RENEWABLE ENERGY POLICY FORMULATION AND IMPLEMENTATION

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ABSTRACT

An important and virtually neglected area in the development of renewable energy technologies (RETs) is the formulation of a rational and coherent renewable energy policy, and its implementation. This paper presents a general approach to formulating such a policy. The methodology is based on a series of evaluations of energy demand, renewable energy base, RETs available, socio-cultural constraints, economics of RETs, and institutional arrangements. After formulating a coherent policy it is also important to examine the methods and constraints on implementing such a policy. Issues, such as, resource requirements, self-reliance, access to information, technical cooperation amongst developing countries (TCDC), research and development, adaptation of techniques, skill requirements, and channels for RET transfer are examined. Finally, in order to demonstrate the general methodology in relation to a specific situation, the case of power alcohol implementation in Kenya and Zimbabwe are evaluated.

INTRODUCTION

Renewable energy technologies (RETs) are capable of satisfying most of the dominant energy end uses in developing countries with the possible exception of diesel fuel.

The extent to which RETs can substitute for conventional energy sources such as petroleum and coal depends on the renewable energy source base of the country, the per capita energy consumption, and the energy end-use. In most cases RETs will not be able to satisfy the total energy demand of developing countries, and in the future energy supply will be comprised of a mix of fossil fuels, macro-hydro and RETs.

While investment in certain RETs appears attractive to many developing countries, governments should be aware of the financial, manpower and organisational resources required to mount a large scale programme. The benefits accruing from the use of these resources should be evaluated against other investment options in the areas of, for example, agriculture, public health, education, infrastructure, to ensure that the optimum "public good" arises from the use of these scarce commodities.

Besides providing energy, one of the objectives of the installation of RETs should be to reduce the disparity in "quality of life" between the rich and poor in developing countries. Unfortunately, like most technical interventions in developing countries, RETs have the potential of exacerbating rather than alleviating this disparity in equity. Capital required to purchase RETs means that only the people able to pay will enjoy the benefits. Wealthier people have a greater access to information and credit and will usually be more aware of the energy/financial savings available. Finally, the use of certain RETs, eg, biogas, gasifiers, will tend to put a premium on certain feedstocks such as dung and agricultural residues previously collected for free by the poor. This process may eventually exclude the poor from their main source of fuel.

Based on these considerations, governments should be aware of the ultimate effect of a renewable energy policy on income distribution and take certain steps, eg subsidies, widespread information dissemination and credit availability, and community energy projects to mitigate these effects.

Despite the considerable amount of work being carried out on RETs in developing countries, and the benefits which will accrue from the extensive use of an indigenous renewable energy source, few countries have a cohesive renewable energy policy or strategy for implementing such a policy.

This is essential to maximise the useful contribution of renewable energy to a developing country's energy budget. Hence, the objective of this paper will be to examine the formulation and implementation of national policies for increasing the contribution of renewable energy resources to energy supplies in developing countries.

FORMULATION OF A RENEWABLE ENERGY POLICY

How are energy policy makers in developing countries going to formulate a renewable energy policy which is able to rationally and efficiently meet the various end-users? The following section briefly details a methodology which can be used for such a purpose. The method consists of accumulating and assessing data under various sub-headings.

Energy demand

In formulating a national renewable energy policy it is essential to have a clear picture of energy demand in the country, not only in terms of end-use (by sectors) but also the forms of energy required, and the consequences of energy use (or lack thereof). With this information, governments can make explicit decisions on priority areas in which energy policy should be oriented.

Unfortunately, at present there is very little hard data on energy use in rural areas of LDC, although there is considerable activity in the field. Rural energy surveys require considerable inputs of time and labour (Howes 1984); however, after a body of data has been built up in different regions of the world it may become possible to reduce the effort required, or make relatively accurate predictions of rural energy use under certain conditions.

Finally, in order to match energy supply with demand, it will be necessary to have a fairly accurate idea of projected energy demand growth in the next twenty years. This would be based on population growth, targets for increased per capita energy consumption (UNIDO 1979), industrialisation, and projected fossil fuel prices.

