community often fill the roles of the technical/administrative elite, either as government and energy industry advisors, or through involvement in research funded by the government or the private sector. However, in many countries members of the scientific community are also allowed (and sometimes expected) to act as societal critics. Individual scientists with natural or social science backgrounds have in fact brought up questions of inappropriateness in official energy technology choice and energy planning methodology, as well as pointing out the need for a broader

*See for example: Crossley, D.J. (1979) Energy and people, pp 76-84 in: Diesendorf, M.(ed.) *Energy and People: Social Implications of Different Energy Futures* Canberra, Society for Social Responsibility in Science (ACT); and Nader, L. and M. Illeron (1979) Dimensions of the 'people problem' in energy research and 'the' factual basis of dispersed energy futures *Energy 4*, 953-967.

public debate of energy issues. Often critical scientists become advisors to community groups and popular movements. In some cases, the same scientists may appear in roles both as government and anti-government experts, with suitable adaptation to the behavioural patterns expected of them.

Political Parties, Labour Organisations and Other Interest Groups

These groups may be involved in energy planning issues through using political processes to influence the energy policy of the government of the day. Obviously, input from such groups demonstrates a bias in favour of the particular group(s) in society being represented by the party or interest group in question. For example, labour organisations tend to favour labour-intensive energy solutions even at the expense of other disadvantages.

Community Groups and Popular Movements

There is a wide range of community groups which could, and have become involved in energy planning, including: environmental groups, resident groups, consumer groups, groups of concerned scientists and professional people, and so on. Community groups can become involved in energy planning in two ways: they can provide comments on "official" energy plans, and they can actually produce energy plans themselves. The same holds for popular movements, which are ad hoc groups focussed on particular issues, such as the anti-nuclear power movement.

Comments from such groups on "official" energy plans can be very valuable since the members of such groups usually have somewhat broader perceptions of societal goals than the members of the technical/administrative elite. Therefore, it is highly desirable that mechanisms be established for allowing comments on "official" energy plans by community groups and for taking into account these comments in the planning process. Community groups should be given access to information and perhaps financial support to enable them to make worthwhile contributions.

One problem which affects the usefulness of community group comments on "official" energy plans is that comments which are framed outside the boundaries of the perceptions and value system of the technical/administrative elite are often ignored. Some community groups have therefore produced their own energy plans based on their own perceptions and

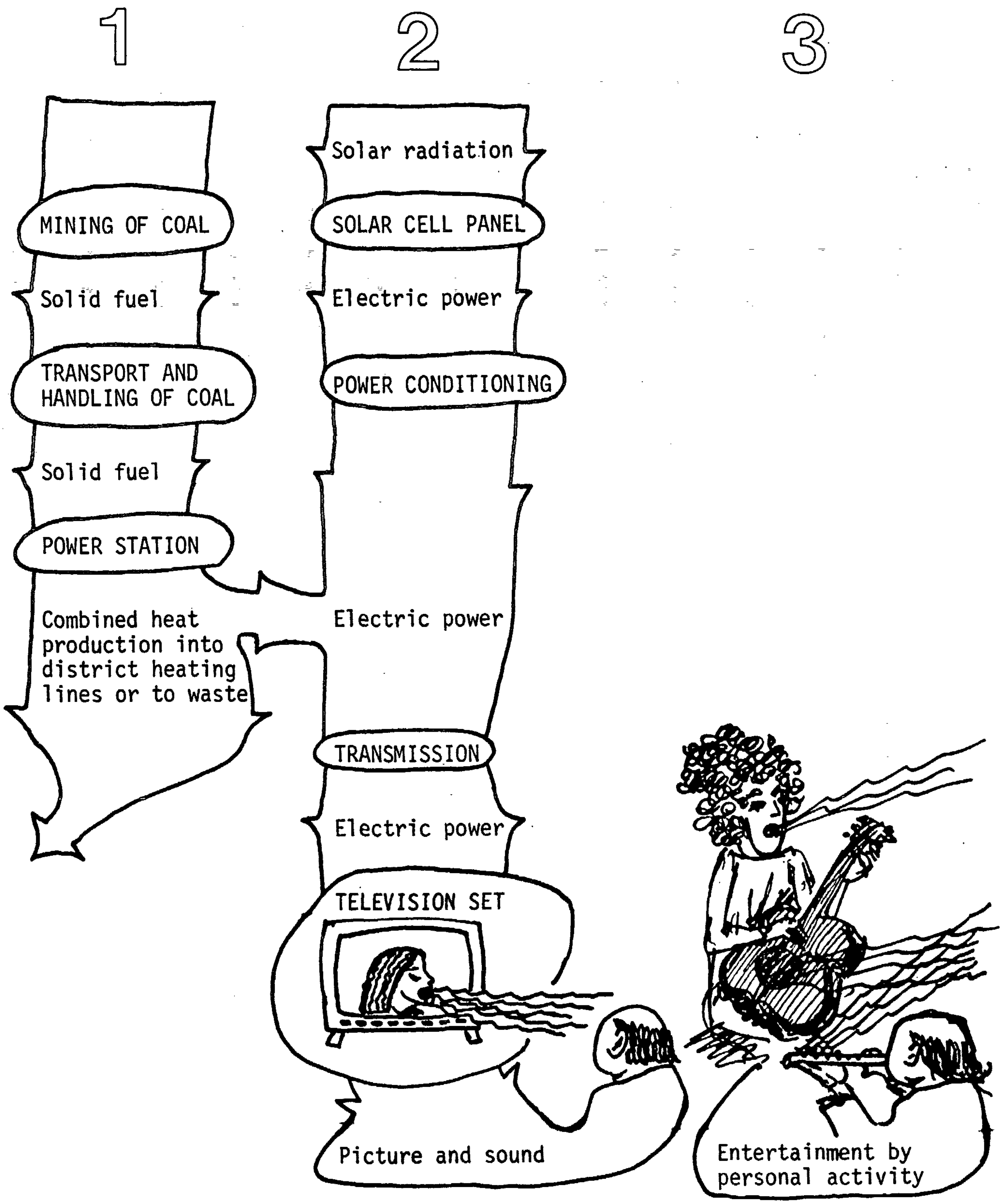
TABLE 1. ROLES OF VARIOUS ACTORS IN ENERGY PLANNING.

