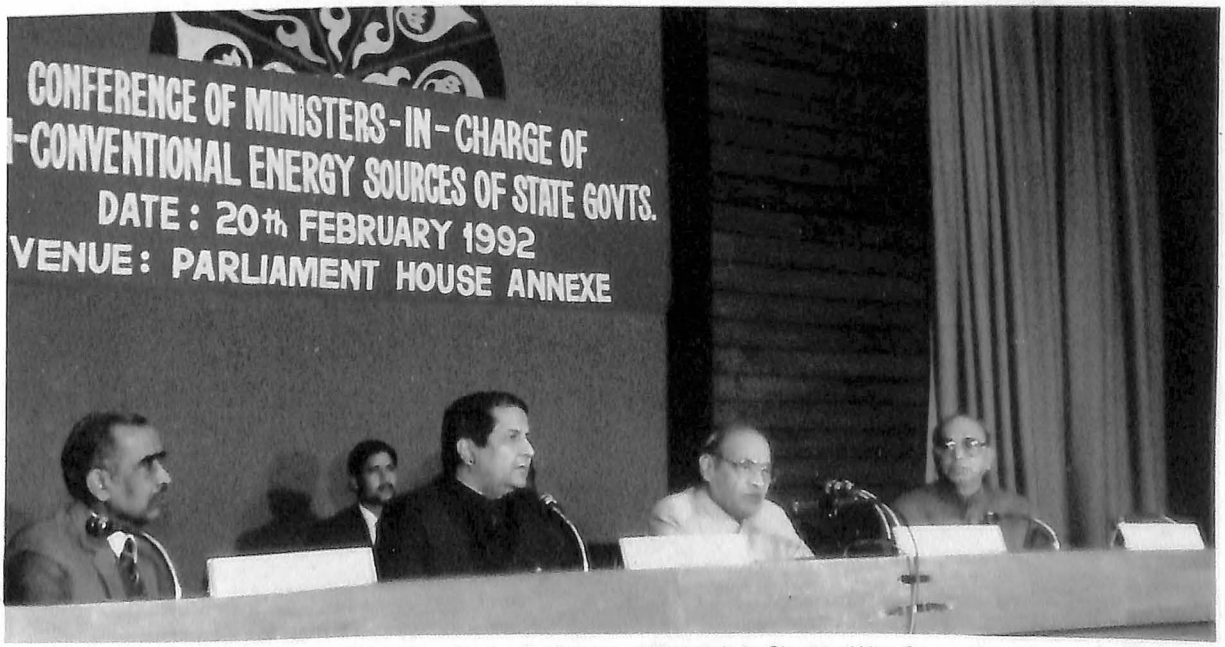
Contents

Introduction

Energy is a vital input for economic and social development. With the increasing industrial and agricultural activities in the country, the demand for energy is also rising. The use of conventional energy sources is expected to continue increasingly to meet the rising energy requirements. It is being realised that the exploitation of renewable energy sources could not only contribute but also supplement meaningfully alongwith the further development of conventional energy sources. As the new and renewable sources of energy provide clean energy and help preserve the environment and ecology and are locally available, their development and utilisation would change the complexion of the rural areas of the country and improve the quality of life. New and Renewable Sources of Energy (NRSE) can be harnessed gainfully in a decentralised way even in remote and hilly areas. NRSE projects can be carried out in a short period of time and such schemes contribute directly towards the promotion of women's welfare especially in the rural areas.

1.1 Our country has made rapid strides in the development of energy generation capacity which has gone up from nearly 1700 MW in 1950 to over 67,000 MW today, but the demand is continously going up. Similarly, while the number of villages electrified has multiplied manifold, covering almost 83% of the total villages, the vast population living in rural areas have only low levels of energy consumption which limits their access to basic amenities. Nearly 42% of India's total energy consumption requirement is met from non-commercial sources, which leads to unplanned exploitation of the forests.

1.2 The assessment of current and future power scenerio, in view of the need for faster economic growth and improvement in quality and standards of living of the people leading to higher per capita energy consumption, clearly brings out that a radical strategy is called for to tide over the impending energy crisis. In a situation of energy shortage, it is imperative that not only new sources of conventional energy are explored for sustaining the development process, but equal importance is given to non-conventional or renewable sources of energy. Such energy sources are particularly suitable for being harnessed in a decentralised manner and which can play a supplemental role in contributing to the total energy needs. They may also become cost-effective, especially in locations where the cost of consumption and distribution of conventional energy may be quite prohibitive.



The Prime Minister, Shri P.V. Narsimha Rao addressing the Conference of Minister's-In-Charge of Non-Conventional Energy Sources of the State Governments, at New Delhi.

Potential

1.3 Sun, Wind, Water and Biomass are renewable, perrennial, dependable and widely available sources of energy. One or more than one types of these energy sources are available in each and every part of the country. Generation and utilization of energy from renewable energy sources is non-polluting and environmentally benign. Potential of various types of New and Renewable Sources of Energy (NRSE) and technologies in India are given below:–

Source/Technology	Approx. Potential/Availability
Biogas Plants	40 Million
Biomass	17000 MW
Improved Chulha	120 Million
Solar Energy	5×10^{15} KW hr/year
Mini-Micro Hydro	5,000 MW
Wind Energy	20,000 MW

Utilization

1.4 Renewable energy sources and technologies are being used for the following sectors of applications:

Sl. No.	Sector	Sources/Technologies
1.	Cooking Energy	: Biogas, Improved Chulha, Solar Cookers.
2.	Power Generation	: Wind, Solar Photovoltaic, Mini-Micro Hydro, Biomass based technologies, Waste recycling, cogeneration.
3.	Process Heat	: Solar Thermal Energy Systems, Biomass Energy Systems.
4.	Alternate Fuels for Surface Transportation	: Battery Operated Vehicles, Alcohal—Diesel vehicles, Compressed Natural Gas fuelled Vehicles.

Achievement

1.5 It is a matter of great pride that during a very short period, the Department of Non-conventional Energy Sources has developed and taken technologies to literally the homes and hearths of people distributed throughout the country including remote and tribal villages. This has been achieved in a reasonably cost effective manner where the returns on investments in terms of non-polluting energy generation, energy conservation, reduction in the pressure on forests, environment improvement, reduction in drudgery for the women and improvement in health appear to have far outweighed the government allocation so far made for this sector. It is also heartening to note that investment in this sector now is being universally recognized as no less than an investment in the future viability of our Planet.

1.6 The salient achievements of the Department are depicted in the following and in Table-I.

Energy Generation/Fuel Savings

1. Biogas

(a) Wood/wood equivalent per year : 52.7 lakh tonnes/year

(b) Valued at : Rs. 263.5 crores/year

(c) Manure (NPK) Production per year : 253.3 lakh tonnes/year

(d) Valued at : Rs. 159.6 crores/year

2. Wind Power Generation (Cumulative output) : 106 million KWhr. (31.12.91)

3. **Improved Chulha**

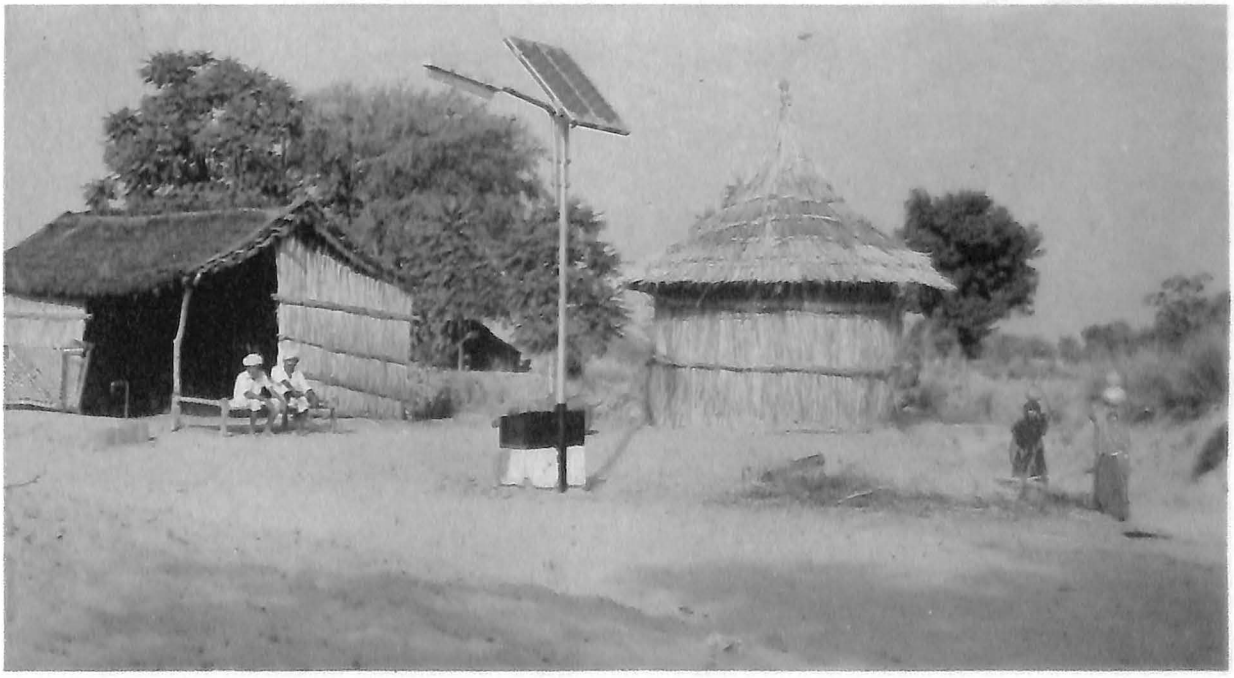
(a) Wood/wood equivalent : 79 lakh tonnes/year

(b) Valued at : Rs. 316 crores per year

4. **Soar Thermal Systems** : 128.25 million KW hr/year

Table-1 Physical Achievements at a Glance

Sl. No.	*State/Uts*	*Units*	*Cumulative Achievement upto 31.12.91*
1.	National Project on Biogas Development (family size biogas plants)	Nos. in lakh	14.90
2.	Community/Institutional Biogas Plant	Nos.	750
3.	National Programme on Improved Chulhas	Nos. in lakh	113.05
4.	Solar Thermal Energy Systems	Coll. area in sq. mts. (In '000)	190
5.	Solar Cookers	Nos. in '000	201
6.	Villages provided with Photovoltaic street lights	Nos.	8050
7.	Photovoltaic Water Pumps	Nos.	1181
8.	Photovoltaic Power Units	KWP	601.2
9.	Photovoltaic Community lights/TV and community facilities	Nos.	938
10.	Photovoltaic Domestic lighting units	Nos.	5050
11	Wind Pumps	Nos.	2756
12.	Wind Farms	MW	38.3
13.	Mini-Micro Hydro	MW	79.35
14.	Urjagram Energy Surveys	Nos.	1385
15.	Urjagram Projects	Nos.	153
16.	Biomass Energy Plantations	Hectares	17165
17.	Biomass Gasifiers	Nos.	760
18.	Biomass Stirling Engines	Nos.	100



N.R.S.E. Serves far and wide.

Biogas Programme

Biogas is an important renewable source of energy which can be produced and utilised in a decentralised manner by majority of our rural population. The indigenously developed biogas technology has withstood the test of time. It is being accepted not only in the rural areas of our country but also in other developing countries. Biogas programme can be grouped under three headings, namely promotion of family type biogas plants, setting up of large community and institutional biogas plants and research and development projects.

National Project on Biogas Development

2.1 The National Project on Biogas Development (NPBD) caters to promotion of family type biogas plants. It was started in 1981-82 and over 14.03 lakh rural families have been covered under the project during the period 1981-82 to 1990-91. The broad objectives of the project are (i) to provide energy in a clean and unpolluted form, (ii) to produce enriched manure to supplement the use of chemical fertilisers, (iii) to bring improvement in the life of rural women folk and children by relieving them from drudgery and (iv) to improve sanitation and hygiene.

Targets and Achievements

2.2 A target of setting up of 1,47,000 biogas units was fixed for 1991-92 with a Budget Estimates of Rs. 64.00 crores. The Revised Estimates is, however, only Rs. 60.80 crores. The target was allocated in accordance with the demand raised by different State Governments and implementing agencies, Khadi & Village Industries Commission (KVIC) and National Dairy Development Board (NDDB). A target of 200 biogas plants was also allocated to Department of Forests, Government of Madhya Pradesh, for setting up plants in and around forest areas with a view to reducing pressure on forests. The progress reports received from various agencies indicate that about 87,700 biogas plants have been set up during the period April-December, 1991 against the target of 73,500 plants for the corresponding period. State-wise and agency-wise achievement vis-a-vis targets are indicated in table 1. The annual target of 1.47 lakh plants is expected to be achieved and even surpassed.

New measures

2.3 Considering the escalation in the cost of construction of biogas plants, the rates of Central subsidy have been revised upward with effect from 23rd December, 1991 as indicated below:

(Amounts in Rs.)

Capacity of plant (cubic metre of gas/day)	For NE Region States excluding plains of Assam, Sikkim, J&K, HP and 8 hilly distt. of UP excluding Terai regions of 2 distts.	Plain areas of Assam, terai region of two hilly distts. of UP, Western Ghats and other notified hilly areas and A&N Islands	For other areas		
			SC/ST and desert distts.	Small and marginal farmers & landless labourers	For all others
1	4000	2400	2000	2000	1700
2	5100	3600	3100	3100	2200
3	6200	4300	3600	—	2600
4	7300	4900	3600	—	2800
6, 8 & 10	6600	4400	3000	—	2200

2.4 A new training course for turn-key workers has been developed and is being organised at various Regional Biogas Development and Training Centres. The duration of this course is 25 days. The trainees are eligible to receive a stipend of Rs. 50/- per day and to and fro travel cost upto a maximum of Rs. 250/- per trainee. Similarly, a new three-day course has been initiated for the staff of banks involved in financing of biogas plants. Further, a two-day Orientation Programme has been sanctioned to State Governments and implementing agencies, including KVIC and NDDB for training of representatives of local bodies, namely Panchayats and Zilla Parishads. An Orientation Programme for opinion makers, each of one hour duration, has also been planned.

