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# NEW AND RENEWABLE ENERGY PROJECTS: FROM POLICY TO ACTION

By

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# NEW AND RENEWABLE ENERGY PROJECTS : FROM POLICY TO ACTION

by

UK Srivastava and AK Subramanian*

## I EXISTING ENERGY SCENE

The per capita consumption of energy in India at present is extremely low (315 kg coal per year). Therefore, almost all the studies dealing with the future energy scene in India have projected substantial increase in total energy consumption in the future (6, 10-12, 16, 17, 26, 28, 35, 39-41, 43, 45, 46).

There has been a progressive decline in the share of non-commercial sources of energy in the total energy consumption. Non-commercial sources of energy used to account for 67% of the total energy consumption in 1953-54. But today they account for only 40%. Moreover, the access to commercial energy sources has become difficult and prohibitively expensive. Some of the projections further indicate that the share of non-commercial energy use will come down to as low as 20% by the year 2000 (12).

From the national point of view, the three sources of non-commercial energy, i.e., firewood, cow dung, and vegetable wastes, have better alternative uses than they are currently being put to.

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A recent study (6, 7) has estimated that it should be possible to replace the diesel oil required for water pumping and rural industry by renewable sources by the year 2000. It may also be possible to replace 50% of petroleum products required in the household and transport sectors. Some 25% of fuel oil and 20% of coal normally used for low and medium temperature heat can also be replaced by renewable sources. If the appropriate policy measures are taken to bring about the replacement of commercial energy sources with that of new and renewable sources, it may be possible to meet about 45% of total energy demand in the year 2000 through non-commercial and new and renewable sources including hydro-power (6). The new and renewable sources of energy include hydro-power, solar energy, bio-energy, wind energy, ocean energy, and animal energy.

## II OBJECTIVES OF THIS PAPER

In the light of various findings relating to future energy scene in India, the development of new and renewable energy sources have been given substantial emphasis in the Sixth Plan. Some evidence from field level experience of a few of these technologies has become available through micro studies. The focus of this paper is a) to review this evidence to determine its implications for a strategy for developing new and renewable energy sources on a large scale and b) to suggest some critical elements that will determine the success of the strategy for the implementation of such projects.

## III SIXTH PLAN APPROACH

A broad approach of the Sixth Plan to develop new and renewable sources is as follows (15, 16):

a. To implement on a large scale, programmes like energy forestry and biogas where technology development permits field application.

b. To carry out field testing and demonstration on a countrywide basis of technologies which have the potential to become commercially viable in the next five to seven years.

c. To intensify research and development of other technologies where the potential is likely to be available over a longer time horizon.

To understand the Sixth Plan approach to the development of new and renewable energy sources, a brief review of technology development for field exploitation is presented below (4, 9, 13, 14, 16, 21, 24, 27, 33, 38, 44):

In solar energy, substantial efforts have been made in solar thermal applications; water heating units are now at the stage of commercial production and utilization. Similarly, sügnificant advance has been made in the development of solar drying systems; the technology for solar cookers and solar distillation plants ia available for multiplication. Some progress has also been made in photovoltaic research and development in India; its most important application has been in pumping water for micro irrigation and drinking water supply, and some effort has been made to generate other applications of photovoltaic systems for lighting in community establishments and lighthouses, radio, TV sets, communication equipments and others. But all these developments are at the pilot plant stage.

Substantial progress has been achieved in biogas technology for large scale application. About one lakh biogas plants of various sizes have already been installed in several states in India, and efforts are underway now to set up community size biogas plants in different parts of the country. Progress has been achieved in developing an engine which runs entirely on giogas; but this technology is still not at a commercial stage.

Energy plantations are another source of bio-energy. The idea of energy plantations include the use of selected three species grown on short rotation systems which permit a harvest of biomas at least once in every two years for conversion into fuels. Progress has been made to identify a number of tree species, shrubs, and other plants suitable for energy plantations. The technology for conversion of agricultural residues into usable energy forms is at its developmental stage.

The technology to harness wind energy is in the developmental stage at the moment. Its major application has been in pumping water. Some efforts are also being made to develop wind electric generators, but the technology has not yet reached the commercial stage.

