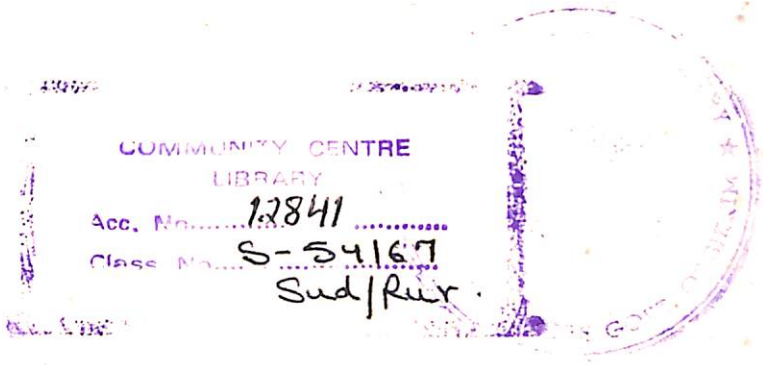
RURAL ENERGY PLANNING IN SIKKIM



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SUSTAINABLE DEVELOPMENT SERIES

For the majority of people in the world, our abode is far from a pleasant place to live in. There are today more people who are undernourished, physically and mentally unwell, and cruelly impoverished than there have been at any time since the Second World War. Yet all the political-economies that currently dominate the world's people are unable to hold out credible hope of development that is equitable and sustainable. Indeed, some of these systems deny the possibility, even in theory, of achieving equitable, sustainable development.

The possibility of sustainable development is predicated on change and resilience in man's interaction with nature. If human activities which are in their essence transactions in society and interventions with natural processes are not to be counter-productive, such transactions and interventions must be designed with a fuller understanding of the way different societies (and the physical environment on which they depend) react and respond to such transactions, interventions, perturbations and environmental change. Such understanding may be brought about by application of the methods of science.

Sustainable development requires wholly new types of thinking, new types of institutions and new kinds of technologies. To evolve such technologies, we need to fashion a new range of knowledge based on those sciences that elucidate the processes of nature and of society, separately and in concert.

The social activity of science, as practised in the scientifically developed parts of the world (which include isolated segments of the Developing World), has established a wide variety of channels which facilitate efficient and copious communication among the practitioners of science on a global scale. The mechanisms of such communications—expeditious publication, peer review, rewards for high quality, and punishment for shoddy work—are certainly designed to ensure quality of work,

PREFACE

The New and Renewable Sources of Energy Department has invited Development Alternatives to prepare a project report under the framework of the Integrated Rural Energy Programme (IREP) initiated by the Planning Commission, Government of India.

Development Alternatives is a non-profit Society established to formulate and implement activities aimed at promoting sustainable development, i.e., those activities which enhance

— economic efficiency

— equity

— environmental quality

— indigenous capacity and self-reliance

The primary strategy of Development Alternatives is to design appropriate technologies, environmentally-sound projects and effective institutions in a manner which meets these objectives. Through its sister agency, Technology and Action for Rural Advertisement, it manufactures, markets and franchises a variety of rural technologies. Development Alternatives also undertakes projects and contracts for various international and governmental agencies in these fields. Development Alternatives has had more than 3 years of experience in designing, producing and marketing various renewable energy technologies.

This report is primarily based on the field survey conducted in Soreng Sub-division and the published material available, including reports of the Government of Sikkim.

I am grateful to Sheela Bajaj who edited the manuscript and Renu Rao for designing the book.

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P.P.S. Gusain

Section 1

ENERGY AND ENVIRONMENT

1. Introduction

1.1 ENERGY IN SIKKIM

Sikkim's large hydro power potential constitutes one of its major natural resource endowments. However, for a variety of reasons this resource has not been exploited to any appreciable extent. As far as other sources of energy are concerned, most of them have to be imported, for example, kerosene, coal and LPG. Potential coal reserves have been reported in south Sikkim. They are, however, of inferior quality and exploiting them at the present level of technology would not be commercially viable. Thus, it is evident that biomass is going to remain as a major source of energy in rural Sikkim for several years to come.

1.2 RURAL ENERGY

Energy is a critical component of the development process. It is needed in all such major spheres of life which are directly connected with man's survival and progress such as in cooking, lighting, heating, physical movement, and operation of the infrastructure needed by society, namely, schools, health centres and water supply. It is a vital input in agricultural operations, food processing, construction, transportation, and in the production of fertilizers, pesticides and farm equipment. Industrial operations that provide jobs and produce goods are also highly dependent on energy.