	Governments and parliaments	Government departments	Energy industry	Local governments	Scientific community	Political parties, labour organisations, community groups etc.
Goal and priority setting	+			+	+	+
Co-ordination of planning		+				
Providing information	+	+	+	+	+	+
Production of outline plan(s)		+			+	+
Comments on outline plan(s)			+	+	+	+
Producing alternative plans				+	+	+
Incorporating comments/ alternatives & implementing plan	+	+				
Assessment of performance of plan	+	+	+	+	+	+
Modification of plan using input from assessments	+	+				

value system. The value of such contributions lies in their innovative approach to energy matters which may lead to plans which are more optimal in relation to a plurality of societal goals than those produced by official energy planners.

Integration of the Planning Process

The roles of the main groups of actors identified above are obviously interdependent and a major requirement is that the efforts of each group of actors should be integrated so as to produce an optimal energy plan. Problems which have arisen when such integration has not been achieved include publicly-owned energy utilities carrying out developments which are at variance with governments plans and community groups making comments on "official" plans which were then effectively ignored. Integration of energy planning requires first a recognition that each of the actors has a definite and legitimate role to pay, and second the establishment of mechanisms so that these roles can be carried out. In relation to the groups of actors identified above, the suggested roles to be ascribed are summarized in Table 1.



Equipment characterized by a definite technical efficiency is circled.

FIG. 2. Three ways of supplying the same energy service.

THE METHODOLOGY OF ENERGY PLANNING

Specification of Energy Demands

As mentioned previously, energy planning starts with one or more visions of future society, characterized by lifestyles, settlement patterns, social and industrial activities, political organisation and emphasis on uniformity/diversity, and so on. Each vision of a future society may then be translated into a list of necessary material processing and service requirements, which again may be spelled out in terms of the associated energy demands (cf. Fig. 1).

The same provision of goods and services may be achieved with widely differing inputs of energy, depending on: i) the structure and organisation at the receiving end (i.e. of society); ii) the structure of the energy supply system, e.g. separate or combined production of heat and power; and finally iii) the efficiency of each of the pieces of equipment used to convert the energy from source to final use (Fig. 2).

In energy planning, energy demands should first be specified with sufficient detail to determine the type of energy needed for each task, e.g. heat of low, medium or high temperature; mechanical energy for stationary or mobile uses; or electric energy. This specification should be of energy actually required at the point of end-use, irrespective of the traditional form of energy used for a given purpose at present (e.g. using three units of heat to generate one unit of electricity to heat water in a washing machine, rather than using one unit of heat directly to obtain the same energy service).