In addition to determining the total energy demand in each sector, it is important to understand the type and form (solid, liquid, gas) of energy required so that supply can be matched both thermodynamically and in terms of convenience to the demand.

It would be useful to understand the reasons for the current patterns of energy use and their consequences. For example, the current pattern of energy use could be due to disparities in land and animal ownership forcing the rural poor to rely on public forests for fuel which results in rapid deforestation; or subsidies on fossil fuels such as diesel and kerosene could result in an over-reliance on these fuels.

The consequences of energy use should be delineated to ameliorate some of the more serious effects of current energy use. For example, deforestation, environmental damage, lack of an equitable access to energy, loss of productive time, dependence on imported fossil fuels leading to balance of payments problems.

Finally, from the data obtained on end-use above, an overt political decision should be taken on the priority sectors in which a renewable energy policy should be oriented.

Energy base

The next step in formulating a renewable energy policy is to evaluate the renewable energy base in the country, their seasonal variation, and estimates of present production and projected growth of the biomass resource base in the next 20 years.

Based on this information the percentage of the present energy demand which can be substituted for by renewable energy, and the potential for savings in foreign exchange can be estimated. This exercise will enable energy planners to determine what level of national resources should be devoted to the development of renewable energy sources.

Renewable energy technologies

The third step in formulating a coherent policy is to assess the RETs available including techniques and their inputs and outputs, thermodynamic efficiencies, and capital costs.

Based on primary technical considerations, a list can be drawn up of ultimate end-uses and the sources and techniques which are able to satisfy them most efficiently. Such a list should contain a ranking of energy paths for each end-use. The final selection of the RET will depend on other non-technical factors such as socio-cultural constraints, economics, and institutional infrastructure.

Socio-cultural constraints

To implement and diffuse RETs into a country it is extremely important to understand the societies in which they will be used, and how this will impose constraints on certain RETs.

One constraint is how the RET affects various groups within a village. If the RET is to provide energy for cooking, eg, stoves, biogas, then the primary effect will be to enhance the quality of life for the woman and children who are usually responsible for collecting fuel and cooking. However, the major financial decisions are usually made by men, although their wives often have considerable influence in such decisions. Nevertheless, if capital is to be outlaid without any financial return it may mean that the RET will not be accepted readily. In contrast, if the RET impinges on the responsibilities of the male, eg, providing energy to pump irrigation water, then the RET may have a greater chance of diffusing.

Finally, if the use of an RET runs counter to certain cultural briefs, eg use of human waste in biogas plants, or involves a considerable change in established behaviour patterns, eg, use of solar cookers in the open during daylight hours to cook meals, then it is highly likely that the RET will not become popular.

In order to gain an insight into some of the serious constraints that could arise in the use of RETs, it is strongly suggested that some anthropological field work be carried out, and that village representatives be included in the planning stages to obtain feedback on the various courses of action.

Economics

The economics of RETs are also extremely important. If the use of a specific technique is not financially viable to its owner, or economically viable in terms of the country's broader social criteria, then obviously it is not worth the investment.

The normal method of evaluating projects is by cost-benefit (financial) analysis, or social cost-benefit (social) analysis. The latter method uses shadow prices and includes certain non-quantifiable parameters. In this analysis, a depreciation of the equipment (lifetime) is assumed together with an internal rate of return (IRR), and based on the annual benefits and costs a net present value (NPV) is calculated. If this is greater than zero then the project is deemed viable. Alternatively, an NPV of zero can be assumed, and IRR calculated. As French (1979) points out, in a developing country due to the lack of availability of capital many investors may not think a project is viable unless the IRR is around 35%, ie, a payback period of three years.

Surprisingly, despite the widespread use of certain RETs in developing countries there is still a dearth of technical information on the performance of most RETs, and the operational lifetime. In addition, there is lack of agreement on how to value the output from most RETs and, hence, considerable confusion amongs economic analysts as to which RETs are economically viable. This makes it difficult to economically compare the various competing RETs and their performance in relation to alternative fossil fuels. Hence there is an urgent need at present to define a common methodology on how to assess RETs.