In urban areas the energy required for domestic use and industrial production is met by various commercial fuels such as coal, kerosene and electricity. In rural India energy from fire-

wood, charcoal, plant and animal residues, human and animal power, and direct and indirect solar energy — the non-commercial sources — is used by the household sector and, largely, for agricultural and industrial operations.

No single energy source can individually meet the total energy requirements of any viable development strategy. It is clear that each region of the country has to evolve the means and range of conventional and non-conventional energy sources most suited to its own requirements and potentialities. Considerable effort has to be made in identifying, developing and disseminating these energy sources and their associated technologies in an efficient manner. Experience has shown that conventional energy sources are by themselves insufficient and must be complemented by other sources.

Obtaining and analysing information on various aspects of energy consumption is necessary for non-conventional energy sources to be developed and widely and effectively used. Economic and behavioural factors can be as important as technological feasibility. In some cases for example, energy efficient devices are unacceptable as their use involves a change in domestic behaviour patterns. In other cases the initial capital costs of the technology needed are beyond the reach of most potential users. It is also not always apparent to some end users that the new energy efficient device will reduce fuel consumption and thus in the long run save money. Some energy sources or technologies are not economically attractive at present prices. However, when other traditional energy sources rise in price or become more scarce, this situation can be expected to change.

Most government agencies also face resource and capital constraints. The collection of such basic information related to energy is thus essential for sound planning of development action at the state or central level.

1.2.1 Impact of Fuelwood Scarcity

In most rural areas, including the low-income hill regions, fuelwood is seldom bought or sold. Scarcity exacts its price in terms of increased time spent in wood gathering (especially by

women and children), a shift to lower quality fuels, and increased burning of crop residues and animal wastes. Studies on time spent by families in fuelwood collection have yielded widely varying results, underscoring the diversity of fuel situations even within small regions. The time spent by women in gathering wood is but one index of fuel scarcity. The others include shifts to lower quality fuels such as leaves and twigs found in closer proximity, increase in the use of crop residues, increase in wood purchases, cutbacks in cooking and in the burning of wood for warmth. Increased gathering of wood by men also is a valuable indicator of the fuelwood situation. Increasing scarcity of any resource such as fuelwood automatically leads to its commercialization. As the prices rise and affordability decreases, the poor find it necessary to collect wood and other fuels from private or public lands, often illegally. The impact of fuelwood scarcity on cooking patterns and nutrition needs attention. Reports from Nepal indicate that some families have reduced the number of hot meals from two to one a day. Cutbacks in consumption of beans and vegetables that require long simmering have also been noted in some areas

Fuelwood scarcity impairs family health in other ways as well. In colder areas the burning of wood for warmth in the home becomes too costly. The boiling of drinking water is often out of the question.

Food production is jeopardized by the increased use of dung and crop residues for cooking thus reducing their availability for fertilizing the soil.

1.2.2 **Renewable Energy**

The growing attention being devoted to renewable or non-conventional energy sources in India and elsewhere stems from a number of interrelated considerations. These include the need to:

— Conserve rapidly depleting reserves of coal, oil and other conventional fuels
— Decentralize development institutions

— Develop indigenous technological capabilities
— Minimize environmental damage
— Generate employment and income
— Make maximum use of scarce financial resources
— Redress the adverse balance of payments and curtail imports.

To fulfil these considerations, energy resources which are abundant, renewable and which can be harnessed continuously for years to come, clearly offer an attractive alternative. The use of these renewable sources has many other beneficial spin-offs, some of which can be measured in economic terms, while others are more intangible but nonetheless equally important.

One of the main economic justifications for the use of renewable energy sources is that they are locally available everywhere. The development and use of locally available resources of energy promote indigenous innovation and technological development. This technological and infrastructural base, in turn provides developmental multipliers in other fields. Moreover renewable energy technologies and devices generally require less capital, are more labour intensive, and are most appropriate to the needs and aspirations of a vast section of the rural population. They can therefore be propagated at the local level in a dispersed manner and so more quickly lead to widespread economic prosperity.

A vast majority of Indians living in rural areas, and a large proportion of those in towns use firewood and biomass fuels. It is not possible for them to use other commercial sources of energy such as oil, kerosene or gas because their price or availability puts them out of reach of the average consumer.

Burning of firewood or other biomass fuels in traditional cooking stoves generally produces excessive smoke and can cause serious damage to health especially that of women. The development of improved, efficient *chulhas*, with reduced emission of smoke can therefore significantly contribute towards improving the quality of life of the rural poor.