Incentives for saving diesel

2.5 Biogas can be a reliable source of fuel for motive power. A demonstration scheme has been initiated for using biogas in dual-fuel engines with a view to replacing consumption upto 80% of diesel oil by biogas. A provision of giving Central subsidy of Rs. 5000/- has been made for setting up of bigger capacity plants, i.e. 8 to 15 cubic metres gas production per day. In addition, a further incentive of Rs. 2800/- is being given for meeting 50% of the cost of the kit to modify the normal diesel engine into dual-fuel engine and for 2 to 3 balloons for storage and transportation of gas from the site of the plant to the place of use. It is proposed to cover about 500 farmers in different parts of the country to use dual-fuel engines for various applications, such as

water pumping, Chaff cutting, small-scale industries, etc.

Family Size Biogas plant

Regional Biogas Development and Training Centres

2.6 Apart from the nine Regional Biogas Development and Training Centres already functioning at Udaipur (Rajasthan), Coimbatore (Tamilnadu), Pusa-Samastipur (Bihar), Indore (Madhya Pradesh), Ghazipur (Uttar Pradesh), Kharagpur (West Bengal), Palampur (Himachal Pradesh), Hyderabad (Andhra Pradesh) and Wardha (Maharashtra), four new Centres at Anand (Gujarat), Jorhat (Assam), Bhubaneswar (Orissa) and Bangalore (Karnataka) have also been started. These Centres are providing overall technical, training and publicity support to the State nodal departments and agencies. Some of the tribal women who received training at Kasturbagram Krishi Kshetra, Indore, have taken up construction of biogas plants as self vocation on turn-key basis in district Jhabua, Madhya Pradesh.

Sanitary latrine linked biogas plant

2.7 The provision of an additional turn-key job fee or Central subsidy of Rs. 150/- per sanitary latrine linked biogas plant was continued during the year. 3600 such plants have been constructed during the period April-December, 1991 making a cumulative total of about 93760 plants set up so far.

Field demonstrations on manure

2.8 A target of 650 field demonstrations on manure has been allocated in 1991-92 to State Governments and their agencies and KVIC. These demonstrations are being organised in farmers' fields. One-day Users' Courses are held at the site to educate farmers about the optimum utilisation of manure in conjunction with chemical fertilisers.

Training Programmes

2.9 Emphasis continues to be laid on organising practical training courses in the construction as well as repair of biogas plants for village masons and technicians and in the efficient operation and maintenance of plants for users, particularly women.

Orientation Programmes

2.10 Orientation Programmes on biogas were organised for senior functionaries at Indore, Hyderabad and Coimbatore and are planned at Jodhpur, Anand, Wardha and Tiruvananthapuram. These programmes are also attended by representatives of Reserve Bank of India, National Bank for Agriculture and Rural Development, lead banks and voluntary organisations etc. The quantum of financial assistance has been revised with effect from 23.12.1991 from Rs. 7,000/- to Rs. 10,500/- per programme of 2 days duration.

Award of prizes

2.11 The scheme for the award of cash prizes has been continued. The States and District awardees at the national level completion for 1990-91 have been provided. Besides, funds are being given to State Governments and their agencies for State level competitions for awarding prizes to the best block or panchayat samiti and District.

Biogas for smokeless Cooking.

Communication Kit for target groups

2.12 Communication kits for the target groups of beneficiaries, biogas managers and supervisors and on repair and maintenance assigned to the Indore, Kharagpur and Udaipur Regional Biogas Development and Training Centres are expected to be ready during the year 1991-92. Besides Tata Energy Research Institute, New Delhi has been assigned preparation of Training and Information Packages for national, State and District level Government officials and entrepruners. All Regional Biogas Development and Training Centres would make use of these kits for imparting trainings to the target groups concerned.

Monitoring and Evaluation

2.13 A three tier monitoring and evaluation procedure exists which comprises evaluation of the programme by the implementing agencies, by DNES's Monitoring Cells and by independent agencies.

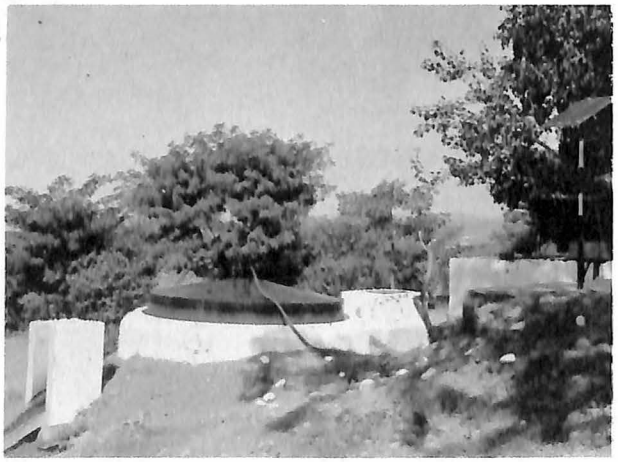
2.14 Implementing agencies have been constantly evaluating the programme in their areas of operation and have initiated remedial actions as called for.

2.15 'Biogas Monitoring Cells set up at Ahmedabad, Bhopal, Chandigarh, Delhi, Hyderabad, Jaipur, Lucknow, Nagpur and Madras are conducting technical inspections of biogas plants, identifying pockets having shortage of trained masons, assessing utilisation of turn-key jobs fee and promotional incentives, bringing out success stories for publication, determining quality of training courses organised at District and block levels and assessing the functioning of Regional Biogas Development and Training Centres. Besides Regional Offices of the DNES have also been involved in this task. During the period April-December, 1991 a total of about 18,000 biogas plants have been inspected. The details of inspected plants are sent to State Government and KVIC concerned for taking up remedial measures.

2.16 An evaluation survey study of biogas plants set up during Seventh Plan period i.e. 1985-86 to 1989-90 was assigned to the National Council of Applied Economic Research, New Delhi. It covers a sample of about 27,000 biogas plants in 21 States and Union territories. The field work has been completed and the report is expected to be finalised during the year 1991-92.

Community and Institutional Biogas Programme

2.17 Setting up of community and institutional biogas plants was initiated in 1982-83. One of the objectives of the programme is to provide benefits of biogas technology to weaker sections of society also, who otherwise cannot afford family type biogas plants. The other objectives are (i) to utilise alternative feedstocks, such as kitchen waste, poultry droppings, water hyacinth etc. for production of biogas, (ii) to optimise use of biogas for meeting not only cooking fuel demand but also motive power or electricity requirements for drinking water supply, irrigation, street lighting, etc. The programme provide financial assistance upto 90% of the capital cost of village based community biogas plants and plants set up by goshalas, pinjrapoles and charitable organisations and societies. Community biogas plants are also eligible for operation and maintenance cost for the first two years at the rate of Rs. 1,000/- per plant per month. Plants set up by Central and State Government institutions, cooperatives or Trusts tied to such bodies, are eligible to receive financial assistance upto 70% of the capital cost. The Government is also providing financial assistance upto 33.33% of the capital cost of the plants set up by private and profit making institutions.



Community Type Biogas plant in a village, Jammu and Kashmir.

Night Soil Plants

2.18 Under the programme, installation of night soil biogas plants was taken up in 1988-89. It aims at sanitary disposal of human wastes and its conversion into manure. The Government is providing 90% of the capital cost for setting up of night soil biogas plants of 15 Cu.M. gas production per day or higher capacities and 70% of the capital cost for smaller capacity plant of 6 to 10 Cubic metres gas production per day.

2.19 The programme is implemented by State Governments and their agencies, Khadi and Village

Industries Commission (KVIC) and registered voluntary societies. A total of 697 plants comprising with 344 community biogas plants 313 institutional biogas plants and 40 night soil biogas plants were completed upto the year 1990-91.

Targets and achievements

2.20 A target for completion of 120 community and institutional biogas plants has been fixed for 1991-92 with a Budget Estimate of Rs. 4.25 crores and Revised estimate of Rs. 3.96 crores. During the period April-December, 1991 a total of 53 plants comprising 18 community plants, 24 institutional plants and 11 night soil biogas plants have been completed in the States of Gujarat, Jammu and Kashmir, Maharashtra, Orissa, Punjab, Tamil Nadu and Uttar Pradesh. Ten new projects have been sanctioned to the States of Andhra Pradesh, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu and Uttar Pradesh. The annual target for completion of 120 plants is expected to be achieved.

2.21 The States of Gujarat, Maharashtra, Orissa and Punjab which have set up a large number of community biogas plants and have attempted setting up of village Renewable Energy Agency or Biogas Society in the villages concerned for managing these plants, including collection of gas charges and sale of manure to meet the cost of operation and maintenance. In some cases, voluntary agencies have also been involved in this regard. The States of Karnataka, Rajasthan, Tamil Nadu and West Bengal have however, promoted setting up of Institutional Biogas Plants at Dairy Farms, Agricultural Farms, goshalas and schools etc. These plants are managed by the institutions concerned and they are also meeting the cost on their operation and maintenance.

Special Achievements

2.22 Special Achievements made during the period April-December, 1991 include setting up of plants for scheduled caste families, leprosy centres, hospitals, boarding schools for tribal children etc. A community biogas plant has been commissioned for scheduled caste families in the Village Grant, Jammu and Kashmir. Similarly a night soil biogas plant has been completed in Malin basti, Dehradun, Uttar Pradesh. An institutional biogas plant is serving the residents of Sri Ganga Kusht Lachar Ashram, Angori Ramganganagar, Bareilly, Uttar Pradesh. Two night soil biogas plants have been commissioned one each at Aturved Rugnalaya and Chandari Trust Hospital, Akola, Maharashtra. Plants have been set up for tribal children, boarding schools at Patel Kendra, Amirgadh, District Banaskantha in Gujarat and Ashram Shala Parali and Adivasi Student Hostel Palghor District Thane in Maharashtra.

Monitoring and Evaluation

2.23 As in the case of NPBD a three tier monitoring system is proposed to be developed for community and institutional biogas plants programme. A half yearly progress report has been prescribed for each project for the State nodal Departments and implementing agencies including KVIC. The second tier is the Regional Offices of the Departments and Regional Biogas Development and Training Centres which have been assigned targets for inspection of these plants during 1991-92. Further it is proposed to assign evaluation survey studies of the plants set up so far in the country to some independent agencies.

Institutional Type Biogas plant.

Research and Development on Biogas

2.24 The thrust of research and development on biogas continues to improve the efficiency of methane production by enhancing bio-degradability of cattle dung and other feedstocks and to develop consortia of efficient micro organisms including genetic improvements. Besides greater emphasis is laid on development of low cost new designs of biogas plants particularly for processing of feedstocks like leafy biomass, crop residues, banana stem non-edible oil cakes etc. Projects are also in

progress to improve and diversify usages of biogas as well digested slurry.

Coordinated Project

2.25 Seven research institutes are working under phase I of the Coordinated Project on Microbiology and Bioprocess Engineering of Methane Production. Highlights of the work done during 1991-92 are as under:-

i) Two efficient anaerobic cellulose degraders namely *cellulomonas* and *clostridium* have been isolated from a digestor using rice straw mixed with cattle dung, at Tata Energy Research Institute (TERI), New Delhi. Purification of enzymes produced by *cellulomanas fimi* for degradation of native cellulose has also been attempted. Genetic engineering of genes responsible for cellulose degradation is in progress. TERI has also developed a mixed bacterial consortia for degrading ligno cellulosic complex present in rice straw.

ii) Two research groups at Tamil Nadu Agricultural University (TNAU), Coimbatore and Indian Agriculture Research Institute (IARI), New Delhi have developed bacterial consortia capable of degrading aliphatic acids, aromatic acids and rice straw respectively.

iii) National Dairy Research Institute (NDRI) Karnal found increase in biogas production by about 17% when cattle dunge was mixed with dairy industrial effluent in the ratio of 1:1.

iv) The work done at Annamalai University, Annamalainagar Tamil Nadu showed increase in biogas production by about 30% when sugarcane trash and *Impomea* biomass were pretreated with efficient fungal clutures and then mixed with cowdung in the ratio of 3:1.

v) Experiments conducted at TNAU showed that almost all enteric pathogens were eliminated during the process of anaerobic digestion of human waste. The work on survival of worms and viral pathogens is in progress.

vi) Maharashtra Association for Cultivation of Sciences (MACS), Pune found an increase in the production of biogas when cow dung slurry was enriched with 1.2% cellulose. Further studies on isolation of cultures resistant to low temperature and high salt concentrations are in progress.

2.26 Under phase II of the Coordinated Project, studies on development and field trials of designs based on leafy biomass have started at the Indian Institute of Sciences, Bangalore. The results obtained under phase-I at the different institutions are being used in developing field worthy plung flow digestor and solid state fermenter.

Diversified Uses of Manure

2.27 Central Institute of Fish Acquaculture, Bhubaneswar is at a final stages of developing a package of practices for using digested slurry in fish ponds. Similarly Punjab Agricultural University, Ludhiana has taken up about 10 villages having community biogas plants for demonstrating the economic use of digested slurry in the production of mushrooms. Field demonstrations on the use of wheat seeds coated with enriched digested slurry have been taken up in the District of Gorakhpur, Uttar Pradesh under the aegis of Foundation for Rural Recovery and Development (FORRAD) in District Udaipur, Rajasthan under the College of Technology and Agricultural Engineering Rajasthan Agriculture University and in the State of Tamil Nadu under Annamalai University.

Culture Collection Centre

2.28 A National Culture Collection Centre on methanogens set up at MACS, Pune has been maintaining and supplying pure cultures of five species of methane producing bacteria to other laboratories in the country for research work. An information sheet on characterisation of methanogens has been developed and circulated to many research institutions to enable them to deposit their new cultures for long term preservation at the Centre.

2.29 Two other field oriented projects taken up during the year are as follows:

i) Vivekananda Kendra, Kanyakumari, Tamil Nadu has undertaken studies on repair and revival of non-functional biogas plants to prepare a manual for wider use.

ii) A new methane producing bacteria isolated from a biogas digestor based on leave of subabul is being studied for field applications at Indian Institute of Technology, Madras.