Extending the analysis to include shadow prices and intangibles (eg, reduced deforestation, enhanced strategic position, improved public health etc.) makes the exercise even more complex. Nevertheless, it is important that a comprehensive economic analysis be carried out on the RETs being considered for use based on the data available. In this regard a sensitivity analysis may be used to pinpoint the key variables.

Finally, the other factor of importance in the overall economics is the "lumpiness" of the capital investment. If the initial investment is high, eg, photovoltaics in contrast to biogas, then even if the IRR is high there may be problems diffusing the technology unless institutional arrangements are available to finance or subsidise the initial cost.

Institutional

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

The extent to which a developing country should build up an R and D capacity in RETs is very much case specific, and could vary considerably depending on the technique. This issue will be discussed in more depth later.

Another vital area in the widespread use of RETs is a network to diffuse the technique, and to provide technical back-up for repair, advice etc. The requirements for this will depend strongly on the size of the units, and hence their numbers, eg, two 120,000 l/day ethanol plants versus 500,000 family biogas plants. In the case of small scale rural techniques an existing infrastructure could be extended, eg, agricultural extension workers are used in Brazil to diffuse and provide technical advice with biogas units (Umana, 1982). It is important that this infrastructure be established before widespread diffusion begins otherwise many failures may occur, and the lack of technical back-up is cited as one of the reasons for failure of some biogas units in India.

Skilled manpower is an obvious prerequisite of a competent R and D and technical back-up infrastructure, and this issue will be examined later.

In terms of hardware, the capacity of the local capital goods sector has an important influence on the degree of technological self-reliance a country can achieve. If it is weak then the country has to depend strongly on "turn-key" projects. If it is well developed, the country has a number of advantages in shopping around for technology in the world market place. This point was extremely important in developing power alcohol projects in Kenya and Zimbabwe (Stuckey and Juma, 1984).

Finally, the financial infrastructure in a country is important since lack of access to capital and loans or subsidies can severely retard the diffusion of RETs, especially when they are small scale rural technologies where a large number of owners do not have any experience in negotiating loans. Hence some thought should be given to establishing a simple loan/subsidy scheme, and informing financial institutions on the viability of the various RETs. This latter point is important. Many of these institutions have no experience in lending money in this area, and hence no criteria to judge loan applications. This factor was important in Brazil where the Federal government provided money to the banks for loans but little of it was utilised due to the banks' lack of knowledge and confidence in the technology (Umana, 1982).

Formulation of policy

Based on the data collected and evaluated in the previous sections, ie energy demand, energy base, RETs, socio-cultural, economics and institutional, the energy planner should now be able to formulate a relatively cohesive renewable energy policy to meet specific end uses. However such a policy should also answer the following questions:-

(i) the degree of technological self-reliance the country is aiming for, and whether this will change with time,

(ii) the channels by which RETs are transferred from developed or other developing countries,

(iii) how are the various skills required in R and D, diffusion, and the capital goods sector going to be built up.

(iv) how can a suitable infrastructure for RET diffusion be established.

Hence, in addition to formulating a renewable energy policy, developing country governments should also give serious thought to the steps involved in implementing it in the real world. In the next section the issues raised in these questions will be examined.

IMPLEMENTATION FOR UTILISING RETs IN DEVELOPING COUNTRIES

In order to implement a renewable energy programme, governments need to seriously consider factors such as access to information, technical cooperation amongst developing countries (TCDC), development of research and development skills, adaptation of existing techniques, the buildup of technical and administrative skills, and access to the international market. These factors, and their ramifications on the implementation of RETs will be analysed in this section. However, before examining these factors in detail it would be useful to look briefly at process of technical change in developing countries in order to provide a framework for such an analysis.