The Energy Supply System

If the goods and services demanded in the future are known, then the planning effort consists of finding an optimum path from energy sources to final demands, by selection of the most viable set of conversion devices, energy system layout and demand organisation. To do this the energy supply options would also have to be known or estimated, fuel type energy sources would have to be described by physical availability (resource size and location) and cost profile as function of time, while renewable energy sources should be described by magnitude of renewable energy flow and time variability.

Typically, the larger the usage of energy resources, the greater will be the financial cost and the undesirable impacts (e.g. on the environment). There will also be usually (but not always) increasing costs associated with establishing a more efficient supply system (energy conversion, transport and storage between source and final user) and energy use system (equipment at the final user which converts energy delivered into services or goods).

Optimization of Energy Supply and Use

Optimization will involve going so far with efficiency measures, that each unit of energy input eliminated would have been more expensive to provide than the system investment leading to its elimination. If energy resource prices were constant, this optimization could be performed for each energy use category separately, but when energy costs increase with the volume consumed (globally) and with time, all the energy use categories must be looked upon together, and the entire system must be optimized. Compared with 1980 level national energy systems, the optimum derived in this way - for cases of modest increases in goods and services as well as in fuel prices - is at a primary energy input around a third of the 1980 value, assuming no significant change in lifestyles and social priorities. Some scenarios with changing value systems (less emphasis on consumption) find an optimum energy input level four to six times lower than the 1980 level.*

System Aspects

In assessing supply options, geographical peculiarities should be kept in mind: geological resources, soil fertility, climate and also population densities. The solutions to the supply-demand matching problem will not be the same for different regions, neither in fuel nor in renewable energy alternatives. Furthermore, the best boundaries for doing energy planning will in many cases not be the administrative borders (national or province/county limits). Rather one should do more restricted studies for areas with similar patterns (local planning based on habitat type or land use distribution),

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* Several of these studies have been published in the journals *Soft Energy Notes* (Friends of the Earth, San Francisco) and *Alternatives* (Trent University, Peterborough, Canada).

combined with regional (multi-national) studies probing into the advantages of energy grid connections, import/export arrangements and other forms of international co-operation.

Flexibility

The approach outlined here has been based on the presence of a vision of some future society. Normally, several visions - maybe conflicting ones - are being debated in a society. Each important one could be looked upon from an energy point of view, and the guiding principle for proposing a single energy development plan could be its compatibility with several different visions of the future. In other words, a desirable plan would be one which does not lead to rigid structures, but uses equipment that can form part of several possible overall systems, different energy source choices, etc. A similar flexibility could be built into an energy plan to make it compatible with a future society, where much decision-making is decentralized and where local communites may be realising different visions of the future. In such a case, the energy system may look different and serve different needs (different goods and services) in the different local communities, and still be more or less interconnected to form a more stable and invulnerable system than if the local sub-systems were not connected and collaborating.

THE PROCESS OF IMPLEMENTATION

Implementation of energy plans is carried out by governments at either the national, regional or local level. Governmental actions seek to set the parameters within which energy production and use take place. Through this controlling function, governments aim to achieve the goals and objectives which have been set for the energy plan.

Governments have available three main categories of policy instruments with which they can influence energy production and use :

1. Information instruments
2. Financial instruments
3. Regulatory instruments

Information Instruments

Information instruments are directed to encourage certain patterns of energy production and use and to discourage other patterns. Examples include: information services providing advice on methods of saving energy and of utilising renewable energy sources; demonstrations of innovative methods of energy production and use, and short practical courses on energy conservation techniques and utilisation of renewable energy. The target of information policy instruments may be the general public or may be industry. Information instruments are necessarily indirect methods for controlling energy production and use and their effectiveness in achieving desired goals and objectives is therefore limited. However, they are probably the method of government intervention most immediately acceptable to the business community and the general public.

Financial Instruments

Financial instruments are used to encourage certain patterns of energy production and use by providing financial incentives, or to discourage other patterns by providing financial disincentives. One commonly used financial instrument is pricing. However, it is not always in the hands of governments to directly influence prices. Instead, governments may use taxation disincentives and tax reduction incentives and they may make capital available for specific purposes through various forms of loans or loan guarantees.