Table-1 National Project on Biogas Development Achievement Vis-a-vis Target for 1991-92 (April-December '91)

Sl. No.	*State/Uts*	*Annual*	*Target for the period under report*	*Achievement*
1.	Andhra Pradesh	9000	4500	8519
2.	Arunachal Pradesh	10	5	8
3.	Assam	1000	500	279
4.	Bihar	4000	2000	1545
5.	Goa	200	100	101
6.	Gujarat	28000	14000	14037
7.	Haryana	2000	1000	850
8.	Himachal Pradesh	3500	1750	2161
9.	Jammu & Kashmir	150	75	—
10.	Karnataka	4000	2000	2005
11.	Kerala	2500	1250	948
12.	Madhya Pradesh	3500	1750	1753
13.	Maharashtra	25000	12500	17656
14.	Manipur	100	50	51
15.	Meghalaya	50	25	18
16.	Mizoram	100	50	63
17.	Nagaland	10	5	—
18.	Orissa	10000	5000	5120
19.	Punjab	2000	1000	1491
20.	Rajasthan	3000	1500	2112
21.	Sikkim	150	75	149
22.	Tamil Nadu	8000	4000	3929
23.	Tripura	10	5	13
24.	Uttar Pradesh	10000	5000	5976
25.	West Bengal	8000	4000	3547
26.	Andaman & Nicobar	10	5	—
27.	Chandigarh	5	3	1
28.	Dadra & Nagar Haveli	10	5	1
29.	Daman & Diu	5	3	—
30.	Delhi	20	10	7
31.	Pondicherry	70	34	6
	Sub Total (a)	124400	62200	72346
32.	KVIC	22000	11000	15275
33.	NDDB	400	200	96
34.	Forest Deptt. (M.P.)	200	100	—
	Sub Total (b)	22600	11300	15371
	Grand Total	147000	73500	87717

National Programme on Improved Chulha

Considering that Improved Chulha is the most immediate means of fuel conservation, mitigating health hazards and drudgery caused by burning of wood and collection of fuel for cooking, Government of India launched the National Programme on Improved Chulha (NPIC) in December, 1983. The programme envisages reduction in fuel wood consumption, upgradation of environment, mitigating drudgery of women working in the kitchens and employment generation. National programme is directed to cover all categories of beneficiaries in rurual, semi-urban and urban areas. Priorities and preferences are given to tribal areas, fuel scarcity areas, areas experiencing serious deforestation etc.

3.1 The programme was initially launched as a demonstration project and was subsequently converted into a National Programme w.e.f April, 1985 in view of the overwhelming response from the beneficiaries. The programme forms part of the '20 Point and Minimum Needs Programmes' of the Government. Over one crore Improved Chulhas have already been installed since inception of the programme and by March, 1992 this figure is expected to reach at 1.25 crore.

Types of Chulhas

3.2 The programme envisages installation of fixed and portable metallic chulhas. Fixed model of chulhas are being installed by trained self-employed workers. Portable models are manufactured by small scale industries. The minimum thermal efficiency for Improved chulha has been fixed at 20 and 25% for fixed and portable chulhas respectively against the thermal efficiency of 5-10% of traditional chulhas.

Approved Models

3.3 The following options are available for selection of models under the National Programme.

a) Mud fixed chulhas with or without chimney;
b) Mud-clad pottery lined, fixed chulha with or without chimney;
c) Portable metallic chulha;
d) Portable metal-clad-ceramic lined chulha;
e) Portable chulhas with separate hood chimney system

3.4 Damperless fixed chulhas and metallic portable chulhas are available with different power ratings, capability of using different fuels and cooking one or more foods simultaneously. Improved chulhas for community, commercial and industrial applications have also been developed. There are 66 nos. of approved models comprising of 35 nos. of fixed & 16 numbers of portable models of chulhas for family applications and 10 numbers of fixed and 5 numbers of portable models of chulhas for community/ commercial applications. Cost of family type fixed chulhas ranges from Rs. 50/- to Rs. 105/- and that of portable chulhas from Rs. 60/- to Rs. 165/-. Cost of community chulhas depends on its application, size and type of materials used. New models are added to the approved list after sufficient field trials, based on certification by Technical Committee.

Implementation

3.5 A multi-model and multi-agency approach has been adopted for the implementation of the programme. It is being implemented through State Governments agencies, automonous bodies, housing corporations, KVIC, NDDB and voluntary organisations, etc. A trained man-force of the Self-Employed Workers (SEWs) have been created under the National Programme. SEWs are responsible for installation and maintenance, feed-back & follow-up of the improved chulhas for a period of one year. SEWs are engaged purely on-contract basis.

Improved chulha Fixed-type for Cooking in a Tribal village

3.6 Identification, training and deployment of SEWs in almost each and every block has been ensured. SEWs are responsible for construction and maintenance of maximum number of 400 chulhas and paid a contract amount of Rs. 10 per chulha. However, for hilly, far-flung, remote areas the maximum limit of chulhas is fixed at 300 with contract amount of Rs. 15. In addition SEWs also get Rs. 10 from the beneficiaries directly as supervision fee. In addition, a SEW receives Rs. 5 per chulha as service charges for sale of portable chulha. Supervisory fee of Rs. 30/- is payable to SEW by beneficiary for construction of community chulha. The services of SEWs are also utilised for repair & maintenance of already installed chulhas. Their work is being supervised by implementing agencies.

Improved chulha serving a semi-urban household.

Training

3.7 The Self-Employed-Workers (SEWs) engaged in the installation of improved chulhas are trained through the Technical backup units attached with the National Programme on Improved Chulha. Refresher Training courses are organised for the SEWs already engaged in the installation of chulhas, in order to up-date their knowledge regarding the latest developments in the chulha technology. Fresh SEWs are given detailed training through separate training courses. Field functionaries of the nodal departments are also trained during these training progrmames. The management exposure training programmes are organised for the officers and field functionaries of the nodal/implementing agencies for proper and effective implementation.

Users' Education

3.8 Radio jingles in the regional languages have been devised and are played from the commercial service of AIR to popularise and educate the masses regarding the Improved Chulha. Posters, brochures and booklets in the regional languages are also brought out for the beneficiaries of the improved chulhas. Users' training programmes are also organised for the beneficiaries.

Financial Support

3.9 For the fixed model chulhas the beneficiary has to contribute Rs. 15 for the installation of chulha (Rs. 5/- towards the material cost and Rs. 10/- towards supervision charges for SEW). Balance of the cost is borne by the Government. The beneficiaries are also required to provide local material, like, clay, straw, labour etc., for the chulhas. For the portable chulhas 50% of the cost of the chulha is borne by the Government for the general categories of beneficiaries and for SC/ST/hilly area beneficiaries, Government assistance is 75% of the cost of the chulhas. For the commercial/community chulha a token subsidy of Rs. 100/- and Rs. 50/- is provided by the Government for portable and fixed chulhas respectively. Financial provision for creating organisational & infrastructure support, transport & handling, training of SEWs, functionaries engaged in implementation of progrmme and repair & maintenance of old chulhas have also been made under the programme.

R&D and Technical Support

3.10 As a result of intensive R&D efforts in the past eight years, improved chulha technology in the country has passed through various stages of transformation from chulhas with the dampers to damperless chulhas, mud chulhas to pottery lined chulhas, mild steel to cast iron portable chulhas and mud-clad-ceramic to metal-clad-ceramic chulhas with and without insulation. The thermal efficiency of some of the models has reached about 40 per cent. Twenty-one technical backup units have been set up under the National Programme and are working in the field to promote R&D in the chulha technology, and to cater to the specific technical and local requirements.

Standardisation of Design and 'ISI' Standardisation

3.11 Intensive field experience and R&D efforts on the part of DNES officers and the Technical Backup Units have enabled the Department to standardise

material specifications and dimensions of metallic chulhas and pottery/ceramic liners for the mud-clad and metal-clad chulhas. Department has continued its efforts for quality control in portable models of chulha.

BIS is coordination with the Department of Non-Conventional Energy Sources have finalised 'ISI' standard No. IS 13152 (Part 1): 1991 for 'Solid Bio-mass chulha' (Portable-metallic chulhas). It is expected that 'ISI' marked portable metallic chulhas will be shortly available to the beneficiaries.

Targets & Achievements

3.12 Targets and achievements of Improved Chulha Programme since inception are given below:-

Period/year	*Targets*	*Achievements No. (in lakhs)*
VIth Plan		
Dec. 1983 to March 1985	5.00 (Demonstration period)	8.12
VIIth Plan		
1985-86	10.00	11.22
1986-87	6.50	9.05
1987-88	12.00	15.18
1988-89	15.00	18.33
1989-90	18.00	21.99
Annual Plans		
1990-91	16.72	19.88
1991-92	19.27	19.27 (expected)

Improved chulha brings household happiness.

Feed Back & Monitoring

3.13 A four-tier arrangement has been made for monitoring & review of the programme. Feed-back inspections are carried out by implementing agencies, Technical backup units, independent agencies, and the DNES through headquarters, its regional offices and monitoring cells. The programme is reviewed at national/regional and state level by the Department. Division and District level meetings are also organised by various implementing agencies.

3.14 According to the feed-back and monitoring conducted by various agencies, functionality of improved chulha programme varies from area to area, average being 70%. To improve the functionality, the following steps have been taken by the Department.

a) Association of beneficiaries in selection of models:
b) Introduction of incentive schemes for various levels of field functionaries and users;
c) More thrust on users' education;
d) More financial participation from users;
e) Modifications of the designs appropriate to users' local needs;

Incentive Schemes

3.15 Improvement in the functionality of Improved Chulhas and quality implementation has been the major thrust of NPIC during 1991-92. The model scheme for promotional incentives for all level of field functionaries was introducted to generate healthy competition amongst them, and to motivate them to achieve desired objectives. Under the scheme, Certificates of Appreciation and cash awards have been proposed for different level of field functionaries users, Technical backup units etc.

Fuel Saving

3.16 Studies made by the TBUs show that an Improved Chulha, if used properly, can save as much as 1000 kgs. of wood per year. However, considering variables like, less than optimum use of chulhas, different types of fuels used, sensitivity to fuel saving by the users etc., it can be assumed that the actual saving per Improved Chulha would be around 700 kg. of wood/wood equivalent per year.

Employment Generation

3.17 A large number of SEWs engaged in the installation and maintenance of Improved Chulhas

Improved chulha Portable type provides Convenient Cooking and gainful employment.

have found useful employment. This aspect is proving helpful in checking migration of the rural young enterpreneurs from rural areas to urban areas. A large number of Technical and Non-technical personnel are also employed by the manufacturers of Improved Chulhas, technical backup units and implementing agencies.

Projections for 1992-93

3.18 It is proposed to step-up the Programme during 1992-93 with the installation of 25 lakh chulhas. It is also proposed to make efforts to make the programme self-sustainable. In this connection, mass awareness through various means is proposed to be undertaken on war footing. A massive campaign for publicity and awareness is proposed to be undertaken through T.V./Radio both at central as well as state level. The subsidies are proposed to be limited during 1992-93 and gradually planned to be reduced during the subsequent years.

3.19 State-wise achievements of Improved Chulha Programme during 1991-92 (upto Dec., 91) vis-a-vis annual targets is given below:-

National Programme on Improved Chulha Targets and Achievements for 1991-92

Sl. No	*State/UT*	*Annual Target 1991-92*	*Target upto December, 1991*	*Achievement upto December, 1991*
1.	Andhra Pradesh	1,20,000	57,600	84,545
2	Arunachal Pradesh	2,000	960	2,332
3.	Assam	55,000	26,400	18,141
	A. R.D.D.	50,000	24,000	18,141
	B. Assam Agro	5,000	2,400	Nil
4.	Bihar	1,20,000	57,600	56,978
5.	Gujarat	1,00,000	48,000	26,524
	A. R.D.D.	30,000	14,400	13,080
	B. G.E.D.A.	60,000	28,800	13,444
	C. Gujarat Agro	10,000	4,800	Nil
6.	Goa	10,000	4,800	7,295
7.	Haryana	60,000	28,800	6,703
8.	Himachal Pradesh	40,000	19,200	17,257
	A. R.D.D.	20,000	9,600	9,915
	B. Himurja	10,000	4,800	4,758
	C. H.P. Agro	10,000	4,800	2,584
9.	Jammu & Kashmir	40,000	19,200	10,661
10.	Karnataka	1,00,000	48,000	44,597
11.	Kerala	50,000	24,000	30,978
12.	Madhya Pradesh	1,60,000	76,800	31,029
13.	Maharashtra	1,40,000	67,200	78,139
	A. R.D.D.	1,30,000	62,400	71,099
	B. M.E.D.A.	10,000	4,800	7,040

14.	Manipur		6,000		2,880	4,662
15.	Meghalaya		5,000		2,400	—
16.	Mizoram		2,500		1,200	1,800
17.	Nagaland		3,000		1,440	—
18.	Orissa		60,000		28,800	29,080
19.	Punjab		85,000		40,800	31,544
	A. R.D.D.	80,000		38,400	28,750	
	B. P.E.D.A.	5,000		2,400	2,794	
20.	Rajasthan		1,45,000		69,600	70,402
21.	Sikkim		5,000		2,400	2,545
22.	Tamil Nadu		1,10,000		52,800	80,239
	A. R.D.D.	1,00,000		48,000	71,964	
	B. T.E.D.A.	10,000		4,800	8,275	
23.	Tripura		2,000		960	787
24.	Uttar Pradesh		3,00,000		1,44,000	1,61,113
	A. R.D.D.	2,10,000		1,00,800	1,10,431	
	B. N.E.D.A.	50,000		24,000	25,682	
	C. U.P. Agro	40,000		19,200	25,000	
25.	West Bengal		55,000		26,400	26,700
26.	Andaman & Nicobar		5,000		2,400	3,006
27.	Chandigarh		500		240	678
28.	Dadra & Nagar Haveli		1,000		480	586
29.	Daman & Diu		500		240	—
30.	Delhi		25,000		12,000	14,725
31.	Lakshadweep		200		96	86
32.	Pondicherry		2,000		960	1,350
33.	KVIC		50,000		24,000	28,215
34.	NDDB		15,000		7,200	3,158
35.	AIWC		10,000		4,800	9,491
36.	Others		42,300		20,304	42,781
	Total		19,27,000		9,24,960	9,28,127

Cooking through Portable Chulha is relaxing and enjoying too.

Solar Thermal Energy

Solar Thermal Energy Programme has the main objective of meeting the heat energy requirements for varying range of temperatures. To attain this objective, following steps are being persued:

i) Research & Development
ii) Demonstration
iii) Extension

4.1 The Department in addition to utilising facilities at its Solar Energy Centre, is also sponsoring projects to various R&D institutions and IITs in the country. The new technologies, processes and materials are being developed there. The field testing of the new technologies/products is undertaken through Demonstration Programme and eventual large scale utilisation is under extension programme. The programme also focuses attention on utilisation of solar energy route. The details of the activities undertaken during the year are in the following:-

Research, Development and Demonstration

4.2 Low grade solar thermal technologies for water heating, air heating, desalination, timber seasoning, drying, cooking etc. have been commercialized as a result of indigenous research and development efforts. In order to make these technologies more efficient and cost effective, further efforts to develop new durable materials and improved designs based on field feedback are being attempted as the first priority. Simultaneously, equipments and systems designs are being developed for utilising thermal energy for applications like refrigeration, water pumping, process heat, energy efficient buildings, power generation etc.