1.2.3 Bioenergy

Bioenergy resources include biomass obtained directly from plant sources such as trees, shrubs, weeds, leaves and agro- residues; from animal sources such as dung, nightsoil, poultry droppings; and from processed sources such as kitchen or municipal wastes. These may be directly used in fuel stoves, *chulhas*, furnaces or other thermal devices or they may first be converted into solid, liquid or gaseous fuels such as charcoal, briquettes, biogas, producer-gas or alcohol.

1.2.4 Fuelwood

Fuelwood is obtained from several sources such as forests, privately owned farm-land or plantations, common village woodlots and vegetation along the roadside and banks of rivers.

The National Council of Applied Economic Research (NCAER) survey (1978-79) found that most of the fuelwood required by rural households is gathered from private farmland or from roadsides. According to the report of the fuelwood study committee (1982) the total availability of fuelwood from forests (only officially recorded production), social forestry and private land, meets less than half the actual requirements of the country. Illegal felling and collection from private woodlots may account for the balance.

1.2.5 Agricultural Residues

In rural areas a large amount of biomass is left over from agricultural operations. Byproducts of various agricultural processes include stalks and leaves of cereals and pulses, corn-cobs, rice husk, wheat husk, bagasse, tea waste and others. These residues are commonly being used as fuel, especially when other sources are not available. They have, however, many other competing uses such as animal feed, roofing material, organic matter for mulching or compost making and as raw materials for paper and other industries. Thus, the actual amount of agricultural residue which is available for fuel use is dependent on local conditions, and in any case is rarely without some opportunity cost.

1.2.6 Biogas

In India a considerable proportion of domestic energy need is met by the direct burning of dung. However, dung has other competing uses. Dung obtained from cows, buffaloes and other animals can often be better utilized if converted into biogas. Although, a large number of biogas plants have been installed throughout India, the number installed so far in Sikkim is few. Biogas can be used for cooking and lighting purposes at the household level. Larger community biogas plants can also be used to run diesel engines and to generate electricity.

Some major constraints in the large scale dissemination of biogas plants have been identified. These include insufficient number of cattle per household, problems encountered in the collection of dung, the high initial capital investment, and the lack of local technical support.

1.2.7 Hydro Power

Hydro power is renewable, cheap and the most important commercial source of electric power in India. Yet more than 80 per cent of the hydro potential in the country remains unharnessed.

The main reasons for this are:

- Most of the areas with hydro power potential lie in somewhat inaccessible areas of the sub-Himalayan region or north-eastern India
- Long gestation periods and high capital costs
- Adverse environmental and socio-economic impact of large hydro projects.

Because of these reasons, more attention has been focused in recent years on small hydro units. Mini and micro units can take advantage of mountain streams, canals and waterfalls. They can provide decentralized and economically viable power to rural and remote hilly areas.

1.2.8 Wind Power

Wind energy is one of the most promising sources of non-conventional energy, as it is an economically viable energy

source. Through the centuries people have used windmills to grind grain, crush sugarcane, pump water for irrigation and to drive electric generators.

One of the major constraints in the development of wind energy has been the high initial cost. However, in the long run the high initial costs are offset by zero fuel costs, low maintenance costs, and the potential long life of the windmill. A second limitation in India is the lack of reliable, maintenance-free models, and technical support in remote areas.

1.2.9 Solar Energy

The most widespread source of energy exists in the form of solar radiation. Its decentralized distribution is particularly relevant to rural areas characterized by remoteness or community clustering. Solar energy can be harnessed and used for various purposes such as water heating, space heating, water pumping and generating electricity. Solar systems have proved cost-effective in areas where traditional systems have high fuel consumption, excessive delivery costs and extensive infrastructural requirements.

1.2.10 Draught Animal Power

Draught animals are an important but often undervalued source of rural energy. They are primarily used for transportation and agriculture. Animals are used both as pack-animals and to haul vehicles that carry loads and people. Bullocks, buffaloes and horses are indispensible in many agricultural systems. They are used for a variety of agricultural operations such as ploughing, harvesting, threshing grain, lifting water from rivers and wells and in the extraction of oil.

Most of the landholdings in India are less than two hectares in size and therefore mechanized farming is not feasible. The farmer is therefore dependent on animal power which continues to maintain its importance in the domestic economy of rural India. Misconceived notions about draught animal power have hampered its rational development. Little effort has been made

to assess the energy contribution of animals. The modest research carried out so far has been scattered and undocumented.