Financial instruments are also indirect methods for controlling energy production and use. Their effectiveness varies with the importance of finances to the energy producer and consumer and with the degree of control over energy financing exerted by the government. Householders may not carry out certain energy conserving practices if the amount of money they save is relatively minor compared with their income, even if the payback period for the investment is fairly short. A government controlled/owned utility may increase electricity prices to encourage conservation and substitution to other energy forms, but if, for example, solar panel prices are coincidently increased by private companies, the desired substitution may not occur.

The outcomes of a policy utilising financial instruments are not easily predictable because of the complexity of the financial system involving energy. In particular, actions by energy utilities (including oil companies) can be particularly difficult to control since they are able to generate their own capital for financing their energy production activities through revenue from previous sales.

Regulatory Instruments

Regulatory instruments require compliance with certain patterns of energy production and use through the force of law. Maximum levels of energy use could be set through rationing; mandatory standards can and have been established which require energy-using devices and buildings to achieve a set level of energy efficiency; and energy producers can be required to meet certain levels of production. Regulatory instruments are direct methods for controlling energy production and use, but in some countries they tend to have low levels of acceptability among the business community and the general public; therefore, governments are likely to use regulatory instruments carefully.

Role of Non-governmental Bodies

Though governments are the actors with the greatest ability to implement energy plans, various other actors potentially can influence patterns of energy production and use. Information activities can be sponsored and carried out by educational institutions, commercial concerns and community groups. Energy suppliers can also influence patterns of energy use by their pricing and advertising policies. The final pattern of energy production and use which emerges will therefore be the result of a complex pattern of complementary or competing pressures on both energy producers and users.

THE METHODOLOGY OF IMPLEMENTATION

Information Instruments

Each measure taken in the effort to implement a given energy plan requires the mobilisation of support by groups in society or by the whole society. Information must be a two-way process in which the problems and reactions of recipients of "official" information are communicated back to the planners. This process could be assisted by involving community groups directly in energy information programmes.

Demonstration programmes, where the government produces working examples of energy efficient ways of providing energy services, or illustrates new or novel energy resource utilisation and conversion equipment, have a large hardware component. Therefore, it is important to involve construction and manufacturing industries at an early stage, and to involve them in such a way that they acquire experience pertaining to real-scale production of the equipment concerned. Many demonstration programmes have failed to achieve this by accepting that the equipment for the demonstration were custom-built for that single purpose, without regard to later mass-scale manufacture.

Financial Instruments

Financial incentives must be very carefully planned if they are to have the desired effect. Incentives given to manufacturers (especially the smaller ones) can be useful in the development stage, but unless user groups are part of the administrative set-up, so that they can control the use of the subsidy, the advantage obtained from the subsidy may not be passed on to the customers. The same is true for subsidies given directly to the consumers: they are often cashed by the manufacturers, who simply increase the price relative to the calculated price in the absence of incentives. If a co-operative of users, potential users and manufacturers can be formed, the chance of distorted price structures diminishes.

The reason for giving incentives for energy investments should be clear. Investments in efficient use of energy and resource-conversion equipment are beneficial to society as a whole, by improving security of energy supply, by reducing environmental impacts, by displacing fuel imports from unsure suppliers, and most often also by reducing the cost of energy averaged over the lifetime of the equipment and the structural changes involved. However, only society as a whole, or very affluent individuals, can afford to make assessments based upon such lifecycle costing. To most of the consumers and institutions responsible for making the investments, the initial financing burden is more important. That burden may be higher for those alternatives which are optimal in the long term than for a continuation of the current way of supplying energy. Thus the purpose of incentives should be to make those solutions attractive to the initial investor which are preferable to society in the long term.

This calls for a closer examination of the financial situation of different types of investors. Energy investments are today made by a variety of different actors: governments (building infrastructure such as harbours and roads, and sometimes directly operating energy companies); concessioned utilities; private energy companies; local governments; and individual, large or small, industries, businesses and consumers. Some of these actors have indigenous sources of financing. Governments and concessioned utilities have funds collected from the public (tax revenues, the capital accumulation allowance in concessioned power rates, etc.), which can be used to finance energy investments, and which make the investor fairly independent of market interest rates and other indicators of capital scarcity. The utility capital accumulation even makes it possible to earn interest during the accumulation period, making the value of their assets larger the more scarce capital is generally. Most other investors, in manufacturing industry (especially smaller companies), commerce and certainly private individuals, will have to finance their energy investments by loans from banks or financing institutions. They are thus very sensitive to interest rates and repayment times and profiles.