Animal energy has been the traditional source for a number of applications in agriculture, transportation, and other sectors. Some developmental work has been undertaken to design agricultural equipments for more efficient utilization of animal power. But very few such innovations have yet been popularized on a large scale.

While technology for major hydro-power projects has been well established in India, recently there have been some developments of mini and micro level generating sets. Some designs have already become commercially available. But large scale application of micro hydel sets is yet to be achieved. The technology for harnessing geothermal energy is at the experimental stage in India, and the potential for its exploitation is also very limited.

Some technologies are also available for exploiting ocean thermal energy. But they are at the experimental stage.

This review of available technologies indicates that, among the new energy sources, mainly the biogas and energy forestry and perhaps some solar nergy devices are at a commercial stage for large scale multiplication. The technologies for other new and renewable resources are at various stages of research, development, and experimentation. Even though the technology is available for commercial multiplication, it does not necessarily follow that the desired large scale multiplication would in fact take place. Success in the field is more than mere design and engineering perfection. Therefore, before examining the implementation strategy for achieving large scale multiplication of available technologies, let us briefly review the findings of various evaluation studies on the functioning of these new energy units.

## IV FIELD STUDIES

Several micro studies have been undertaken in the last few years to assess the performance of biogas plants and to assess the functioning of energy plantations and social forestry projects. Some of these findings are as follows:

### 1 Notional Cash Flows

In the case of biogas plants, it has been emphasized that the so called benefits to farmers are only notional, valued in the form of savings measured either in the kerosene equivalent, coal equivalent, or firewood equivalent (3, 29, 30, 37, 48). The farmer does not get any cash returns from the biogas plants while he has to forego other alternatives which could have yielded him cash inflows. For example, when the farmer has to borrow for a biogas plant, he foregoes the opportunity for borrowing for other durable assets. Suppose he buys a tractor, he can not only cultivate his fields but also hire it out and earn more cash inflows. Thus the farmer's acceptance of the new energy sources has to depend on the acceptance of benefits derived in income earning use of family labour which would be otherwise used for collection of firewoods and dung and in terms of convenience to him and his family. It is well known that the valuation of convenience is much lower when one is poor than rich. This also restricts the acceptance of the biogas plants on the part of the smaller farmer.

2 Divergence Between Private Cost and Returns and Social Cost and Benefits

Several studies of biogas plants have brought out the fact that there is very large divergence between private cost and returns from the point of view of the farmer who is supposed to set up the plants and social cost and benefits from the point of view of the society. The farmer mainly perceives various gains from biogas plants in terms of the other fuel sources available. For example, if he has access to fuelwood through poaching or purchasing cheaply from those who have poached or to agricultural residues like 'karathi' in Gujarat, he values the gains from biogas very minimally. On the contrary the benefit in the form of prevention of further denudation of forests is valued much higher by the society. An effort has been made to bridge the gap between private cost and returns and social cost and benefits by providing the subsidy. But it has been found that a flat rate of subsidy benefits larger sizes of biogas plants more than smaller sizes and therefore, it is regressive (3, 29, 30, 37, 48).

3 Scale Economies

Many studies have found that larger biogas plants are more viable financially and economically than the smaller biogas plants (3, 29, 30, 36, 37, 48). Family size plants are also found to be viable in absolute terms subject to the constraints mentioned above that cash flows are at best notional. These studies indicate that community size plants are the ideal if other systems can be lined up.

4 Lack of Knowledge About Logistics of Setting up of Community Size Systems

Although the studies found that the community size biogas plants are most economical, the logistics of setting up the systems for collection of dung, operation and maintenance of the plant, pricing and distribution of gas, etc., are not very well known and these are at best at an experimental stage (29, 30). Despite the best care taken in setting up a community size plant in Fateh Singh Ka Purwa in Uttar Pradesh, the plant began to have problems in collection of dung and local participation.