Technical change

As Bell (in Barnett et al. 1983) points out, there has been little written in the area of technical change in renewable energy technologies and hence in order to gain some understanding of the process examples have to be drawn from the general literature on technical change in developing countries. As we saw earlier, due to the primary end-use of many renewables, and the structure of the market, it seems unlikely that consumers of RETs will force a large scale reallocation of resources and the development of an appropriate infrastructure on the supply side. Hence, policy intervention appears necessary in order to develop, allocate and organise the resources needed to implement technical change in the renewable energy technologies. Amongst the questions which need to be addressed in this area appear to be fundamental ones:-

(1) what type of resources will be needed to implement the renewable energy policy formulated by the government?

(ii) what degree of self-reliance in terms of technical knowledge, services and goods should the government aim for?

Resource requirements

Often, in attempting to answer the first question, policy makers focus on the role of R and D. However, this appears to be due to a carry-over from the technical change policies originating in the more industrialised economies where there are a lot of implicit assumptions made about the chain involved in the process of technical change. For developing countries, R and D is only one facet of a process requiring a number of other levels of expertise. Bell (in Barnett et al. 1982) suggests that there is a "core" sequence of technological activities which create new technical knowledge, and progressively elaborate and transform it into specific systems which are in actual use. This core will consist of one or more of the following: creation of technical knowledge (formal and informal R & D); pre-investment and feasibility studies drawing on existing knowledge; production of designs and specifications for technical systems; transformation of designs into concrete elements of an operating system, eg hardware, software, training; storage and communication of technical knowledge and information.

In addition to these technological core components will be an over-riding management function. This will decide what is done, by whom, and the terms upon which the technological activities are carried out. Management of technical change can either be passive where vested interests dictate the direction and change, as is the present case in RETs in developing countries, or it can be active where an explicit goal is aimed for.

It is commonly assumed that all the activities involved in the technological core will be necessary in order to implement technical change. However, on examining the types of change commonly encountered in implementing RETs it is apparent that this linear sequence will be the exception rather than the rule. For example (Barnett et al. 1983):-

(a) System replication - this usually requires only a feasibility study to suggest minor modifications, and R and D and engineering activities would rarely be required. However, management would be essential, eg biogas plants.

(b) System adaptations - in order to adapt an existing system to new constraints various engineering activities and turning specifications into functional software and hardware will be required. R and D will rarely be required.

(c) Special purpose development - new knowledge may be required here. However R and D would probably focus on the overall system and on its software components rather than on developing new technology.

(d) Innovations - in this case, it is highly likely that all the components of the core will be mobilised to effect technical change.

Hence, from this brief overview it is apparent that the technical and managerial resources required to implement RETs will vary considerably depending on the technique implemented. Thus, in considering the factors mentioned previously, eg development of R and D, skill requirements, access to information etc, governments should be cognisant of the different resource requirements for implementing a renewable energy policy. However, the assessment of resources required to implement such a policy needs to be placed in an international context in order to decide what degree of self-reliance the government should aim for. Thus, we will now turn to examine the second question posed.

Self-reliance

In attempting to define the degree of self-reliance, ie degree of local input, there will be a considerable degree of variation amongst the various core activities. Other factors affecting the degree of self-reliance include:-

(i) the type of technique. Obviously, implementing village scale biogas plants will involve different degrees of self-reliance compared to large scale continuous culture ethanol plants.

(ii) variation with time. The degree target could alter with time starting with a small local input initially which would build up to a high percentage in 5 to 10 years.

Furthermore, the degree of self-reliance is contingent to quite a strong extent upon the international market for the various inputs required. This market is dominated by the R and D efforts of a few developed countries. However, developing countries rarely import R and D. Rather they import goods and services which have this knowledge embodied in them via the highly developed infrastructure resources of these countries. As Bell (in Barnett et al. 1982) suggests, "inequality in the availability of these resources matters perhaps more than inequality in R and D resources themselves".