Solar Refrigeration

4.3 For storing life saving drugs and vaccines in remote/unelectrified areas, R&D projects are being sponsored at IBP Co. Ltd., Bombay, Sardar Patel Renewable Energy Research Institute, Vallabh Vidhyanagar (Spreri) and IIT, Madras for development of a solar thermal energy based refrigerators. These organisations are working on calcium chloride ammonia-fareon, activated charcoal-methyl alchol, zeolite-water and lithium bromide-water based systems. Spreri has developed a prototype solar absorption refrigerator in collaboration with Solar Energy Centre for producing one kg. of ice per day using zeolite water systems. The refrigerator is being monitored. Efforts would be made to develop solar refrigerator with 10 kg. ice per day capacity.

Solar Thermal Pump

4.4 Under an Indo-German project, BHEL, Rudrapur has successfully developed solar thermal pump of 1 kw (hydraulic) output capable of pumping upto 60 m^3 of water from a depth of 40-60 m on a clear sunny day. Two such pumps based on evacuated tabular collectors and reciprocating prime mover are being installed at Solar Energy Centre, Gwalpahari for performance monitoring/field trial. One pump has been manufactured in Germany and other has been manufactured in India by BHEL on the technology transfer from Germany. Subsequently based on their performance and economic viability these pumps could be installed at places having low ground water table.

Solar Pond

4.5 Solar pond is emerging as a competitor to flat plate collector to meet large amount of process heat/hot water requirement in areas where availability of cheap land is not a constraint. Research and Development efforts are being made to study the parameters and materials required for the construction of solar ponds in the country. A project for investigating 'Dynamics of Solar Pond' has been completed at IISC, Bangalore. These experiences would benefit in promoting solar pond technology on large scale.

Energy Efficient Buildings

4.6 In a vast country like India, which has been categorised to have six climatic zones like cold and dry, cold and cloudy, hot and dry, hot and humid, composite and moderate calls for different designs of buildings supplemented with commercial energy input for keeping living/working space comfortable. The requirement of additional energy input for creating comfort conditions in the buildings could be reduced by incorporating passive features in the buildings. Efforts have been made to develop thumb rules for architects/buildings designers for constructing energy efficient buildings for all six climatic zones. Efforts are also being made through a survey sponsored at NPC, New Delhi to assess the energy consumption pattern in domestic/industrial buildings in rural/urban areas to look into the feasibility of using

renewable energy based devices for replacing/ supplementing commercial energy based appliances. The R&D efforts made so far in designing and constructing energy efficient buildings have already been put to practice for constructing 'Solarised huts' in hilly and cold areas of Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh. Department has also launched a cost sharing scheme for the construction of solar passive buildings in government sector.

4.7 The concept of thermal conditioning of space based on both active solar thermal systems and passive features for providing thermoneutral environment to new born babies to improve neo-natal survival is being investigated thoroughly by JJ Hospital and Grant Medical College, Bombay. In such a thermally conditioned space more than a baby could be kept in a specially designed tray in comparison to costly incubators which can house only one baby at a time.

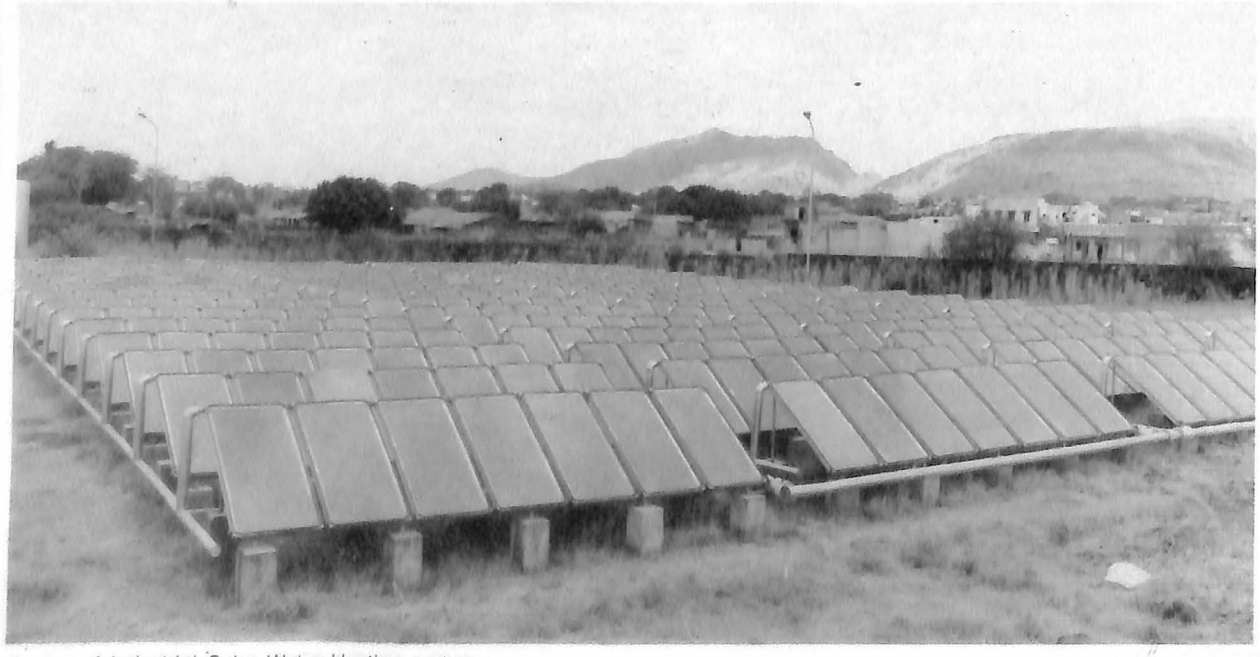
4.8 The department has provided 200 solar huts to the ITBP forces in high altitude border areas. The monitoring of these huts has shown that the requirement of bukharies to keep the hut warm in solar hut is reduced from 5 to 2 per day. These huts are now quite popular among the military/paramilitary forces. A cost sharing scheme has been initiated to enlarge the programme on solar huts.

Domestic Solar Water Heating System.

4.9 The Department has established through demonstration of solar green houses that vegetables would be grown during off season in the desert areas like Leh and Kargil. Seven green houses constructed in Leh and Kargil are now being used by the forces and civilians for growing fresh vegetables. The technology is now being taken to different climatic zones on cost sharing basis.

Power Generation

4.10 Electricity could be generated from solar energy through solar thermal route. Two experimental plants of 20 Kwe and 50 Kwe have been successfully



A view of Industrial Solar Water Heating system.

installed in the country at Salojipally near Hyderabad and solar energy centre, Gwal Pahari, respectively. A proposal for setting up of a 30 mw solar thermal power plants is under appraisal for its techno-economic viability.

New Materials/Processes

4.11 EPDM, PVDF and Other Polymer based new materials have been developed for application in solar thermal devices and are being tested for their suitability under Indian conditions without appreciable deterioration in their optical and mechanical properties at Shriram Institute for Industrial Research, New Delhi and IIT, New Delhi. A pilot plant facility is being created at Solar Energy Centre in association with IIT, Delhi for coating the collector receiver tubes of parabolic through collectors with black cobalt selective coating using spray pyrolysis method.

Extension Programme

4.12 After the successful demonstration of indigenously developed low grade solar thermal technologies in early Eighties a cost sharing scheme for the utilisation of solar cookers, solar water heaters, solar crop dryers, air heaters, wood seasoning kilns and solar desalination systems was started in 1984 in order to encourage the users to make use of these new systems. In the initial years the share of the Government was large which was reduced during the successive years. The percentage of Government share during financial year 1991-92 is shown in Table I.

Targets and Achievements

4.13 Out of all these systems, solar water heating systems have become most popular both in the domestic and industrial/commercial sectors. These systems are in demand in process industries, dairies, canteens, hospital, hotels etc. either for hot water supply or for preheating the boiler feed water. A large scale utilization of solar assisted water heating system is intended for the Eighth Plan period.

4.14 Standard specifications have been laid down for each sub-component of solar water heating systems. These specifications are updated on the input from the R&D and field feed back reports. Based on this information, Bureau of Indian Standards has brought Indian Standards on collector testing and collector materials etc. Efforts are now being made to encourage the manufacturers to go in for ISI mark for their collectors and domestic solar water heaters. The technical information along with the guidelines for systems design are being issued by the department to each manufacturer and nodal agency from time to time. Efforts have also been initiated for integration of solar water heating systems with the architecture of the buildings. Such an integrated system may find wide acceptability among the architects in the urban areas.

4.15 Under the programme, 4300 industrial/commercial and 7200 Domestic Solar Water heater systems, 52 Solar Air Heaters Cropt Dryers, 50 Solar Timber Kilns and 9100 Solar Stills have been installed in the country from the time of the initiation of the programme till December, 1991. A collector area of 1.90 lakh m^2 installed for these applications is capable of generating about 130 million KW hour of thermal energy per annum. During April-December 1991, the number of Solar Cooker sold was 18,318, Domestic Solar Water Heaters 966, Industrial/Commercial Solar Water Heaters 355, Solar Stills 357 and the solar collector area mistalled was 33000 m^2.

Solar Cooker prepares delicious dishes.

Solar Cooker Programme

4.16 An investment sharing scheme for the purchase of box type solar cooker was launched in 1982. Under this scheme, the DNES share is $33^1/_3$% or Rs. 150 whichever is less, of the cost of the cooker. Standard specifications have been laid down for the cooker which are made available to the manufacturers. Over 2.0 lakh solar cookers have been sold in the country from the date of inception of this scheme. A target for sale of 40,000 solar cookers has been set for the current financial year which may be exceeded as per past experience.

4.17 Community Solar Cookers for cooking meals for group of people, after successful demonstration in tribal hostels, mid-day meal schemes etc. have also been made available to the users under the cost sharing scheme with a Government share of $33^1/_3$% or Rs. 1050/- whichever is less.

4.18 Box type solar cooker currently available in the country can be used for boiling, baking and roasting type of cooking; it can not be used for frying operations and for making Indian chapaties. Efforts have been initiated for development of new solar cooker designs for this purpose. The solar steam cooker developed by IBP, Bombay and the concentrating cooker developed by Maharashtra Gandhi Smarak Nidhi, Pune under the sponsored R&D scheme of the Department, are currently being tested in field conditions to get the feed back data on these technologies.

Table I

Cost sharing scheme for installation of Low Grade Solar Thermal Systems and Devices

Sl. No.	*Category of Users*	*% of Govt. sharing 1991-92*
1.	Private Sector	30%
2.	Govt. Public Sector Enterprises	30%
3.	State Govt. Buildings, Cooperative Societies, Central Govt. Buildings, Govt. Institutions, IITs, Universities, Schools, Anganwadies, Charitable and religious bodies.	40%
4.	Domestic Solar Water Heaters*	50%
5.	Solar Cookers**	$33^1/_3$%
6.	Community Solar Cookers***	$33^1/_3$%

* Subject to a maximum of Rs. 3000/- per system.
** Subject to a maximum of Rs. 150/- per Solar Cooker
*** Subject to a maximum of Rs. 1050/- per Community Solar Cooker.

Solar Energy Centre

Solar Energy Centre established at village Gwalpahari district Gurgaon, in Haryana, continued its activities in the areas of research, pilot plant studies, testing & standardisation and development of technical manpower for the promotion of solar thermal energy based systems. The focus during the year has been on activities for low and medium temperature heat applications, testing & standardisation, power generation and technology transfer, keeping in view the requirements of making solar energy technologies adaptable for widespread utilisation.

Low and Medium Temperature Heat Applications

5.1 The objective of activities in this area has been to make the available devices more efficient, reliable and cost effective, as well as, to develop new devices capable of meeting a diverse range of applications in industry and other sectors. Solar Energy Centre through its regular activities of testing & standardisation, product development and field demonstration continued to provide technical support for the implementation of solar thermal programme of the Department.

5.2 Recognising the pressing need for clean drinking water in vast portions of the country, development of solar thermal energy based distillation systems has been accorded due priority. While further optimization and development activities continued on the multi-stage distillation system taken up during last year, a new prototype involving the concept of regenerative heat recovery was built and tested in this year. The initial test results of both these systems have been found to be encouraging and the systems are believed to provide higher quantity and better quality of output. Once brought to levels of commercialisation, these systems are expected to find widespread use for supply of potable water.

5.3 Systems capable of delivering medium temperature heat can find large applications in domestic sector for cooking and in industry for process heat. Work on paraboloid concentrators using different reflective surfaces was continued and experimental systems were fabricated. It has been realised that during fabrication of such concentrators importance has to be given to: selection of adhesives and sealents, proper edge preparation of the reflective facets, proper contour development and proper design of the absorber etc. Accordingly, studies to identify suitable adhesives, sealents, reflective surfaces and absorber materials have been undertaken. Studies on linear solar concentrators with various absorber configurations also continued. Use of heat pumps to boost low temperature heat to medium temperatures is now being favoured internationally. The hybrid systems promise better cost effectiveness and reliability as compared to solar alone systems. Initial studies in this area have been carried out at the Centre and a developmental programme is expected to be taken up.

Testing & Standardisation

5.4 Infrastructural facilities for testing of solar collectors, water heating systems and solar cookers have been improved upon. During the year, the Centre continued to provide testing services for the above devices to the manufacturers. The procedure for certification of solar cookers under the subsidy scheme of the government has been simplified.

5.5 Keeping in view the technology upgradation, specifications of box-type solar cookers have been revised and circulated by the Department. On the basis of documents prepared by the Centre, the Bureau of Indian Standards (BIS) have formulated and published the following Indian standards in the area of solar thermal energy:

i) IS 12934: 1990	Solar energy thermal applications Vocabulary
ii) IS 12976: 1990	Code of practice for water heating system
iii) IS 12933 (Part 1): 1990	Solar flat plate collectors: Part 1 General Requirements
iv) IS 12933 (Part 2): 1990	Part 2 Components
v) IS 12933 (Part 3): 1990	Part 3 Measuring instruments
vi) IS 12933 (Part 4): 1990	Part 4 Performance requirements and accepted criteria
vii) IS 12933 (Part 5): 1990	Part 5 Test methods
viii) IS 13129 (Part 1): 1991	Solar heating– Domestic water heating system Part 1 Determination of thermal performance using indoor test methods

ix) IS 13129 (Part 2): 1991	Part 2 Procedure for systems performance characterization and yearly performance prediction
x) IS 13129 (Part 3): 1991	Part 3 Procedure for system component characterization and prediction for yearly performance using component data performance
xi) IS 13129 (Part 4): 1991	Part 4 Test methods to determine durability, reliability and functional requirements

5.6 Draft standards for other solar thermal devices are being prepared by the Centre and would be submitted to the Bureau of Indian Standards for their adoption. Availability of Indian standards is expected to improve the quality of solar thermal devices in the country. A meeting of manufacturers, BIS and the Government Officials was also convened to discuss the implementation of these standards.