5 Regional Variations in Financial and Economic Viability

It has also been found that there are many regional variations, in financial and economic viability of plants (29). For example, the performance of biogas plants is much different in the regions which experience extreme winter than the regions where the winter is mild. The production of the gas fluctuates widely between summer and winter. Similarly there are large local variations in the performance, use, and maintenance of plants, and these factors require the examination of financial and economic viability for each area before going ahead with the technological intervention.

6 Lack of Standardized Fabrication and Repair and Maintenance Facilities

Fabrication of biogas plants varies from place to place. There is very little standardization in the components, particularly gas holders and other parts, and this creates serious problems in getting the replacement of parts off the shelf (8, 29, 30, 37, 44, 45, 48). Similarly it has been found that the repair andmaintenance facilities to revive the system after a breakdown are not readily available or are available in places far away from the plant (30). Thus on top of an already perceived low level of advantages from these plants, there is the additional factor of low level of supportive services. Private after-sales service has been found to develop only when there is a concentration of plants in an area. Therefore, many plants have not been revived and used after a breakdown.

7 Limited Credit Facilities

Given the perceived disadvantages, the farmer's decision to go in for a renewable energy technology will be determined also by the availability of institutional finance at cheaper rates. Bank finance for new and renewable energy projects is available mainly for biogas plants because the Reserve Bank of India has issued detailed guidelines to banks for such lending (29, 30). But such efforts have not been made for energy plantations and solar devices.

8 Lack of Peoples' Participation

While it has been established that plantation crops on marginal land, which are characterized by low availability of plant nutrients, extreme PH values, poor status of organic matter, coarse structure, and poor suitability for intensive cultivation, are more remenerative than food crops (20), it has been observed that two major problems beset the large scale shift of marginal lands to energy plantations: a) very little attention has been given to generate alternative means of subsistence to farmers during the period of gestation in raising plantation crops and b) very little participation from farmers has been achieved in such projects (47), most likely because of the first reason. Moreover, the new technology in the form of energy plantations or biogas, brings with it a whole host of imponderables which a subsistence farmer may find difficult to cope with. Therefore, large scale multiplication of such projects is constrained.

9 Weak Promotion and After-Sales Service Organization

The promotion of energy plantations as well as biogas plants has been undertaken with the help of government machinery at block and village levels. This set up is already involved in numerous other activities (8, 9, 29, 30, 44). Biogas plants have also been promoted by the functionaries of Khadi and Village Industries Commission/State Board. In some states the promotion of biogas has been undertaken by the Department of Agriculture through the revenue machinery. But in most cases the emphasis of promotion organization has been on meeting the targets of new plants and additional area covered under the energy or social forestry schemes and not so much on servicing the ongoing units. Thus, local level organizations of farmers in planning and implementation of energy projects are lacking.

## V IMPLICATIONS FOR STRATEGY FORMULATION

The major implication of these findings is that the new and renewable energy projects themselves are not financially very attractive to the farmer. They are of course much more attractive to the society. The projects are also handicapped from many other dimensions, particularly from the fact that they do not generate hard cash as in the case of biogas plants. In energy plantations, if the farmer has the means to survive the gestation period, he can earn more money than he would have earned under annual crops. But the problem is that the means of subsistence are not adequately provided for. So the farmer is very reluctant to take up these projects. The implications of this finding is that the task of promoting these projects is difficult and necessitates the creation of a conducive environment for setting up such projects in which the initial handicaps from the farmer's point of view, are at least partly overcome. Therefore, the following types of tasks appear to be necessary before the new and renewal of energy projects can be multiplied on a large scale.

a) Financial support and incentives: Since most of the new and renewable energy projects are recently developed, it is necessary to evolve procedures for their financial and economic appraisal and to educate the bankers in conducting such appraisals.