Finally, there are a number of social considerations affecting the degree of self-reliance. In many situation, decisions by private entrepreneurs involved in the supply and purchase of inputs for technical change will result in local inputs lower than the optimum in terms of social development objectives due to their lack of financial return. This may occur in areas such as:-

(i) generation of local employment

(ii) social value of foreign currency

(iii) the appropriateness of the systems used

(iv) learning by doing

(v) economies of scale

In summary then, the process of technical change is a complex one, and in considering the implementation of a renewable energy policy, governments should be sure to have a clear picture of the resources required in implementing certain techniques, and the degree of planned self-reliance. Using the above discussions as a general framework we will now turn to the consideration of more specific areas involved in the implementation of RETs.

Access to information

In order to keep abreast with current developments in RETs, and enable negotiators to maintain a strong bargaining position in the purchase of technology from external sources, it is important that developing countries obtain access to up-to-date information. In addition, they require skilled personnel to digest the information and give sound advice to policy makers.

The information required to implement a renewable energy policy falls into a number of general categories. Firstly, is the current research (both technical and socio-economic) being carried out in both developed and developing countries. Most of this is available through scientific journals and conferences. Secondly, is knowledge about firms involved in the manufacture and sale of RETs. Embodied in these goods and services is often a considerable degree of experience and potential knowledge which is difficult to obtain directly. Finally, there is the information generated by R and D in developed countries. In many cases this is patented and protected by law. Hence, it is usually only available by the purchase of equipment embodying these latest advances.

A major difficulty seems to be the assimilation of information and its application to rational policy decision making. A number of solutions are possible. Firstly, the establishment of an international renewable energy centre operated along the lines of IRRI in the Philippines. This centre would carry out R and D and produce "state of the art" reviews on various techniques and end-uses. The second option would be to establish smaller "honest brokers" based at universities or consulting companies who would advise policy makers on the various options available in an impartial and informed fashion.

Finally, with respect to a long term strategy it would obviously be desirable to build up technical and assessment skills in the appropriate energy planning group of developing countries.

Technical cooperation amongst developing countries (TCDC)

Since the problems faced in implementing RETs in many developing countries are quite similar there is considerable scope for transferring knowledge between developing countries. This is already occurring with biogas in China, power alcohol in Brazil, and gasifiers in the Philippines. However, the wide variation in social conditions means that knowledge about diffusion may not be readily transferable, eg between China and Africa. Cooperation could occur in a variety of forms:

(i) information exchange on all aspects of RETs including patents, an experts pool, listing of manufacturers and consultants in the field. ESCAP have published a series of documents on Solar, Wind and Biogas to enhance the accessibility of this type of information (ESCAP, 1980, 1981a, b).

(ii) exchange of scientists and policy-makers

(iii) assistance with implementing specific techniques, eg India (through KVIC) is helping a number of African countries implement biogas programmes.

(iv) joint development of RETs. Through an FAO sponsored network on the gasification of agricultural residues a number of countries in the Asian region are developing designs for gasifiers, and running pilot and full sized units. (FAO, 1983).

Research and development (R and D)

The investment in R and D will vary in intensity and direction depending on the technique of interest. Where "mature" technology exists, eg for large scale alcohol production plants, then it would seem advisable to develop bargaining skills to purchase the technology from overseas companies and, perhaps, some on-site adaptation to suit local conditions.

In contrast, if small scale (500-2,000 l/day) village distilleries were of primary interest then development work based on well established principles would be a priority. Many developed countries are directing extensive R and D to "high technology" systems such as photovoltaics, large scale ethanol and wind turbines which are suited to their level of economic development. Techniques such as wood stoves, small biogas plants, small low cost windmills, and small gasifiers are of little interest in developed countries. Using existing basic knowledge, developing countries could mount an economically effective R and D programme oriented more towards development than basic research.