Solar Timber kiln for quality wood seasoning.

Power Generation

5.7 Operation of the experimental 50 KW Solar thermal power generation system installed at the Centre was continued to generate experience and feedback data. Developmental and indigenization efforts specially in the areas of electronic components and the receiver tube are bearing results. This plant also continues to be an attraction for scientists working in this area and many national & international visitors were received during the year.

5.8 Theoretical studies on sub-systems of solar thermal power generation systems using line focussing collector technology have also been taken up at the Centre with a view to optimize the plant configuration for Indian conditions. These studies relate to selection of back up capacities, co-generation possibilities, effects fo dust, etc.

Solar Passive Architecture

5.9 The Centre continued to provide technical assistance to architects, prospective institutional builders and scientists working in this area. A special emphasis has been laid on development and promotion of architectural designs suitable for high altitude regions of the country.

International Cooperation

5.10 The UNDP—Solar Energy Centre Project has been extended for this financial year also. A number of international experts in the areas of power generation, heat pumps, testing and standardization, technology transfer and day lighting, visited SEC with UNDP sponsorship under this programme. Discussions by the officers of the Department were organized with these experts. Many of the programmes discussed above have become more definitive and the discussions have helped in bringing the work in conformity with international trends. Specifically, the experts have contributed in preparation of base documents in the areas of testing & standardisation, heat pumps, technology transfer and power generation. A number of short duration workshops and lectures were also organized by the Centre with these experts, at academic and research institutions, government agencies, state nodal agencies, etc. The idea behind such lectures/workshops has been to provide international exposure to a large number of people actively engaged in solar and allied activities.

5.11 A Five-day Workshop on technology transfer has been arranged with co-sponsorship of UNDP. The Workshop was attended by number of manufacturers, state nodal agencies, engineers and scientists from various other organisations. A highlight of the workshop was active participation of three experts from Australia in the area of technology transfer. Besides indepth discussions on process of technology transfer, an outcome of this workshop has been prepara-

tion of drafts of information dissemination material in various areas of solar thermal energy.

5.12 A Two Weeks training programme for five Afghan nationals visiting under UNDP fellowship was organised by the Centre in the field of new and renewable sources of energy.

5.13 The document prepared by the Centre on Solar thermal area for the G-15 Group was taken up for discussion in the Experts Group Meeting held in New Delhi and was adopted for presentation to the G-15 Group Head Summit.

Publications and Documentation

5.14 A number of scientific papers prepared by the officials of the Centre were presented and published by the various national/international proceedings and journals during the year. Library set up at the Centre continued to be enriched by number of specialised publications.

Testing of Solar Water Heating systems at Gwalpahari.

Solar Photovoltaics

Solar photovoltaic (SPV) technology is a convenient way of generating electricity directly from sunlight in an environmentally clean and reliable manner. Efforts made in the country during the last two Plan periods have resulted in the establishment of a strong research base and indigenous production capabilities covering the entire range from high purity silicon to solar cells, modules and systems. Photovoltaic systems are not only being used for small loads such as lighting, water pumping and telecommunications, but also as village size power plants in rural areas. These systems are particularly useful and cost-effective in unelectrified areas that are far away from the electrical grid and can bring the benefits of electricity even to the remotest locations. The programme being implemented by the department aims at achieving further progress in technology, improving its cost-effectiveness, and promoting the wider use of this technology.

Research & Development

6.1 The R&D efforts supported by DNES aim at improving the efficiency of solar cells, development of newer materials, reducing the cost of production of solar cells and modules and improving the performance and reliability of systems. About 20 research projects were supported during the year.

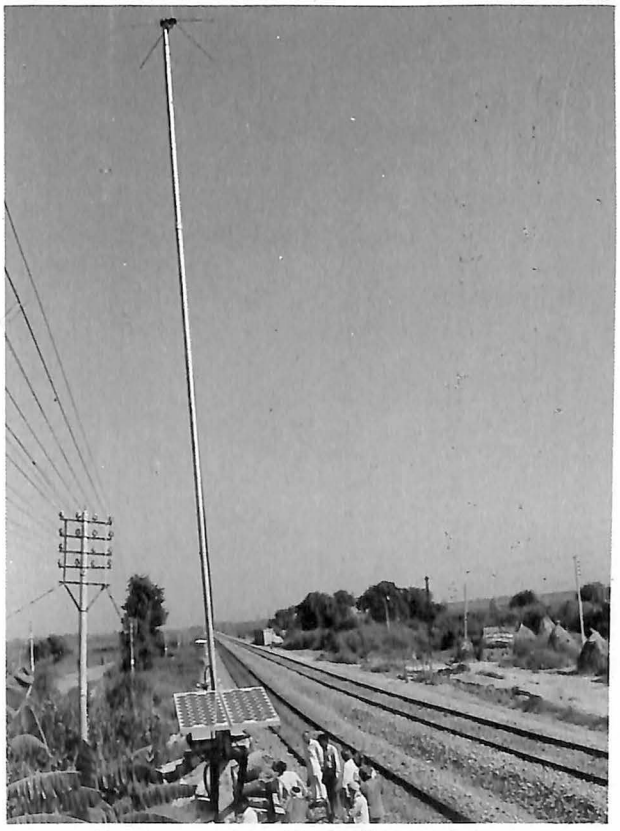
6.2 An R&D project, with the objective of reducing the cost of producing silicon material through reduction in energy consumption and recycling of process materials, is progressing at Metkem Silicon Limited, Mettur. An energy efficient 10 tonne reactor for the production of polysilicon was designed, installed and commissioned last year. Three hydrochlorination reactors were also added and integrated with the production process. Encouraging results have been obtained on the energy consumption per unit of polysilicon produced. Further data on energy and materials consumed is being compiled and analysed.

6.3 A technology upgradation project sponsored by the Department to improve efficiencies of crystalline silicon solar cells is also in progress at BHEL, Bangalore. Another project aimed at fabricating high efficiency solar cells has been taken up at the National Physical Laboratory. The development of thin film solar cells has been receiving increasing attention in view of their potential for achieving low cost photovoltaics. The areas being pursued are amorphous silicon solar cells and polycrystalline thin film solar cells using newer materials such as copper indium diselenide and cadmium telluride.

6.4 The department took up the implementation of a science & technology project for the development of amorphous silicon solar cell technology in a mission mode during the Seventh Plan. The project has three main components: (a) strengthening R&D efforts, (b) establishment of a pilot plant for amorphous silicon solar cells and (c) development of systems compatible with amorphous silicon modules. The project has resulted in the creation of a strong research capability in this field with a lead centre being established at the Indian Association for the Cultivation of Science, Calcutta. The problems being studied by the research groups include fabrication of amorphous silicon solar cells with different structures, development of a plasma CVD system, stability issues, material development, etc. Efficiencies of over 12% have been achieved on 1 cm × 1 cm single junction solar cells. Silane gas which is an important raw material for amorphous silicon solar cells, was successfully produced in an experimental pilot plant. This plant is being developed into a facility with a capacity for the production of 300 kg of silane gas per year, sufficient to meet the requirement of the amorphous silicon pilot plant.

6.5 The establishment of a pilot plant for the production of amorphous silicon solar cells and modules by BHEL on behalf of the Department has been com-

A 5 kW SPV power plant installed in Andaman & Nicobar Islands.



Warning Signal powered by SPV for Northern Railway.

pleted. During the year, many pre-commissioning trial runs were made at the plant and over 2000 modules made with different process parameters. An aperture-area efficiency of 6.1% has been achieved on 30 cm × 30 cm modules and efficiences exceeding 7% were achieved on individual cells in the modules. The transparent conducting oxide (TCO) furnace which is a part of the pilot plant has been commissioned and is functioning satisfactorily. All support facilities such as airconditioning, deionised water supply, compressed air, standby power supply, etc. are fully operational.

6.6 The performance of the modules made at the pilot plant and their stability under outdoor conditions are being studied. A few systems for applications such as lighting and TV have been designed and fabricated using amorphous silicon modules and are being tested.

6.7 The development of PV systems and the study of their field performance is an important activity in the R&D programme. The Department has funded projects for the design and testing of solar lanterns at Jadavpur University, small lighting systems at the Indian Institute of Technology, Delhi and water pumping systems at Central Electronics Limited, Sahibabad. A study of the performance of solar lanterns is being undertaken through the Administrative Staff College of India, Hyderabad and that of small power plants through the Tata Energy Research Institute. The Department is also setting up a solar photovoltaic test facility with assistance from the United States Agency for International Development.

Demonstration and Utilisation

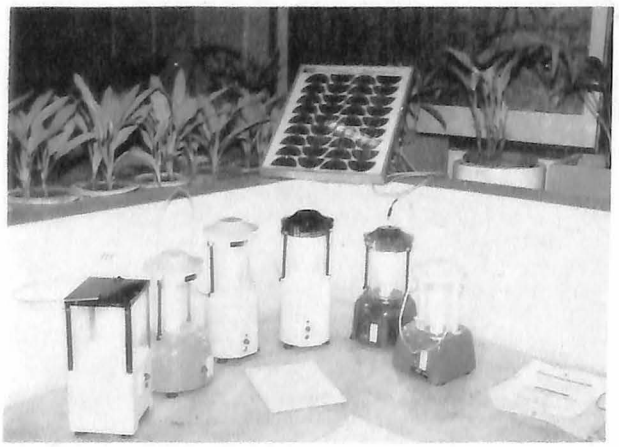
6.8 The Department is implementing a countrywide programme for the demonstration and utilisation of solar photovoltaic systems with emphasis on applications for rural areas. This includes stand-alone street lighting systems, domestic lighting units, portable solar lanterns, community television sets and water pumping systems. Small decentralised photovoltaic power plants with array sizes ranging from 2 to 10 kWp are also being installed in increasing numbers for meeting the electrical energy requirements of hitherto unelectrified villages. In all, about 40,000 Photovoltaic systems have been installed in various parts of the country. Small PV power plants have been installed in 50 villages. The demonstration programmes has helped carry out improvements in the systems based on the experience generated in the field. The response from various states participating in the programme has been very encouraging and there is considerable demand for new products such as solar lanterns. The targets and physical achievements for the demonstration programme for 1991-92 are as follows:

S. No.	Name of SPV system	Target for 1991-92	Achievement upto December 31, 1991
1.	Street lighting systems	2000	550
2.	Water pumping systems	50	10
3.	Domestic lighting systems (portable and fixed type)	3000	2000
4.	SPV power plants and other applications	100 kWp	62.5 kWp

6.9 The largest programmes for the establishment of small PV power plants have been undertaken in Andaman & Nicobar islands and in U.P. Two power plants of 5 Kw each were commissioned at Potatang

and Middlestrait in Andaman & Nicobar islands in January, 1992, while 17 more are under construction in different islands. Among other power plants completed during the year are systems at Akkaryangam, in Arunachal Pradesh, 4 plants in U.P., 1 plant of 2.5 Kw at Maullien in Meghalaya, and 4 power plants of 1 Kw each in Ukhrul District of Manipur. A 15 Kw power plant at Suheli, 2 plants of 10 Kw each at Tinnakara and Bangaram have been taken up at Lakshadweep. The 5 Kw SPV power plant at Bitra island of Lakshadweep is being augmented to 30 kw capacity.

6.10 A notable development during the year has been the decision of the Department of Telecommunications to procure about 25,000 solar PV systems for powering rural radio communiction systems. This action not only opened up a large market for the Indian photovoltaic industry, but also established the technical and economic viability of PV systems of low load and high reliability applications. The use of PV systems by organisations such as Railways and Border Security Force, also increased during the year.



A range of SPV powered Solar-Lanterns.

6.11 To provide guidance to various states and other users in the design and selection of photovoltaic systems and components, the Department published a 3-volume compilation of guidelines and specifications.

Industrial Activity

6.12 The Department functions as the administrative ministry for matters relating to industrial licences, foreign collaboration, imports and exports, etc. in the area of solar photovoltaics. There are about 25 companies which have obtained licences or registrations for production of solar cells, modules or systems. The bulk of the module production, totalling over 1 MW per year, is at present from 3 public sector organisations, namely Central Electronics Ltd., Bharat Heavy Electricals Ltd., and Rajasthan Electronics and Instruments Ltd.

6.13 Industrial production during 1991-92 received a big thrust due to expansion of the market for commercial applications such as telecommunications. This is expected to lead to substantial increase in production volumes and turnover in the industry in the coming years. Among the policy changes announced by Government during the year were the shifting of photovoltaic cells, modules and systems from the restricted list to the limited permissible category under the import policy. The requirement of industrial licencing has also been removed.

Other matters

6.14 The Sixth International Photovoltaic Science & Engineering Conference (PVSEC-6) was held at New Delhi from 10 to 14 February, 1992. This is one of the three major series of international conferences in the area of solar photovoltaics. The conference was sponsored by the Department of Non-Conventional Energy Sources, the National Physical Laboratory and the Solar Energy Society of India. The conference was attended by about 350 scientists, engineers, officials, business representatives from over 20 countries. The conference covered all aspects of photovoltaic technology, including crystalline silicon, amorphous silicon, new thin film materials, solar cells for space applications, PV system design and field experience and national programmes. The conference was inaugurated by the Minister of State for Power & Non-Conventional Energy Sources. A technical exhibition was also organised during the conference. The event provided a valuable opportunity for the Indian photovoltaic community to interact with specialists and industry representatives from other parts of the world and follow the latest developments in this field.

6.15 A mission sponsored by the World Bank visited India in June-July 1991 to identify and analyse potential projects relating to the development and use of non-conventional energy sources for possible funding under the Global Environmental Facility (GEF). The mission recommended that a project in the field of solar photovoltaics be considered for GEF support. Further consultations are in progress with the World Bank in this matter.