This step would help considerably in making the projects bankable and in increasing the private investment in the enrgy projects. Since it has been found that a flat rate of subsidy is regressive, it is necessary to evolve a scheme of differential rate of subsidy on various sizes and disburse this subsidy speedily (29, 30, 48).

b) Delivery system: While the local participation and financial support and incentives generate demand for new and renewable energy projects, it is necessary to set up delivery systems which can fabricate the required machinery and equipment on a large scale so that the cost per unit can be brought down on the one hand and some amount of standardization can be brought about on the other. The standardization of equipment and machinery and hence the availability of spare parts would be very helpful in keeping the units in operation during their economic life. In the case of biogas plants, the plants need to be fabricated on a large scale. In the case of energy plantation, saplings from suitable tree species need to be multiplied on a large scale and distributed to farmers at convenient locations.

c) Repair and maintenance of facilities: The finding that private initiative will not develop for repair and maintenance service unless there is adequate business turnover, can be utilized in promoting plants and projects in such a way that it becomes commercially viable to provide after-sales service to these facilities. In such cases, the present organization which is responsible for promotion and after-sales service need not be the only source for after-sales service for these facilities. It is very crucial to provide follow-up service within and easy reach because the farmer cannot take the trouble of keeping the system operational for reasons inherent in the project itself (lack of cash flow coming out of it and availability of alternative sources to meet the needs).

d) Making the project organic to the system: The most challenging task is to make these projects organic to the system by adapting them to the felt need in the typical local conditions and generating adequate participation from the user system (1, 2, 21, 47). The participation in the context of new and renewable energy system has been defined "as associating oneself, individually or as a member of a group with a legitimized task, be it a programme, scheme, project, an activity, or a movement, with an appreciable degree of either adaptive, emotional, expressive, or instrumental involvement inclusive of positive and negative connotations" (47, p.4). Such participation can be of several types. A recent study (47) elaborated the probable types of participation in the context of social forestry scheme as follows: 1) process participation - which involves participation in the process leading to better decision making, 2) cognitive participation - which involves identifying oneself with the concept, idea, or task but not necessarily physical participation, 3) interactive participation - which involves education, organizing, guiding, and preparing people for a particular task, and 4) material participation – which includes individual contribution by way of time, money, labour, or other resources necessary for achieving the goal. Since there are large regional and local variations in the financial and economic viability, it is necessary to examine these under the local conditions and create local institutions which will not only help set up these projects but also continue to maintain and use the systems after they have been installed.

These tasks could be initiated by the Additional Energies Commission, which has been set up to prepare policy, coordinate implement, and generate awareness about the projects related to the new and renewable energy sources.

## VI AREA VS. GENERAL APPROACH

It is, therefore, clear that it is necessary to adapt the available technologies to suit local conditions and enlist the participation of local institutions. Therefore, one has to ask the question whether the approach for promoting the new and renewable energy projects should be area based or only technology based. Evidence seems to indicate the advantages of an area based approach where the efforts may be made first to understand the local variations in energy use and sources and the clues for local participation and then take steps for appropriate technological intervention.

The appropriateness of energy technologies to be introduced in an area will be determined by the appropriateness with which they move from the demonstration sites into normal use in the household, farm, and other sectors of use in rural areas. Attempts to induct new and renewable energy technologies without reference to the context of their use are likely to lead to several unintended consequences in the process of implementation. Indeed an understanding of the context through an appreciation of the ecological setting would help in the selection of an appropriate technology.

An appreciation of the context of setting can be obtained through an analysis of a set of two mutually influencing, interlinked segments or rural ecology and economy: 1) the physical system by which occurs the transformation of a basic energy resource into usable energy forms and 2) the user system by which a) users in the various sectors such as the household and the farm convert needs into demand on the basis of their own priorities and b) others respond to this demand.

1 Physical System

The transformation of resources into usable energy forms occurs through a natural chemical or technological process. The energy available at the end use stage in the form of motive power, heat, or light is derived from a basic resource such as forest, woodlots, or trees. The first stage of transformation is the derivation of a usable fuel from fuelwood sticks obtained from the woodlots by a process of felling and cutting. This fuel form is converted at the second stage into a usable energy form such as heat for cooking through combustion. The third stage requires the further conversion of the energy form into an effective use form depending on the equipment and applications used such as ovens and utensils. This physical system is shown in Figure 1.