Many loans offered at present have a repayment profile with high payments during the first years and low payments towards the end of the repayment period (e.g. annuity loans in times of high inflation rates). The repayment during the first years may be so high, that the investment becomes unaffordable, even if its overall economy over the repayment period may be very attractive. In this case, an incentive, which changes the repayment profile without altering the total (present-value) repayment may solve the problem of making investments attractive for the individual, if they are attractive for society. The technical solution is called indexation of repayments, either tying the instalments to inflation or (better in the case of energy investments) tying them to the energy price index. Over the total repayment period, the revenue of the financing institution will be the same, but during the initial years it will be small or even zero. Therefore, an incentive from the government may be needed, unless the financing institution has a very long business horizon, or has a surplus of capital to invest.

Regulatory Instruments

In high competition industrial sectors, energy efficiency improvements both in manufacturing and in energy-consuming products (eg refrigerators) are often neglected because even a marginal increase in product cost is seen as unacceptable, unless the better energy efficiency can be expected to increase sales. In such cases, legislation may be the only way to ensure that the steps making sense in the eyes of society are actually taken. This may be the case for buildings (building codes specifying maximum heat loss), electric appliances (specifying maximum power use and demanding that electric power is not used for low-temperature heating - e.g. in washing machines) and vehicles (specifying minimum fuel efficiency). Another use of legislation is to control energy companies (private utilities, oil companies), in order to direct their investments to the benefit of society as a whole.

Social Consequences of Policy Implementation

For both financial and regulatory instruments, very thorough attention must be paid to the effects on disadvantaged groups in society, low-income groups, the young and the elderly, and generally people who cannot make long-term investments due to fluctuating income levels (e.g. people in sectors with high or periodical unemployment). Such groups will not be attracted by indexed loan arrangements, and legislative demands may only worsen their overall situation. Therefore, specific measures must be taken to assist disadvantaged groups, including increased level of direct subsidy or governments assuming responsibility for required investments.