Wind Energy Programme

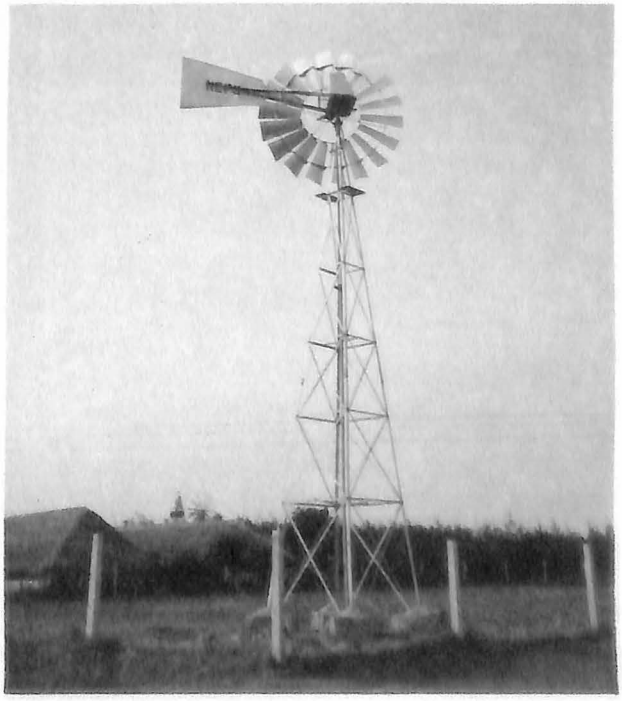
The Department's programmes in Wind Energy comprise wind resource assessment, research and development, and demonstration aimed at exploiting technologies which have a promising commercial future for such applications as water pumping, battery charging and power generation. As a result of the strategy and planned approach adopted for harnessing the vast wind potential in the country, the generation of mechanical and electrical energy by windmills has emerged as a viable and cost-effective technology for large scale use in agricultural, rural and electric power sectors. Good progress was maintained under the programme during 1991-92. Further thrust is proposed to be given during the 8th Plan to achieve complete indigenisation and build up installed capacity by way of encouraging private sector industries, wind farm developers and State Electricity Boards through a package of policy and institutional measures. Simultaneously, by targeting wind power capacity build up at 400 MW over the Plan period, indigenous production of wind electric generators will be achieved.

Wind Resource Assessment

7.1 An extensive wind survey programme comprising wind mapping, wind monitoring and complex terrain projects is under implementation in 22 State/UTs. Establishment of 540 wind mapping stations consisting of cup counter anemometers installed on 5m masts in 19 States has been undertaken, of which 322 have become operational, as on 31.12.91. A wind mapping project for 10 stations was initiated in Sikkim during the current year. Interim Wind Climatology Reports containing one year's data have been prepared for nine States, of which reports for Himachal Pradesh, Kerala and Maharashtra were prepared during this year. A simple system with a speed sensor and a single channel data logger developed indigenously to replace the manually read cup counter anemometers, is undergoing field trials.

7.2 109 wind monitoring stations involving sophisticated continuous recording instruments installed at two levels on 20m masts, have been taken up in 11 States/UTs. 101 stations were installed, of which 85 are in operation as on 31.12.91, the weak stations have been closed and are to be relocated. Twenty six new stations will be taken up during the current year, six each in Andhra Pradesh and Karnataka, five each in Tamil Nadu and Himachal Pradesh, and four in Madhya Pradesh. Six Interim Reports on wind data from these stations have been brought out, including one during the current year, with another to be brought out in March, 1992. A State-wise list of stations having mean annual wind speeds greater than 18 kmph is given in Table 1. The second volume of the Handbook on "Wind Energy Resource Survey for India" which will contain data based on three to five years measurements at 58 wind monitoring stations, will be brought out during 1992. An indigenous wind monitoring system is undergoing trials.

7.3 Wind resource studies in complex terrain undertaken so far in six States have confirmed possibilities of strong winds on low hills and in mountainous areas. Large potential inland areas have been identified, particularly in Andhra Pradesh and Karnataka. The data from the wind survey projects is being utilised in preparing detailed project reports for wind energy projects for specific sites, as well as area-based Master Plans for identification of the potential for power generation. Further to the Master Plan already prepared for southern Tamil Nadu districts, a Master



Gear-type Wind-Mill for Water Pumping.

Plan was prepared during the current year for the four southern districts of Andhra Pradesh, viz. Anantapur, Nellore, Chittoor, and Cuddapah. A total exploitable potential of about 830 MW has been indicated for this region, and pre-feasibility reports have been prepared for 13 sites having a total capacity of about 90 MW.

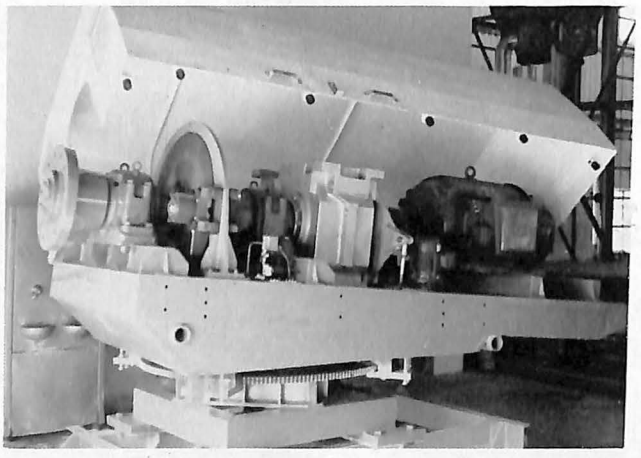
Research & Development

7.4 Performance of the indigenously developed gear-type 'Maruti' windpump has been found to be encouraging, and steps are being taken for finalisation of the know-how package and its transfer to prospective entrepreneurs for commercial production. Design and development efforts on small wind battery chargers of capacities upto 4 KW have progressed further during the year. A test field for small wind battery chargers is also planned.

7.5 An R&D project sponsored by the Department has resulted in successful development of two prototypes of 55 KW grid connected wind electric generators, undertaken by Bharat Heavy Electricals Ltd. (BHEL). These two units have been installed for field testing and evaluation. Based on the confidence gained in this project, the Department took up a 500 KW wind farm project with indigenously developed machines. This project commissioned by BHEL at Tuna is a totally indigenously planned and executed wind farm project with indigenously produced machines with a local content of over 70%. In addition, development of the first prototype of their 200 KW machine with about 50% indigenous content has also been completed. The unit has been installed and synchronised with the grid at Kayathar in Tamil Nadu in January, 1992. The installation of the second prototype at Lamba in Gujarat is expected to be completed by the end of the current year.

Demonstration and Field Trials

7.6. The windpump demonstration programme was continued during the year. A total of 2756 windpump, mainly of 12-PU-500 type for shallow well pumping, have been installed in 23 States/UTs under the demonstration programme, of which 45 windpumps have been installed during the current year, upto 31.12.91. Under the Operational Research Programme, taken up for comparative performance evaluation of indigenously developed gear-type models, 75 windpumps have been installed in nine States, of which 27 windpumps have been installed during the current year, upto 31.12.91. Performance of these windpumps for deepwell pumping has been found to be encouraging. A demonstration programme based on these windpumps is planned.



Assembly of 55 kW Wind Electric Generator by BHEL for 550 kW Wind Farm at Tuna.

7.7 Ninety seven small wind battery chargers have been installed in different parts of the country under the current year, upto 31.12.91. In addition to the five 10 KW stand alone systems installed in Ladakh and Lakshadweep, two such systems have been taken up for installation in West Bengal. Performance monitoring of the wind battery chargers and stand alone units has been continued.

7.8 The programme for establishing wind farms initiated in 1985, has now emerged as an important thrust area of the Department. The technical feasibility of using wind as a major source of energy has now been well established, and wind energy today ranks as one of the most promising of the renewable energy technologies for generating electricity. A total wind power capacity of about 50 MW has been taken up so far, of which 38.3 MW has been commissioned. The State-wise wind power capacity is given in Table 2. The completed projects include wind farm demonstration projects of aggregate capacity 32.2 MW comprising 247 wind electric generators commissioned at 13 locations in seven States, since 1986, namely, Okha, Okha-Madhi, Mandvi, Lamba and Tuna in Gujarat; Tuticorin, Kayathar and Muppandal in Tamil Nadu; Puri in Orissa; Deogarh in Maharashtra; Tirumala in Andhra Pradesh; Kheda in Madhya Pradesh; and, Talacauvery in Karnataka. A total capacity of 6.9 MW comprising 41 wind electric generators is under installation under the demonstration programme. This includes a 500 KW expansion to the 550 KW Tirumala wind farm project in Andhra

Pradesh, taken up this year. A further capacity of 10 MW is planned during the current year.

7.9 About 106 million units of electricity have so far been fed to the respective State grids from the demonstration wind farm projects, of which 36.7 million units were supplied during the current year, giving an overall capacity utilisation of 19% for nine months ending 31.12.91. The highest monthly capacity factor of 53% was achieved for the month of July 1991 in the Kayathar-II 6 MW project.

7.10 The Danish-assisted 10 MW wind farm project 'Pavan Shakti' established at Lamba in Gujarat was dedicated to the Nation by Hon'ble Minister of State for Power and Non-conventional Energy Sources, Shri Kalp Nath Rai, on 24th September, 1991, in the presence of the Chief Minister of Gujarat and the Ambassador of Denmark in India. The project, which is the largest wind farm project in Asia and the Far east, comprises fifty 200 KW pitch-controlled wind electric generators.

BHEL 200 kW Wind Electric Generator at Kayathar.

Costs of Wind Power Generation

7.11 The average capital cost of wind power projects ranges between Rs. 2.50-3.00 crores/MW, including local civil and electrical works costing Rs. 40-50 lakhs/MW. O&M costs have been reported as 1.1%, and transformer losses/local consumption as 1.43%, of the total expenditure. Strictly speaking, cost of wind power should be compared with conventional fossil-fuel based power taking into account externalities. Such a comparison is gaining wider acceptance in the context of worldwide concern for global warming. Nevertheless, even assuming a lifetime of 20 years, and taking O&M @ 2%, the levelised cost of generation varies from Rs. 1.50-2.00/KWH, depending upon the site. These costs compare quite favourably with those for new thermal power projects located away from coal mining areas. Cost data from the small wind farm projects is not strictly comparable with large scale coal thermal projects. During peak or power shut down periods, wind could replace diesel power, which has very high operating costs. The costs of wind power generation will decline further through higher efficiencies obtained from advances in technology, larger scale and more efficient manufacturing, discovery of windier sites, as also with increase in size of wind turbines and wind power projects. Wind electric generators are the most "environment-friendly" method of producing electricity,and have no adverse effects on the global environment, unlike the conventional coal or oil fired power plants.

Production and Installation by Industry

7.12 Water pumping windmills and small wind battery chargers are already being manufactured indigenously based on local developments and adaptations. Emphasis has continued to be placed on the implementation of the wind power programme on the basis of progressive indigenisation of large grid-connected wind electric generators. In the light of the customs policy changes during this year restricting duty free import to only selected parts and components by manufacturers, the wind electric generators will now be manufactured in India involving a mix of indigenous and imported components. Besides the indigenous production already initiated by BHEL, the private sector companies have also progressed with

vendor development, and are expected to come out during 1992 with indigenous machines under their phased manufacturing plans. The projects will be based on machines in the 200-250 KW class to facilitate standardisation, maintenance, and spare parts availability.

7.13 There is considerable interest in the private sector to harness wind power. In view of severe power cuts and the rising costs of diesel based captive power, wind power offers high marginal benefits from the timely availability of power. To encourage and facilitate private sector generation, States such as Tamil Nadu and Gujarat have introduced promotional incentives including wheeling and banking, attractive buy back rates, capital subsidy, etc. Facilities for accelerated depreciation, concessional finance, and exemptions from various duties and taxes, are also available. In Tamil Nadu, a total private sector capacity of 5 MW has been installed and orders for another 5 MW capacity have been finalised. The Tamil Nadu Electricity Board has created a Wind Energy Development Cell at Madurai, to promote and assist private sector development.

International Assistance

7.14 A site-specific pre-investment study was carried out under the World Bank/UNDP ESMAP Programme to develop a bankable wind farm project for Tamil Nadu. The Green Cover Report of the Study was received in December, 1991 and further interactions with World Bank are planned. Wind farm projects are also proposed to be considered for three-four potential States, including private sector projects. Discussions are in progress with several States to finalize the project portfolio. Donor interest has been expressed in providing mixed credits for these projects. Possibilities of using unutilized bilateral grant assistance for wind power projects to be taken up through State agencies/electricity boards, are also being explored.

Table-1 Wind Monitoring Stations with mean annual windspeeds greater than 18 KMPH

S. No.	Station	Mean annual wind speed (kmph)	S. No.	Station	Mean annual wind speed (kmph)	S. No.	Station	Mean annual wind speed (kmph)
I.	**TAMIL NADU**		**III.**	**GUJARAT**		**VII.**	**KERALA**	
1.	Sultanpet	19.1	1.	Harshad	20.8	1.	Kanjikode	23.5
2.	Poolavadi	20.2	2.	Okha	20.2	2.	Kottathara	20.9
3.	Andipatti	19.1	3.	Mundra	20.1	3.	Kotamala	18.6
4.	Kayathar	20.6	4.	Surajbari	18.3	4.	Ponmudi	20.0
5.	Muppandal	26.1	5.	Okha Madhi	18.7	**VIII.**	**ANDHRA PRADESH**	
6.	Sembagaramanpudur	21.8	6.	Navi Bander	20.7	1.	Tirumala	20.3
7.	Puliyankulam	19.1	7.	Dhank	24.5	2.	Payalakuntla	20.8
8.	Alagiyapandiyapuram	22.2	8.	Kumma	18.6	3.	Narasimhakonda	21.0
9.	Talayathu	20.2	**IV.**	**MAHARASHTRA**		4.	Kukulakonda	25.5
10.	Ayikudy	22.6	1.	Vijayadurg	19.3	5.	MPR Dam	20.7
11.	Kattadimalai	25.1	2.	Panchgani	18.3	6.	Ramagiri	20.6
12.	Rameswaram	24.1	3.	Chalkewadi	19.3	7.	Bhimunipatnam	18.7
13.	Kethanur	22.7	**V.**	**RAJASTHAN**				
14.	Metukadai	18.4	1.	Khodal	18.0			
15.	Meenakshipuram	18.7	2.	Jaisalmer	18.1			
16.	Arasampalayam	21.4	**VI.**	**KARNATAKA**				
17.	Edayarpalayam	23.4	1.	Gokak Hilla	20.3			
II.	**LAKSHADWEEP**		2.	Malgatti	20.2			
1.	Kadmath	18.1	3.	Hanamsagar	21.1			
2.	Agatti	18.6	4.	Jogimatti	32.5			
3.	Kavaratti	18.3	5.	Bommanahalli	19.1			

Table-2 State-wise Wind Power Capacity (MW)

State	Total Installed		Demonstration Wind Farm Projects		Private Sector Projects		Individual Grid-Connected Machines	
	Compltd	U/Imp.	Compltd	U/Imp.	Compltd	U/Imp.	Compltd	U/Imp.
1. TN	19.24	8.22	13.85	2.80	5.00	5.00	0.39	0.42
2. GUJ.	14.74	2.25	14.50	2.05	—	—	0.24	0.20
3. MAH.	1.19	1.50	1.10	1.50	—	—	0.09	—
4. OR.	1.19	—	1.10	—	—	—	0.09	—
5. M.P.	0.64	—	0.50	—	—	—	0.14	—
6. A.P.	0.55	0.50	0.55	0.50	—	—	—	—
7. KAR.	0.55	—	0.55	—	—	—	—	—
8. GOA	0.11	—	—	—	—	—	0.11	—
9. KER.	0.10	—	—	—	—	—	0.10	—
	38.31	12.47	32.15	6.85	5.00	5.00	1.16	0.62

Indigenous Manufacture & Installation of 550 kW Wind Farm at Tuna.