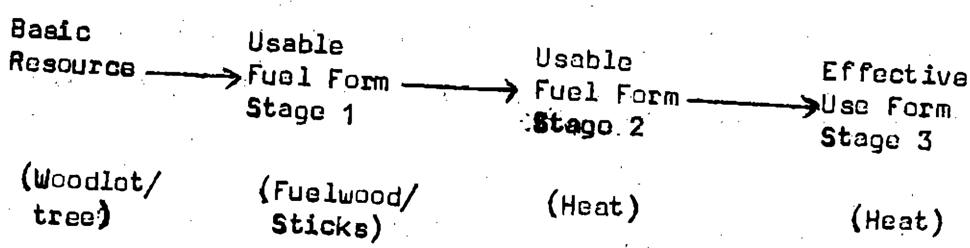
It is necessary to understand the demand for the end-use form for realistic new and renewable energy projects. Very specific end-use forms have been identified for the rural areas: low temperature heat for cooking, medium for water heating, high heating for local industry, etc. (12, 16). This will indicate the extent to which the demand can be met by decentralized, local, renewable energy systems. While resource endowment (forest, cattle heads) will doubtless determine the local availability of the basic resource for conversion into the end-use forms, it is the users' needs and priorities that initiate the interventions in the physical system.

2 User System

A major determinant of the conversion of the basic resources into a usable form is the use of energy. This use may be said to occur within six sectors in rural areas: a) household, b) agriculture, c) transporation, d) industry, e) public services and social events, and f) commercial and other establishments (6, 12, 16). The latest national paper (16) also suggests the application of renewable systems to industrial uses and urban or rural areas where low temperature heat