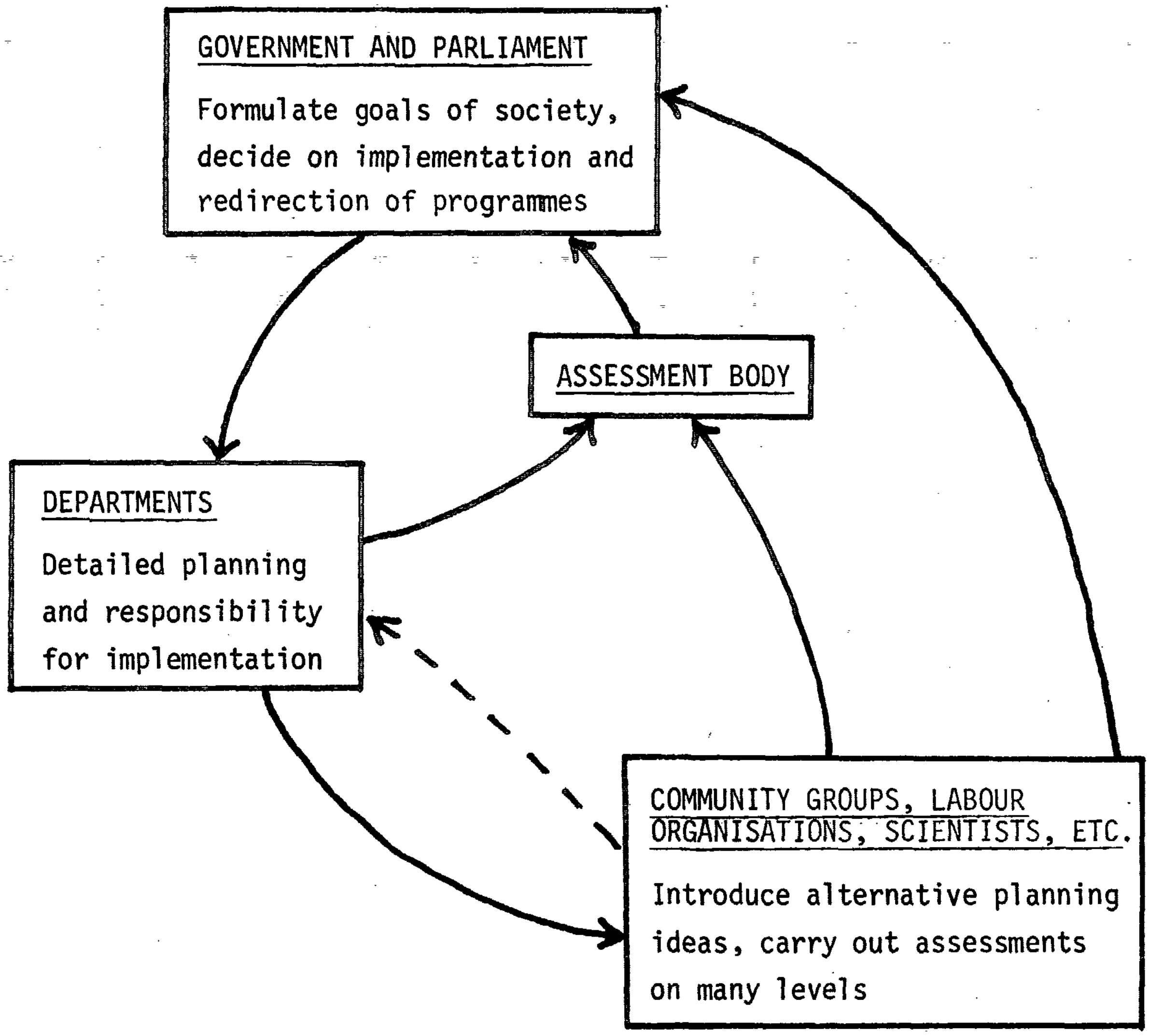

FIG. 3. Possible structure for assessing the implementation of an energy plan.

THE PROCESS OF ASSESSMENT

After the formulation of an energy plan and during its implementation, it is essential that continuing assessment be carried out. This is necessary to determine whether the outcomes are indeed the desired ones, to identify any unexpected outcomes or impacts at an early stage, and to modify the energy plan and policy initiatives so as to achieve more closely the desired goals. Even if outcomes are close to expectations, the implementation of an energy plan will undoubtedly meet or create new conditions likely to require progressive modifications to the plan. Energy planning should therefore be seen as an iterative process involving continuing cycling through the three stages of planning, implementation and assessment.

As any program under active implementation possesses a considerable amount of inertia, mandatory assessment points should be build into the implementation process from the beginning. The people responsible for assessing the outcomes of energy plans should not be the same as the people who actually formulated the plan. It is important to establish a mechanism for ensuring broad public participation in the assessment process. Since any negative impact of an altered energy structure is likely to affect different groups in society differently, a determined effort should be made to encourage all groups of people to contribute to the assessments. The government should establish a process for accepting criticism on energy policy from the public, and as well for routine incorporation of such criticism and any unsolicited submission (e.g. from the scientific community or popular movements) in the process of modifying the energy plan.

A possible structure for this process is outlined in Fig. 3. The proposed assessment body could take the form of an independent council or select committee. It could provide financial and documentary support to enable outside groups to make meaningful assessments of the implementation of the energy plan. To ensure that the suggested modifications to the energy plan will actually be treated seriously, it is important that the assessment body rank higher in the power hierarchy than the departments responsible for implementing the energy plan. It is also essential that modifications suggested by the assessment body be subject to another round of public discussion before they are implemented. This is probably best achieved through some form of public enquiry or public hearing giving input to the decisions made by government and in parliament.

No matter how the assessment of the energy plan is carried out, it is essential that the assessment process be seen as a legitimate, and vital, part of energy planning. Assessment should be encouraged, and there should be no restriction placed on the groups or individuals who may take part. Particularly, assessment should not be seen as solely the province of policymakers, since other groups in society will have unique information and perspectives to contribute to the debate and may well be able to identify policy outcomes and impacts which are unknown to the policymakers.

From the government perspective, a major challenge is to ensure that the contributions from the various groups and individuals involved in assessing an ongoing energy program are fed into an iterative process whereby new policy initiatives are continuously being formulated, implemented and assessed as conditions and societal and group value systems change. The precise mechanism by which this is achieved will vary with circumstances. Generally, if a government is genuinely concerned to formulate an energy plan which is appropriate and optimal for achieving specified societal goals, it should allocate top priority to devising an effective iterative mechanism for assessing the outcomes of the plan.