Micro-Mini Hydro Programme

The micro mini hydro programme is to harness electricity from low head water resources. Our country has an estimated potential of 5000 MW for this programme. The advantages of this programme include short gestation, indigenous technology, low transmission losses due to local generation and consumption of electricity and no problems of deforestation and resettlement etc.

8.1 This programme was transferred to DNES during 1989 to establish mini micro hydro plants upto capacity of 3 MW each. The steps taken by the Department include:-

(i) Induction of state of art technologies in the country, such as syphon intake for low head small hydro projects, by which eliminating the need for conventional inletoutlet gates, reduce costs and improved reliability.

(ii) Increasing manufacturing base for hydro equipment as also small generator with the result that India has now nine prominent manufacturers for turbines today.

(iii) Initiation of Electro mechanical and civil works standardization efforts to reduce per unit installed capacity costs and per unit cost of power.

8.2 Project and Finance

(i) Completion of a World Bank/UNDP funded study to standardize irrigation canal/dam based scheme from 3 meters to 30 meters head into 6 type-designs. This is now subject matter of a possible World Bank loan of US $ 70 million for creating 110 MW potential in some 58 projects in the private sector.

(ii) Initiation of a similar study to standardize hill hydro schemes through probable UNDP/GEF funding to the tune of US $ 7.52 million.

(iii) Announcing incentives (upto 50% of the cost) of preparation of DPRs (Detailed Project Reports) through reputed private consultants so that a ready shelf-of-project is made available.

(iv) Announcing capital cost/interest burden sharing schemes so as to divert the existing budgetary and extra budgetary resources of State Agencies, Financial Institutions, Private Sector etc. to this sector.

(v) Vetting existing DPRs/Feasibility Reports/Ongoing projects at DNES' cost by engaging private consultants so as to learn from existing experience as well as decide on the need for central techno-economic interventions, if any.

(vi) Initiating studies for upgrading existing village level water mills (Over 100,000 units) into multipurpose efficient units, with a view to ultimately make electricity generation a village cottage industry.

(vii) Creating a high tech Management Information System which would, when full set up, permit:

A 50 kW Mini Hydro plant at Bilkot, U.P.

8.3 Information System

(i) Resource potential estimation, based on hydrological and meteorological data inputs.

(ii) Assigning development priorities to regions based on existing geological and other investigations of the region, strengths of the resource and a variety of financial and social inputs.

(iii) Planning integration of mini hydro units with existing power lines or with other suitable conventional and non-conventional sources in local utility grids.

(iv) Identifying clusters of sites on canal falls etc. on All India basis so as to achieve cost reductions through simultaneous development of such sites.

(v) Identifying specific R&D projects including some specially developed softwares for minihydro development as well as "Computerised Information Retrieval Systems" for retrieving comprehensive bibliographic information from global sources, and thus optimise research.

(vi) Generally attempt to prove the superiority of minimicro hydro over atleast generation in remote and non-grid connected areas.

Projects under execution

8.4 The following 12 projects are at present under execution. Out of these, three projects viz. Bilkot, Khet and Naini in the remote areas of U.P hills have already been commissioned during the current year. These projects will benefit a total population of 8298 in 28 villages in a totally decentralised mode.

It is expected that the third unit of 100 KW in the R&D Project at Kakroi will also be commissioned during the current year. All other projects are due for commissioning in 1992-93.

LIST OF SANCTIONED MINI/MICRO HYDEL PROJECTS

Sl. No.	*Name of Project*	*Unit Size (KW)*	*Total Capacity (KW)*	*Total Outlay (Rs. in Lacs)*	*DNES Share*	*Funding Pattern*	*Agency*	*Remarks*
1	2	3	4	5	6	7	8	9
ANDHRA PRADESH								
1.	Sriramsagar (9m)	500	1000	225.00	110.00	50%	APSEB	
2.	Sriramsagar (14m)	500	1000	225.00	110.00	50%	APSEB	
3.	Sriramsagar (16m)	500	1000	225.00	110.00	50%	APSEB	
HARYANA								
4.	Kakroi, Sonipat	100	300	141.04	119.00	100%	AHEC	2 Units completed
HIMACHAL PRADESH								
5.	Jubal	150	150	30.64	30.64	100%	AHEC	Completed
6.	Manali	100	200	57.564	57.564	100%	AHEC	Completed
MADHYA PRADESH								
7.	Satpura	330	990	247.50	118.80	50%	MPEB	
ORISSA								
8.	Barboria	325	650	193.00	96.50	50%	OPGC	
9.	Kendupatna	250	500	180.00	90.00	50%	OPGC	
UTTAR PRADESH								
10.	Bilkot	50	50	40.00	15.83	50%	NEDA	Completed
11.	Khet	50	100	49.48	21.00	50%	NEDA	Completed
12.	Naini	50	50	39.96	13.52	50%	NEDA	Completed

Urjagram Programme

The Urjagram Programme is aimed at harnessing locally available renewable energy resources such as solar, wind, biomass etc. in an integrated manner for supplementing energy supply options and ultimately bringing about energy self-sufficiency in villages. The projects are modular and progressive capacity additions can be undertaken. Efforts are made to bring about the full involvement of the local people in planning, implementation and operation of these projects. The selection of villages and the non-conventional energy devices and systems to be installed under the urjagram projects is made on the basis of surveys of energy consumption patterns, energy needs and local energy resources. A beginning has been made towards the creation of an energy data base for rural energy planning, and to demonstrate through pilot village-level integrated energy projects that decentralised energy requirements can effectively be met through non-conventional energy sources. Evaluation of technical performance, study of the integration aspects, and institutional requirements, assessment of the socio-economic impact, and multi-level planning studies have also been undertaken. A major thrust in the future programme will be to quantify the techno-economic and social aspects, and demonstrate the technical possibilities and economic benefits of integrated operation at different levels, for meeting diverse requirements.

Rural Energy Surveys and Area-based Planning Studies

9.1 The availability of detailed information on energy consumption patterns, energy needs and resources is of vital importance for planning and development of urjagram projects. Two types of energy survey formats are used. A first level survey is carried out by using the "Quick Energy Survey Format" and a detailed survey is conducted using the "Four Part Energy Survey Format". Unelectrified villages having cohesive population of 500-1000, and SC/ST/ backward/remote area settlements are generally chosen for urjagram projects.

9.2 Energy surveys have so far been completed in 1385 villages in 20 States/UTs, of which 69 have been completed during the current year, upto 31.12.91 Energy surveys are in progress in 564 villages.

9.3 A study has been initiated on collation and analysis of energy surveys having good quality data, with a view to study energy patterns and trends at regional/sub-regional level, and to set up a rural energy data base. Energy survey reports for about 600 villages have been selected out for the purpose. The villages will be grouped on the basis of agro-climatic zones. The data thus segregated will be analysed to examine co-relations between energy use and resources/ownership pattern, economic levels and other relevant information at household level.

9.4 A broad-based co-ordinated programme on multi-level planning has been initiated with a view to preparing decentralised area-based plans and with appropriate mix of technologies for utilisation of renewable energy including institutional arrangements needed for proper implementation of schemes. Six district level studies in different agro-climatic conditions, socio-cultural settings and varying resource endowment regions have been taken up. The first district level energy planning study was undertaken for Wardha district in Maharashtra. Based on local interest, certain new villages have been suggested, and implementation has accordingly progressed during the year. The study for the tribal Mandla district in Madhya Pradesh was completed during the year. A rural energy plan and a methodology manual have been prepared. An assessment of the mini-micro-hydro potential has also been carried out under the study. As the next step, it is proposed to take up implementation of the plan in association with the State nodal agency and district/block authorities.

9.5 Under the study carried out for Tehri Garhwal district in Uttar Pradesh, the survey work and analysis of data for 50 villages in 10 blocks was completed during the year. The largest consumption of energy, about 85%, is in the household sector, with wood contributing nearly 93% towards the total consumption in this sector. Suggestions have been made for local generation of electric power from renewable energy sources. Assessment of the potential for mini-micro hydro plants, and wind electric systems has been made, and few sites have been identified where the resource is available almost throughout the year. Another project is in progress for the preparation of a perspective energy plan for Kutch district of Gujarat, upto the year 2000. Demand and supply options are being studied for 16 clusters identified on the basis of criteria developed under the project. The studies on rural energy planning for Ahmednagar and

A view of Urjagram in Koraput Distt., Orissa.

Beed districts of Maharashtra, and for Dharwad district of Karnataka, have also progressed during the year.

Urjagram Projects

9.6 A total of 153 urjagram projects have been completed so far in 12 States, out of which 13 have been completed during this year, upto 31.12.91. A total of 226 projects are under implementation. Urjagram projects are implemented through the State nodal agencies in association with educational institutions, research organisations, industry and voluntary organisations. The progress of urjagram projects is monitored through periodic review meetings and regular inspection visits to different States. With a view to lead progressively towards energy self-sufficiency in the villages where urjagram projects have been taken up, a review of all the completed projects is proposed to be carried out for their expansion, depending upon the requirements, feasibility and receptivity of the local population.

9.7 The three experimental Reference Urjagram Projects that were taken up for implementation, one each in Gujarat, Tamil Nadu and Orissa have progressed during the year, and their expansion is now planned. The feedback obtained from these projects will serve as input to more effective planning and implementation of urjagram projects. Another reference urjagram project has been proposed for a typical hilly area village in Himachal Pradesh.

Special Programme for Dr. B.R. Ambedkar Centenary Celebrations

9.8 Good progress was made during the year under the 20 urjagram projects taken up in predominantly SC/ST villages in different parts of the country. Two of these projects in Karnataka were initiated during the current year. The Urjagram project for village Ambedkar in Ratnagiri district of Maharashtra was completed during the year. Under this project, 26 family size biogas plants, 48 portable metal wood stoves, five solar photovoltaic street lights, one community colour television, two photovoltaic lanterns, one community solar cooker, and one solar water heating system of 100 lpd capacity have been installed. Two urjagram projects in village Fanar in Dehradun district and in village Hathiyai in Hardoi district of Uttar Pradesh, have also been completed during the year. Other projects under this programme are at various stages of implementation and are likely to be completed during 1992.

Biomass Programme

Biomass, an inexhaustible store house of Solar Energy, offers a convenient, natural route to meet the growing energy needs of society. Terrestrial and aquatic biomass merit a great deal of consideration in any energy development programme, particularly in a country like India. It can be used in solid, liquid and gaseous forms through direct combustion, carbonisation/pyrolysis, gasification and other conversion systems. Keeping in view the variety of bio-resources, diversity of technologies and multiplicity of end-use, there is a need to make available methodologies for maximising bio-productivity of biomass and to develop appropriate technologies for its efficient utilisation. The Biomass Programme envisages R&D and demonstration in the major aspects of production, improvement, conversion and utilisation.

Research & Development

Fuelwood production and improvement

10.1 The ever increasing demand for fuelwood particularly for cooking needs and its acute shortage have resulted in fast depletion of forests and conversion of fertile lands into wastelands at an accelerated pace. It is, therefore, essential that fast growing short rotation fuelwood species suitable for plantation on waste/marginal/degraded lands are identified and their productivity increased manifold from the existing levels through evolving suitable package of practices. In order to achieve this objective, nine Biomass Research Centres have been set up one each in nine different agro-climatic regions of the country. These Centres are located at National Botanical Research Institute, Lucknow; High Altitude Plant Physiology Centre, Garhwal, Srinagar; Madurai Kamraj University, Madurai; University of Calicut, Calicut; Ravishankar University, Raipur; Regional Plant Resource Centre, Bhubneshwar; College of Technology and Agricultural Engineering, Udaipur; Shivaji University, Kolhapur and Tata Energy Research Institute, New Delhi. Three additional Biomass Research Centres are proposed to be set up by the end of 1991-92 in the remaining agro-climatic regions.

10.2 To supplement the work of Biomass Research Centres, a number of complementary R&D projects on areas relating to soil nutrient cycling studies, genetic improvement of the fuelwood species, insect-pests and disease control measures, fixation of atmospheric nitrogen by micro-organisms associated with fuelwood species etc. has been sponsored.

10.3 The Biomass Research Centres are engaged in identifying, screening, testing, selecting and evaluating potential fuelwood species and in evolving package of practices for most suitable fast growing, short rotation (about 5-6 years) fuelwood species. The Biomass Research Centres have taken initiative to prepare package of practices for about 36 fast growing short rotation fuelwood species and about 60 other fuelwood species were selected for initiating R&D work particularly to test their productivity and suitability under different agroclimatic conditions. Studies undertaken so far revealed that it is possible to increase the biomass yield of fuelwood species to significant levels. In some species biomass yields ranging from 25-50 tonnes per hectare per year have been obtained.

Nursery Technology

10.4 Nursery Technologies have been developed and standardised for some of the fuelwood species to produce qualty seedlings. Suitable strains of mycorrhizae capable of fixing atmospheric nitrogen have been screened and identified for application. Tissue culture technique for mass propogation of quality seedlings from elite trees had been developed for some fuelwood species.