1.3 INTEGRATED RURAL ENERGY PROGRAMME (IREP)

The Seventh Plan document states that 90 per cent of the total energy consumed in the rural area comes from non-commercial energy sources. At the national level these sources account for about half of the total energy consumed. The document also points out the excessive dependence on non-commercial sources which has led to large-scale destruction of forests and woodlands. Considering these aspects, the Sixth Plan proposed an Integrated Rural Energy Planning (IREP) Programme, on a pilot basis. This would provide a mix of energy options appropriate to each region to meet the diverse energy needs of rural populations in the most cost-effective manner.

To implement this recommendation, the Planning Commission set up the Integrated Rural Energy pilot programmes in selected states in 1981 with the objective of designing and planning block level integrated rural energy survey projects.

By the end of the Sixth Plan, 20 block-level IREP projects were in different stages of implementation. A total expenditure of Rs 4.13 crores was incurred on the programme during the Sixth Plan.

To carry out the programme a proper institutional mechanism at the state, district, block and village level was needed. The nodal departments at the state level varied from state to state. At the district level the implementation was done by the district magistrate, through the Zilla Parishad, District Rural Development Agency (DRDA), New and Renewable Sources of Energy Department (NRSE), etc. In the case of Sikkim, the department in charge was the NRSE.

The integrated energy plan provides a mix of different energy options, depending on the resource endowments and the availability of commercial and non-commercial fuels. The main items that were promoted were windmills, solar energy-based cooking

and heating systems, biogas plants, improved *chulhas*, bullock carts, kerosene stoves, equipment including pumpsets for better utilization of electricity, diesel pumpsets and pressure pumps. Subsidies were often provided for different energy technologies over and above the standard subsidies being provided through on-going central and state schemes.

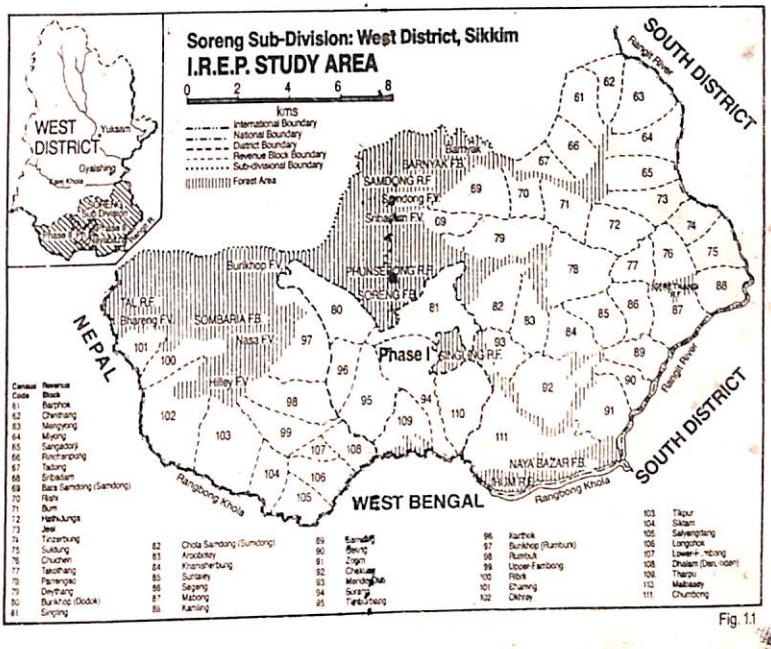

Fig. 1.1

FIG. 1.1

Table 1

All-India IREP Outlay

	Sixth Plan	*Seventh Plan*
Number of Projects/Blocks	20	100
Outlay (crores)	4.13	41.85

More projects would be funded in those states where the programme was a success, particularly in hill states and backward areas.

During the Seventh Plan period, the programme was to be carried out by the states (Rural Development Department, Zilla Parishad), after which it would be transferred to an operating department as a regular programme. See Table 1.

1.3.1 Integrated Rural Energy Programme in Sikkim

Under the Integrated Rural Energy Planning (IREP) programme initiated by the Planning Commission, the tasks and funds were allocated to the NRSE department to commence a rural energy survey. The IREP programme is designed to develop a data base for block-level energy planning. The area selected by the Sikkim government for this project was Soreng subdivision in the West district (Fig. 1). The study would cover seven revenue blocks in five different panchayat units in Soreng subdivision.