Figure 1

The Physical System

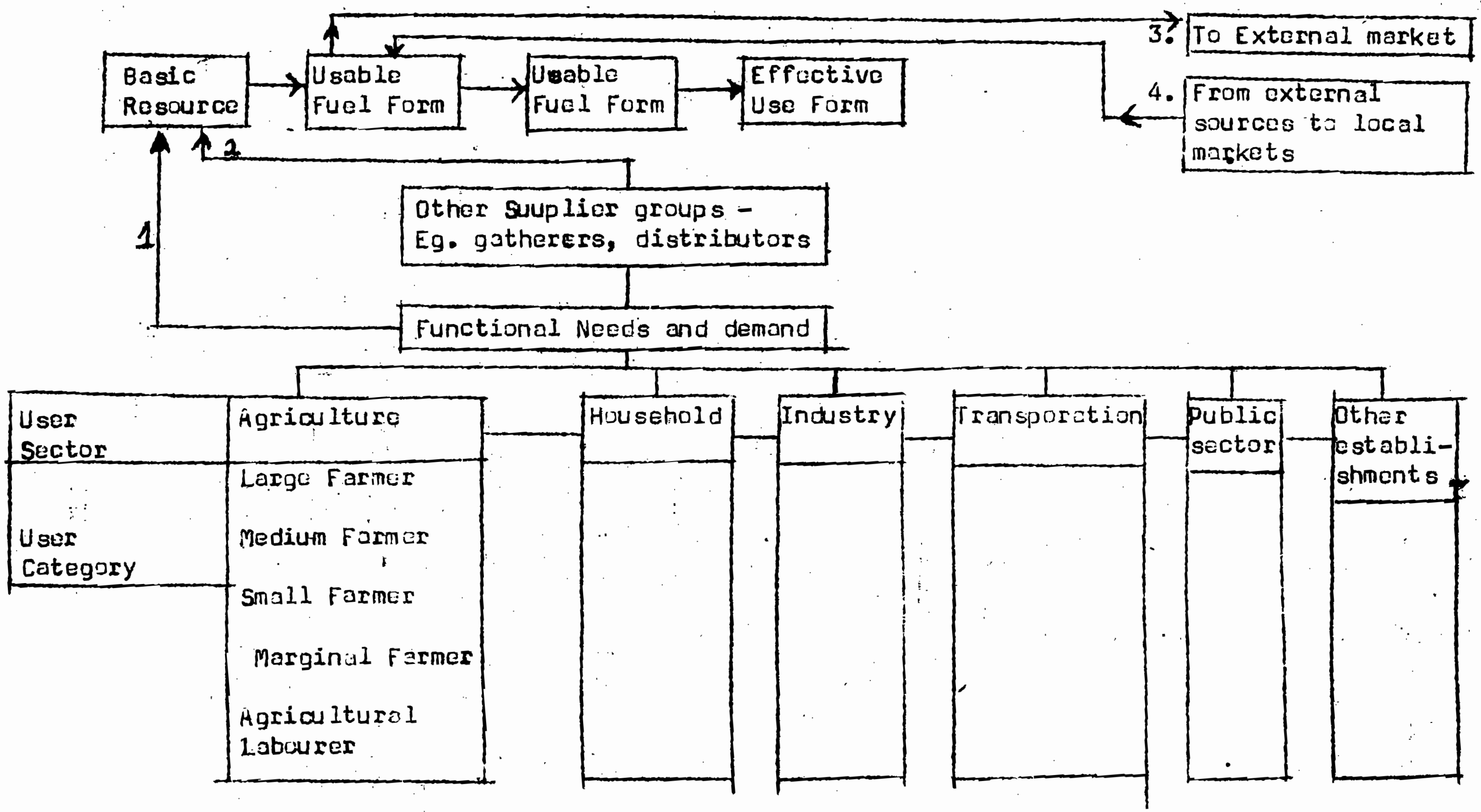


is required, thus giving an interesting turn to an expansion of scope for renewable energy technologies.

Each of these sectors has functional needs like cooking, lighting, tillage, irrigation, etc., for which energy is needed in an effectively utilizable form, i.e., light, heat, or motive power. Decisions regarding use are, however, by the sectors on the basis of 1) functional needs, 2) priorities, 3) resources, and 4) constraints. This set of factors varies with their user categories in each sector. Thus, marginal farmer and middle peasants in the agricultural sector will have differing needs, priorities, resources, and constraints with respect to the functional needs.

The user sectors will have a large section of the population which will meet its own needs in its own ways, i.e., most of the poor have to depend on their own actions to meet their needs. Only in places where usable fuel forms (branches, twigs, dung) are not available at zero cost will a move be made for procurement from other sources including the market where this is possible. For those who would expect others to meet their needs for fuel forms, supply services may be set up by 1) owners of energy forms, 2) gatherers and processors, e.g., those who collect dry sticks and wood, animal waste, etc., for others or those who process them such as dung cake makers, and 3) distributors and traders who retail usable fuel forms. Thus, the user system with its heterogeneous composition of user categories within the sectors will impinge on the physical system and influence conversion. Figure 2 presents the linkage graphically.

## Linkages between the Physical User Systems in an Area




1. User sectors directly influence the conversion process
2. Suppliers take note of demand and influence the conversion process
3. Flow of usable fuel from such firewood from the area to external market and vice versa
4. To external market

## VII NEED FOR VILLAGE ENERGY STUDIES

"The focus of the policy maker needs to be on the physical system and how the user system influences the conversion of a resource into a fuel form under local conditions where the technology intervention is contemplated. Presently three types of studies are available as aids in planning and implementation of energy policy and projects: 1) futuristic studies which present alternative future scenarios of energy options on different time horizons, 2) monitoring and evaluation studies of an ad hoc nature or conducted periodically to ascertain the performance of new and renewable energy units under field conditions, and 3) technology related studies offering insights into the state of the art in design and fabrication.

There are problems of data availability and reliability in all the three attempts. For instance, the transactions in the commercial energy forms through the monitized channels account for the availability of a degree of reliable data. Even here, the rural data base needs to be improved. In the non-commercial forms, the gap is much wider. As an illustration, in the absence of reliable recent estimation of domestic consumption of the non-commercial forms, the successive governmental committees (10. 11, 12) have all adopted the ratio of 65:20:15 as relative share of total consumption for firewood, agricultural wastes, and cow dung respectively. The Energy Survey Committee itself relied on two NCAER surveys done in the late 1950s and early 1960s (23). This is a problem which will surely be solved over time through the experience and efforts of national agencies involved in such surveys.

Despite the weak data base, these studies help in long-term planning and strengthen some areas of implementation. However, there is still a gap in the understanding of the local environment of areas where renewable energy projects are to be initiated.