THE METHODOLOGY OF ASSESSMENT

We have stressed that assessment is a continuous process. New evidence is bound to turn up during the implementation of an energy plan, and existing evidence may be seen in a new light, particularly as the value systems of substantial groups in society become changed in the course of time. The majority of this new evidence will be gained from an assessment of all important impacts resulting from the utilisation of the chosen energy system. It is impossible to describe all the possible impacts which could result from the choice of any particular energy system, but we would like to list a number of impact categories for consideration.

Universal satisfaction of biological needs. The consideration of whether the chosen energy system contributes (and if so, positively or negatively) to ensuring that every member of society gets adequate food, shelter, personal security, etc.

Health. The impact of the chosen energy system on health may be direct, in terms of accident risks and health damage caused by pollution or poor working conditions (e.g. for miners), or indirect, e.g. in that the structure of the energy system may be more or less suited to bringing clean water and sanitation to rural areas (an impact of great importance in third world countries).

Environment. Impacts on the environment resulting from the chosen energy system may include: pollution from power stations; land and resource mismanagement (e.g. associated with mining operations); possible climatic effects (e.g. from carbon dioxide); and ecological impacts from the entire energy system. In addition to these impacts on the physical environment, there may also be impacts on the work environment and on the mental environment. Some of these environmental impacts lead to human health effects, while other impacts indirectly influence the life and wellbeing of human individuals by changing their environment in the broadest sense of the word.

Social relations. The chosen energy system may or may not create meaningful work through its requirement for equipment manufacture. Through its influence on the organisation and infrastructure of social relations, the energy system may facilitate meaningful social activities, e.g. offering frequent possibilities for social encounter as well as for privacy.

Structure of Society. The choice of energy system may (along with many other factors) exert an influence on social characteristics such as equity, pluralism, participation in decision-making, the kind of institutions formed, the emphasis or non-emphasis on material goods, etc. In particular, the question of whether a society keeps future options open or is locked in a structure difficult to modify may be influenced by the choice of energy system. For instance, space heating based on district heating lines will allow for substitution between many renewable or non-renewable primary energy sources, while systems with separate energy converters in every building unit are less flexible. Another example is nuclear power, which binds future societies to maintain institutions for taking care of radioactive waste, even if they themselves do not choose to generate energy from nuclear fuel.

Cost. One obvious impact (in some studies the only one considered) is the effect of the chosen energy system on the economic situation of the nation or region involved, including direct economy as well as influence on foreign trade balance. This is also an issue for local systems, where "foreign" may be interpreted as "from out of the region". Assessments of cost impacts should include an assessment of the uncertainty in the cost estimate, particularly in the medium to distant future.

Resilience. The consideration of whether the chosen energy system is technically and economically resilient involves determining whether it is sensitive or insensitive to changing conditions, such as the appearance of novel technology or greatly changed economic conditions such as those occurring for oil in 1973-1980.

Global relations. This is a broad category, comprising impacts of the chosen energy system on independence (from central government in case of local systems, from foreign nations and transnational commercial interests in case of national systems); on tensions that may lead to international conflicts; and on the scope for reducing global inequities. Conflicts could arise from competition for localized fuel resources (e.g. Middle East oil) and could be enhanced by dispersion of technologies and expertise with military applications (nuclear power), particularly to politically unstable regions. It is conceivable that increased reliance on renewable energy resources in the industrialised parts of the world would lead to more affordable fossil fuel prices for third world countries depending on such fuels for their processes of development, at least for the near future.

CONCLUSION

In this short paper, we have presented some general principles to guide energy planners in government and the civil service, as well as those who want to check the appropriateness of official energy planning and perhaps suggest alternatives. We have not attempted to describe how energy planning is currently carried out since this varies from country to country and, we believe, leads in many cases to inappropriate and/or non-optimal energy plans. Neither have we attempted to specify in great detail exactly how energy planning should be carried out, since this also will vary with circumstances, and to do so for any specific case would require far more time and space than we have available. Rather, we have produced an outline guide which we hope might prove a useful basis for elaboration to suit specific situations.

The major emphases is this outline guide are: the elaboration of one or more visions of the future as a prerequisite to commencing energy planning; setting of societal goals as an essential first step in planning; the need for effective public participation in all stages of energy planning; and the development of an iterative process whereby new energy policy initiatives are continuously being formulated, implemented and assessed as conditions and societal and group value systems change. In our view, energy planning initiatives which are based on these four elements will stand a good chance of developing an energy plan which is appropriate and optimal for achieving specified societal goals.

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