1.3.2 New and Renewable Sources of Energy in Sikkim

The New and Renewable Sources of Energy Department in Sikkim was formed at the beginning of 1985-86 and is attached to the Rural Development Department. Its basic objective is the conservation and efficient utilization of energy and, more particularly, the promotion of the use of non-conventional sources of energy. Widespread use of such non-conventional energy sources would go a long way towards checking the massive deforestation going on in the state. But first, it would be necessary to devote time and effort on the research and development of the relevant technologies.

Some of the schemes taken up by this NRSE include:

— Popularization of improved *chulhas* and biogas plants
— Energy plantations and extension programmes
— Feasibility studies on solar energy, wind energy and mini-hydel systems
— Research and development in the energy sector.

The smokeless *chulha* programme has been initiated with the basic objective of creating a smokeless kitchen environment for better health. The improved *chulha* on which it is based also has a higher efficiency and, therefore, saves scarce fuelwood. The programme is being undertaken by giving subsidies to the users. The outlay approved under this scheme was Rs 4.5 lakh in 1987-88 for 4000 *chulhas*. The biogas target for 1987-88 was the installation of at least 40 plants (Janata Model).

Besides energy plantations, efforts are also being made to harness solar energy by installing solar cookers, solar water heaters, photovoltaic devices, windmills and micro hydel units.

1.4 ISSUES

To design an integrated energy plan for a specific region, information on a variety of parameters and understanding their interrelationships are crucial. Some of the most important issues include:

Energy Sources

Conventional/commercial/non-renewable
—coal/coke
—oil/kerosene
—electricity
—cooking gas
Non-conventional/non-commercial/renewable
—biomass (firewood, dung, agro-waste, etc.)
—biogas
—solar
—wind
—hydel

Energy Needs and Uses

Domestic
—cooking
—lighting
—water heating

—space heating
—household appliances
Agriculture
—irrigation
—sowing
—harvesting
—other processes
Drinking water supply

Transport
—passenger
—goods
Commercial/industrial
—household/industries
—hotels etc.
—small-scale industries

Efficiency of Energy Devices

Appliance uses
—one/two pot-stoves
—biogas burner
—metal/ceramic stoves
—bulb/biogas lamp
—electric/diesel/petrol/producer-gas engines

Demand and Supply

Daily
—variations between morning/noon/evening/night
—variation in solar radiation
—variation in wind velocity
Seasonal
—summer
—winter
—rainy/cloudy
—collection and availability of wood
—variations in solar radiation and wind speed
Peak demand and load factors

Affordability
- Income distribution
- Subsidy/incentives

Social and Cultural Needs

Awareness of New Technologies

Resources
- Short and long-term potential/availability
- Development of new technology
- New institutions
- —production facilities
- —marketing facilities.

2. Integrated Rural Energy Planning In Sikkim

The New and Renewable Sources of Energy Department under the Rural Development Department of the Government of Sikkim, invited Development Alternatives (DA) to prepare a project report under the IREP framework. A proposal was forwarded by DA in mid August 1986 and discussed with the Development Commissioner and Secretary NRSE/RDD, and Project Officer NRSE/IREP, in October 1986. The project was approved in November 1986 and the project work commenced in January 1987.

2.1 OBJECTIVES

The objectives of the project are :

— To assess the physical, economic and social environment relating to rural energy planning

— To investigate basic needs and quality of life indicators in the study block

— To understand the people's perception of the energy situation and their preferences amongst the available energy options

— To quantify the availability of energy resources and map their consumption patterns

— To relate environmental health and rural energy use and suggest models to optimize use of softwoods, hardwoods and other materials

— To design strategies for the dissemination of energy innovation.

2.2 PROJECT DESIGN

To meet these objectives a research programme was formulated based on household and village level surveys, using structured questionnaires and in depth interviews, as well as investigations based on the information available in literature.

2.2.1 The Advisory Group

In order to successfully address the complex issues involved in rural energy planning, DA constituted a transdisciplinary advisory group, consisting of the following members:

a. Professor B.D. Nagchaudhuri
   Former Member Planning Commission
   Former Vice Chancellor
   Jawaharlal Nehru University
   New Delhi.
b. Professor K.C. Malhotra
   Indian Statistical Institute
   Calcutta.
c. Professor P.S. Ramakrishnan
   School of Environmental Sciences
   Jawaharlal Nehru University
   New Delhi.
d. Professor Padma Vasudevan
   Head
   Centre for Appropriate Technology and
   Rural Development
   Indian Institute of Technology
   New Delhi.
e. Dr. Virendra Kumar
   Former Consultant (Hills), Planning Commission
   Department of Zoology
   Zakir Hussain College
   New Delhi.