The private sector has rarely been involved in RET development, perhaps, owing to the lack of profit, especially in the small rural techniques such as biogas and stoves, the large scale government involvement and the lack of expertise with many of the techniques. There are a few exceptions to this: in China, what amounts to private companies are now heavily involved in constructing biogas plants (Stuckey, 1982) and in Nepal, a company established by the United Mission is also installing biogas plants with some degree of commercial success (Fulford, 1981). In order to diffuse RETs widely it would seem highly desirable to involve private firms in all aspects of these techniques, from R and D through to diffusion.

Governments should seriously consider policies to encourage private firms to enter the market by providing subsidies, guaranteeing markets and enabling joint ventures to be undertaken.

Adaptation of techniques

The requirements for local adaptation will depend on local capabilities, the type of technology transfer arrangement, the degree of self-reliance aimed for, and the technique involved and its level of sophistication.

The adaptation of techniques requires the build-up of skills in both technical capability and the capital goods sector.

Skill requirements

In formulating and implementing a renewable energy policy, developing countries will require a considerable degree of expertise ranging from economists and policy makers through design engineers and research scientists to skilled craftsmen and fabricators. Many developing countries will be faced with a number of problems in building up the skills required. Firstly, there will be competition with other economic activities such as agriculture, industry and government for the scarce resource of skilled manpower. In this case there must be an explicit government policy to divert some of these skills in the direction of renewable energy. Secondly, by its nature, the field of renewable energy is highly multidisciplinary. Its apex, ie policy making, is a relatively new discipline with few, if any, specific courses designed to train people even in developed countries. Hence some of this expertise will have to be learnt on the job with little formal intellectual background to draw on.

Governments need to draw up a strategy to gradually increase expertise in the different areas required. The first step would be to build up a small policy making team which would carry out the initial surveys and formulate a national renewable energy strategy. Based on this, and a reasonable degree of technical expertise, it would then arrange to import a number of techniques with technology transfer agreements aimed at building up local participation in all phases of the various projects.

Ideally this would lead to an increase in competence in all areas of implementing RETs. Eventually a critical mass would be reached where much of the expertise would be local. Obviously, this scenario is very general and would be modified depending on local skills and conditions.

Channels for RET transfer

In 1980, Hoffman examined the market for RETs and concluded that conditions of future technological dependence for developing countries are currently being created in relation to RETs, and that these conditions are likely to be similar to those currently prevailing with respect to conventional energy technologies. Hoffman found that both private firms and public sector organisations were involved in marketing RETs, and that many of them were looking for markets in developing countries. In addition, he found that they often received assistance from multilateral and bilateral aid agencies in entering these markets. These trends may result in distorting the direction of technical change in developing countries, and lead to a heavy dependence on imported goods and services for investment in RETs.

However, Hoffman based his conclusions primarily on two quite sophisticated RETs, ie photovoltaics and large scale ethanol, and the prognosis for other RETs may not necessarily be quite so gloomy. Obviously, market conditions and the availability of various RETs will vary quite strongly depending on their degree of sophistication, their profit potential (often related), and their appropriateness to developed country markets. RETs such as photovoltaics and large scale ethanol have considerable potential in developed countries and hence, large R and D efforts in developed countries are being mounted to produce economical hardware. Nevertheless, it may be possible to transfer these techniques without being totally dependent on the developed countries. Developing countries do hold a number of cards in the bargaining process, eg potentially large markets in some RETs, and field sites to test out state of the art techniques.

In contract, techniques such as wood stoves, biogas plants, simple solar heaters and small scale ethanol plants lack a widespread market in developed countries. In general, the transfer of these RETs involves access to basic knowledge of the fundamentals underlying these processes, and in some cases, to hardware in a relatively "mature" stage of development. Due to its maturity there are a large number of firms in developed countries able to supply such hardware, and with appropriate bargaining skills most developing countries could obtain the required hardware under fairly equitable terms. In this case the relative openess of the field could provide a challenge to some developing countries to develop an expertise which eventually could be exported.