It is in the light of the need for an appropriate response to the context or setting in which energy forms are used by user categories in various sectors of society that the significance of yet another type of studies emerges. Micro or village studies could have a complementary role to play in understanding the rural energy scenario. Haben and Timberg (22) explain how intensive studies can "clafiry decision-making processes, explain linkages between phenomena in different sectors, help form a sample frame for survey research, provide highly reliable data on small samples which can be used to judge the plausibility of survey research findings." In addition, a "bottom" view of how different user categories perceive the problem can be elicited. With the same view, but in another context, Jodha, Asokan and Ryan (25) talk of villages studies in an effort to understand the factors affecting the traditional system of farming in different agro-climatic zones, Shlegel and Tarrant (42) refer to the need for analysing the "effect" of traditional social structure, rural income distribution and land tenure patterns on the viability of a project, and the interaction of related activities if appropriate policy interventions have to be considered. Das (5) drives the point home when he stresses in another context that it was not merely a matter of inserting new technology and seeing the magic at work. There is a need to monitor macro policies through a continual system of feedback from the ground so that corrections can be made. Hence area plans can emerge from a set of local plans, which themselves are formulated on the basis of local studies.

## VIII OBJECTIVES AND METHODOLOGY OF VILLAGE ENERGY STUDIES

The possibility of coordinated, complementary, and relevant studies in renewable energy system was discussed in a recent meeting (March 1981) of interested groups held under the auspices of the Appropriate Technology Development Association, Lucknow. The following objectives were considered for such studies:

1. Understanding the existing energy needs and consumption patterns and of the resources and their use patterns, together with their determinants and dynamics.

2. Identifying methods to improve energy availability to people for development and subsistence needs now and in the near future with an assessment of the relative roles of centralized sources of supply and decentralized systems.

3. Finding methodologies and levels at which decentralized planning can be done.

4. Chosing opportunities and guidelines for effective technological interventions.

Any attempt to initiate studies of this type will have to begin with an effort at forming typologies of energy zones (34). Factors to determine these zones have been given some consideration. The agro-climatic zones suggested by the ICAR could provide a starter. Morse (31, 32) suggests population density, cropping pattern, livestock pattern and forest pattern for a first level clustering. While these factors could take into account inter-regional variations, another set of factors need to be used to differentiate among villages within a given zone and decide on villages which represent fairly homogeneous clusters within the zone. Since location and season related considerations would weigh heavily on the nature of energy transactions, village and household selection will have to be carefully made.

Serious consideration needs to be given to the study process also. The nature of decisions by users to be studied will require a close inquiry into the kitchen and field. The level of quality of data from forays by survey researchers are by now too well-known. If there is to be a marked concern in the quality of primary data, it is essential to strike a rapport with the user catagories (18, 19). Methods including that of participant observation, which will enable a greater level of reliability, need to be incorporated (22).

It is not the goal of the policy maker to merely establish links between the rural user sectors and purveyors of a new technology. This could create dependence of the sectors on an energy system which is beyond their influence, let alone control. Local action to sensitize and mobilize the sectors could empower the users to articulate their views and exercise influence on decisions of policy and operations. For this, agencies which have the potential to work with user categories and sectors could also use the micro study to initiate local planning efforts. Interested district and block officers, panchayats, and voluntary agencies could also thus be the initiators of such studies.

## IX SUMMING UP

Economic growth and development will demand an increasing level of energy consumption by all users in the future. A substantial rise in the availability of commercial energy forms will be required. It appears that the share of non-commercial forms will decline if the past practices are sustained. However, commercial energy forms are proving difficult in access and cost, and questions of ecology are demanding attention. Realizing these difficulties, the government has made serious attempts to plan for new and renewable energy projects in as many settings as possible.

The availability of technology is only a necessary condition for its induction and large scale multiplication. The sufficiency condition will be met only when an understanding of the user environment or the context in which technology is to be introduced is achieved. Several studies available offer insights into the future energy scenario. It is suggested, however, that an area approach and local village studies using intensive observation and interview methods can provide an understanding of the context in which specific technological interventions are to be contemplated. Without such efforts and understanding, new and renewable energy projects will remain hopes without significant positive results.

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