The policy question for developing countries in relation to RET transfer is how to avoid a strong dependency on developed countries, while trying to exploit the very real market "niches" which currently exist in the RET market. In this regard, it is apparent that passive policies oriented towards "waiting and seeing" will only lead to greater technological dependence on imported RETs. An active policy must be formulated based on a long term strategy for managing the supply-side of RETs to result in more favourable development paths. At the core of such a strategy must lie a set of well thought out objectives about the degree of self-reliance based on the benefits and costs of importing rather than relying on locally produced goods and services.

CASE STUDIES OF POWER ALCOHOL IMPLEMENTATION IN AFRICA

No renewable energy projects have been documented that were implemented following the above methodology. In order to examine how some governments have implemented renewable energy projects in practice, two case studies will be discussed in the area of power alcohol.

Zimbabwe

Zimbabwe built a 120,000 l/day power alcohol plant in 1980 (Stuckey and Juma, 1984). At the time the decision was made (1978) Zimbabwe did not have a clear picture of its energy end-use, especially in rural areas, and no renewable energy or even overall energy policy. The decision was based solely on economic grounds in relation to falling world prices for both sugar and molasses, the feedstocks for the alcohol plant. However, the resource requirements and the degree of self-reliance were considered seriously due to international sanctions and the lack of foreign exchange. Due to a well developed capital goods sector, and construction skills a significant fraction (60%) of the total capital investment was spent locally.

These local capabilities, the availability of untied capital from the parent company in South Africa, and access to knowledge enabled the company involved, Triangle, to purchase the technology from West Germany under very favourable terms. This decision only came after an extensive world wide survey of equipment manufacturers and suppliers. In addition to the purchase of the technology, the contract stipulated on-site training for a number of local people. Since the plant has been installed the company has been carrying out tests to determine whether it can be adapted locally to improve its performance.

Since the capital cost and overall production cost per unit of output is extremely low by world standards the programme in Zimbabwe is considered to be extremely successful. While the initial steps in the formulation of a renewable energy policy were not undertaken, this case study shows that a relatively sophisticated RET can be transferred successfully without depending on "turn-key" projects.

Kenya

Kenya instigated the construction of two plants in 1977; a 60,000 l/day plant at Muhoroni producing bakers yeast as well, and a 30,000 l/day plant at Kisumu producing bakers yeast, citric acid, and vinegar. The Kisumu plant was a "turn-key" project with no local input. At the end of 1982 the project was suspended before completion at a cost of US$120 million. The Muhoroni plant came on stream in June 1982 (Stuckey and Juma, 1984).

At the time the decision was made, Kenya did not have any renewable energy policy, or even an overall energy policy. The projects were evaluated on economic grounds, and deemed to be uneconomic by the relevant government departments. However, despite this advice the government still went ahead with both projects.

The plant at Muhoroni was based on a prefeasibility study carried out by an Austrian company. This company was eventually contracted to build a sophisticated continuous fermentation facility on a turn-key basis. Hence there was almost no local input in terms of construction. In addition, no technical training was provided and the plant is operated almost entirely by expatriate labour.

The choice of the technology was dictated strongly by the lack of availability of untied finance. Since the Austrian government offered to finance the plant, the company and technology used were not unnaturally, Austrian.

The above factors led to a plant which has relative high production costs and resulted in little if any increase in indigenous technical capacity. In this case, in contrast to Zimbabwe, it is difficult to argue that the acquisition of a renewable energy technology led to enhanced development, and an increase in skill in implementing renewable energy projects.

CONCLUSIONS

It is apparent that in order to fully exploit the potential of RETs in developing countries and to optimise their use, governments must take an active role. This does not mean that private enterprise should be excluded. To widely diffuse RETs, especially small scale ones, commercialisation is essential. However, governments should maintain a firm control over the evolution of RETs due to the many social factors involved which tend to receive a low priority in the private sector.

Government should be active in assessing sectorial energy demand, and formulating a cohesive and rational renewable energy policy. In implementing such a policy, developing country governments should aim to build up an indigenous technical capacity through technology transfer and developing local skills. It is only through the active pursuit of these goals that RETs will start to fulfill their potential in contributing to energy budgets in developing countries.

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