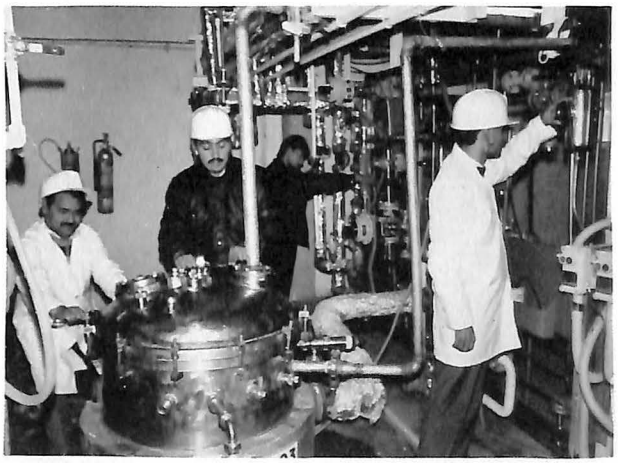
Hydrocarbon—Plants

10.5 Many plants produce hydrocarbons which are similar in their composition to petroleum and can be used directly a fuel or with minor modifications in running the IC engine. These plants are largely latex yielding plants. A survey carried out by National Botanical Research Institute, Lucknow revealed that there are about 400 different species of hydrocarbon plants in India. Out of these, 54 species emerged as potential ones. A feasibility report for setting up an integrated pilot plant for production, conversion and utilization of hydrocarbon plants for use as fuel in the IC engine was prepared to assess the technoeconomic feasibility of the process involved. Though biocrudes from some of the species have successfully been extracted and their composition modified for use as a substitute to diesel/petrol. However it has been observed that the present available technology is not yet viable. Gray areas have been identified for further R&D work, for developing viable technologies

for production, conversion and utilisation of hydrocarbon plants as a petroleum fuel.

Liquid Fuels

10.6 The use of alcohol in running vehicles is now a practical concept. In India, presently ethanol is produced mainly from molasses. The existing production of alcohol is not adequate for using alcohol as a fuel particularly in the transport and agriculture sector. Considering the need for substituting diesel/petrol by alcohol, the Department initiated R&D activities in this field. A R&D pilot-plant for production of ethyl alcohol from rice straw with an installed capacity of 50 litres per day has been commissioned at IIT, New Delhi. Non-edible oils have also been tested for their suitability as fuel in IC engines. It has been established that non-edible oils can be used as substitute of diesel/petrol with minor modification in the engine.



A Pilot Plant 50 Litres per day to produce Ethyl Alcohol from Rice-straw at IIT, New Delhi.

Solid Fuels

10.7 Significant quantities of agro-residues are estimated to be available. Most of the agro-industrial residues do not find economical utilisation due to their size, density, volume and other characteristics which enhance their cost of collection, storage and transportation, etc. Amongst various options for their conversion into energy intensive fuels, briquetting technology is a simple one through which solid fuels from organic materials can be produced to replace many of the conventional solid fuels like coal and fuelwood. Though the briquetting technology has been already commercialised in the country by private entrepreneurs, the existing technology suffers from problems such as high wear and tear of the component in plant and machinery, frequent jamming due to faulty lubricating system, etc. The Department, therefore, initiated R&D activities aimed at solving these problems.

Energy Plantation Demonstration

10.8 The main aim of the energy plantation programme of the Department is to evolve methodologies for the preparation of package of pratices for increasing the productivity to about 40 tonnes per hectare per year. The energy plantation programme now being an integral part of the R&D, is being implemented under close supervision of related Biomass Research Centres. the programme is implemented through the State Governments and their Nodal Agencies and Universities & R&D Institutions on lands belonging to the Government or the Universities/Institutions. The energy plantation projects were evaluated by an independent agency. The overall survival rate of 69.7 per cent has been reported for the plantation.

Biomass Gasification

10.9 Among various alternative sources of energy, Biomass Gasifier and Stirling engine systems are devices which convert biomass wastes such as wood waste, wood chips, twigs, cotton stalk, tur stalk, maize cobs, rice husk, saw dust etc. to energy and power through gasification. These devices run the I.C. engine or stirling cycle engine to produce motive power. In turn, it runs pumpset for irrigation or drinking water or to produce electricity through alternators. The biomass pumpset and gensets are available in different ratings from 5 HP to 10 HP for mechanical applications i.e. water pumping and from 3 KW to 100 KW for electrical applications i.e. generation of electricity. These systems substitute/replace diesel fuel in conventional diesel engine for respective applications over 65%.

Research & Development

10.10 Some of the major highlights/achievements of Research and Development programme during the current financial year include:-

(i) A 20 KW wood-based gasifier system in mechanical and electrical mode was developed at SPRERI, Vallabh Vidya Nagar. Attempts are

being made to modify it for using wide range of agricultural biomass.

(ii) At IISc Bangalore, a prototype of gasifier unit of 5 KW rating capable of using powdery biomass like rice husk, coir pith, saw dust and other agricultural residues was developed and tested. Further R&D is under progress for a complete system of 100 KW plant.

(iii) An instrumentation and control system including the programmable logic controller has been developed and tested for monitoring and automatic correction of the different parameters affecting overall performance of a gasifier system.

(iv) At IIT Bombay, a 15 KW rice husk gasifier system was developed and tested for thermal applications. Attempts were being made to make it suitable for engine application also. IIT Bombay has already identified an enterpreneur for transfer of the developed technology.

(v) The 5 KW gasifier system based on lantana camara—a weed—installed earlier in village Kumbichauk, a non-electrified village in Distt. Pauri-Garhwal and inhabited mainly by SC/ST community was operating successfully. A society has now been formed involving 20 families of the village to look after its management and operation. A diesel replacement of 60 per cent has been achieved. It is being operated for seven hours every day; three hours for running a spice grinder & leaf plate making machines and four hours for providing electricity for household (20 families) and lighting in the village. Each household has been provided with two electric points of 60 W each.

A Gasifier engine for Water pumping.

(vi) A decentralised electricity generation (5 KW capacity) was being conducted at Hosahalli, a non-electrified village in Tumkur District to meet its entire lighting and shaft power needs. Energy plantations in two hectare area has been raised to provide feed stock to the gasifier in a sustainable way. All the 43 households are provided with two lighting points, besides, eight points of tube lights of 40 W each for street lighting. Presently, Gasifier system is being operated for 4-5 hours during night time for lighting. In addition, a sub-mersible pump is being operated by Gasifier system to pump water to the two water tanks for supplying drinking water to the villagers. Eight taps have been provided at different locations in the village with a separate facility for providing water to cattle. About 7000 litres of water is being pumped everyday for the community. Two village boys and one girl have been locally trained in operation of system independently. An eight Member Committee of villagers has also been constituted to look after its management aspects.

(vii) A project for installation of biomass gasifier based milk chilling plant was taken up with co-sponsorship of Bhopal Dugdha Sangh. The project is being implemented in a tribal area of Betul District of Madhya Pradesh.

(viii) Techno-economic feasibility cum detailed project report for over 30 sites in different area was taken up for setting up of application-specific packages in higher ratings of gasifier system (20 KW and above).

(ix) A demonstration unit of 100 KW electric power, based on locally generated biomass, using the gasifier engine genset system at Navodaya Vidyalaya, Tumkur District was also taken up. It aims at providing electricity to the Vidyalaya complex/hostels for variety of end uses.

(x) A phased programme on development of a complete system package of 2/3.7 KW Stirling Engine working on 100% agricultural & woody biomass was initiated during the year.

(xi) Laboratory facilities for characterisation of Biomass at IIT Delhi and testing of gasifier engine genset systems at IIT Bombay was continued.

(xii) An exercise in Monitoring and evaluation of

gasifier system was taken up for a 20% sample.

(xiii) Action has also been initiated to develop and convert four of the existing R&D Groups, IIT Delhi, IIT Bombay, MKU Madurai into centre for action research in gasification technology, its development and utilisation.

(xiv) Techno-economic feasibility study for setting up of gasifier based pilot plant for power generation system (0.5 MW) linked with energy plantation in the Kutch region of Gujarat was completed. Based on it a detailed project proposal by GEDA in close association with Rural Electrification Corporation, Gujarat State Electricity Board and Forest Development Corporation is proposed to be taken up.

(xv) A gasifier based reverse osmosis project for drinking water supply in drought prone areas of Kutch region of Gujarat is proposed to be taken up during 1992-93. Detailed Project Report for some sites have already been prepared.

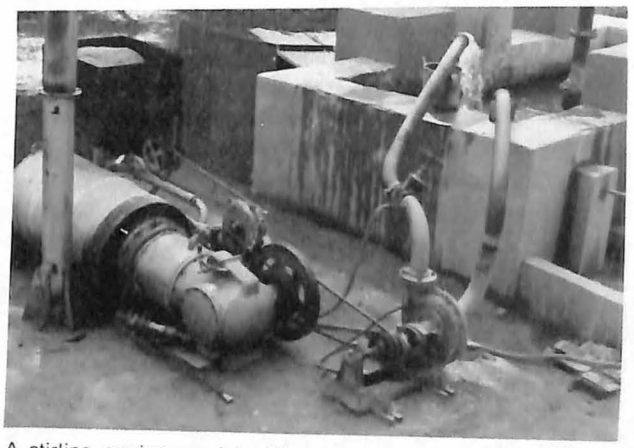
(xvi) An application package for safe drinking water supply in a village in Fathepur (Uttar Pradesh) has been successfully implemented. It is based on locally available biomass to run an stirling engine system (5 Hp) for providing motive power to the water supply system. The per capita cost of above system, accounting for all direct and indirect resources, is reported to be around Rs. 200/- as against conventional piped rural water supply scheme costing about Rs. 2500/- per capita. Further studies in above regard were in progress.

Annual National Technical Meet

10.11 Organisational of Annual Technical Meet, since last three years has greatly helped in attracting young scientists and other experts to take up R&D work gaps in thrust areas including gasification of non-woody biomass. The Annual National Technical Meet on Recent Advances in biomass was organised at GEDA, Baroda during 28-29th Nov. 1991. About 60 participants including experts, professionals and young scientists attended and deliberated on about 40 research papers. In recognition of contribution by young scientists, and to encourage them further, three token awards (or Rs. 5000/-, Rs. 3000/- & Rs. 1000/- each) was made in three distinct areas, namely, a) basic Research and Develop b) Applied Research and Development, c) Allied and Associated R&D aspects.

Demonstration

10.12 Under the Demonstration programme, 860 nos. of gasifier/Stirling Engine Systems of various ratings in different modes of application, (for irrigation and electricity generation etc.,) totalling over 6.5 MW equivalent have been installed so far. It includes 100 gasifier systems in assorted rating and mode of application, equivalent to about 0.5 MW installed during 1991-92 (upto December 1991). Another 0.25 MW capacity would be achieved by the end of current financial year.



A stirling engine used for Water pumping.

Annual Review Meet

10.13 A meeting of GASMACC-IV was convened at Pune, during 4-5th September. It was participated by Nodal Implementing agencies, manufacturers, and other invited experts. It considered various measures for ensuring further improvements and modifications in the strategy of implementation with a view to broad base the same.

Plan Directions

10.14 The programme proposed to be continued during the Eighth Plan, and directed towards and focussed on the following:-

(i) Intensify R&D efforts and step-up demonstration programme towards better reliability, life and cost effectiveness of the systems including engines & other sub-systems; development of gasifier systems using variety of non woody biomass; develop high capacity wood & non-wood based gasifier systems for electricity generation; development of application packages using gasifier output for variety of applications including co-generation.

(ii) Develop biomass based Stirling engine systems to reduce costs and weight and to improve realibility for various applications including pumping & electricity generation; Develop appropriate system packages and integrate gasifier/Striling engine applications with energy plantation demonstration schemes; develop and set up integrated pilot projects in different sectors using or producing biomass, agro-residues and agro-industrial wastes; Develop & set up institutions/regional centres for programme monitoring, providing engineering & technical back up support to implementing agencies/users and to undertake action research in appropriation of technology & system development.

(iii) Develop and fine tune MIS & infrastructure for evaluation, site selection, diagnostic & other related studies; technology transfer & dissemination, training, scientific, technical and engineering exchange programme, servicing & techno-manageial aspects including pre-commercialisation project engineering etc; Information exchange & documentation; encouraging young scientists; creation of awareness, publicity and dissemination of information through mass media, formal and non-formal education, exhibition, publications, workshops, etc.

Albizzia Process is under experimentation for firewood cultivation on Highly Saline Soil.

Energy from Waste Recycling Systems

Agro-industrial wastes are a potential source of energy. In addition, it helps to solve waste management problems. The Department has undertaken a number of R&D programmes to maximise the recycling of organic wastes and develop cost effective processes and suitable technology. Experimental pilot plants are proposed to be set up for waste recycling and generation of methane gas from agriculture, industrial and urban wastes. The pilot projects undertaken so far are based on feedstocks such as sugarcane pressmud, willow dust, kitchen waste, fruit and vegetable processing wastes etc. The progress achieved in respect of some of the individual projects is as follows:-

11.1 Based on the results of successfull R&D activity carried out by Annamalai University on biogas generation from sugarcane pressmud, a large size community biogas plant has been commissioned at village Pinnathur. Some 29 residents of this village are getting biogas for 2 hours daily and the methane content of biogas is 60-62 per cent. Few more demonstration plants for use of pressmud are being installed at cooperative sugar factories in Maharashtra and Karnataka.

11.2 On successful demonstration of willow dust, a waste from cotton spinning mills, for generation of biogas at NTC, Udaipur, some other cotton mills have shown interest. Two such plants of biogas generation for 25 cu.m. and 90 cu.m. have been sanctioned by this Department in Punjab and Madhya Pradesh. The college of Technology and Agriculture Engineering, Udaipur is providing the technical guidance in the matter.

11.3 Use of kitchen waste as a feedstock for biogas at Sardar Patel Renewable Energy Research Institute (SPRERI), Vallabh Vidyanagar has led to installation of a 43 cu.m. plant on kitchen waste at Space Application Centre, Ahmedabad. The results at the two sites are encouraging and establish the feasibility of using biphasic process for biomethanation of agricultural residue.

11.4 A project on microbiological studies for production of biogas from food and agro-industrial waste is given to CFTRI, Mysore. One of the important aspects of the project being studies on unique micro flora involved in anaerobic digestion, isolating the potent micro flora degradlng polymeric organic components leading to efficient methanogenesis.

11.5 Another project pilot scale study on methane generation from fruit and vegetable processing wastes led to installation of two units of 25 cu.m. capacity modified KVIC biogas plant. The gas generated from managoe peals is used in the departmental canteen of CFTRI for cooking purposes. BAIF Development Research Foundation have designed and commissioned two units of 25 cu.m. plant at National Defence Academy, Khadakwasla. The biogas is being supplied to families for cooking.

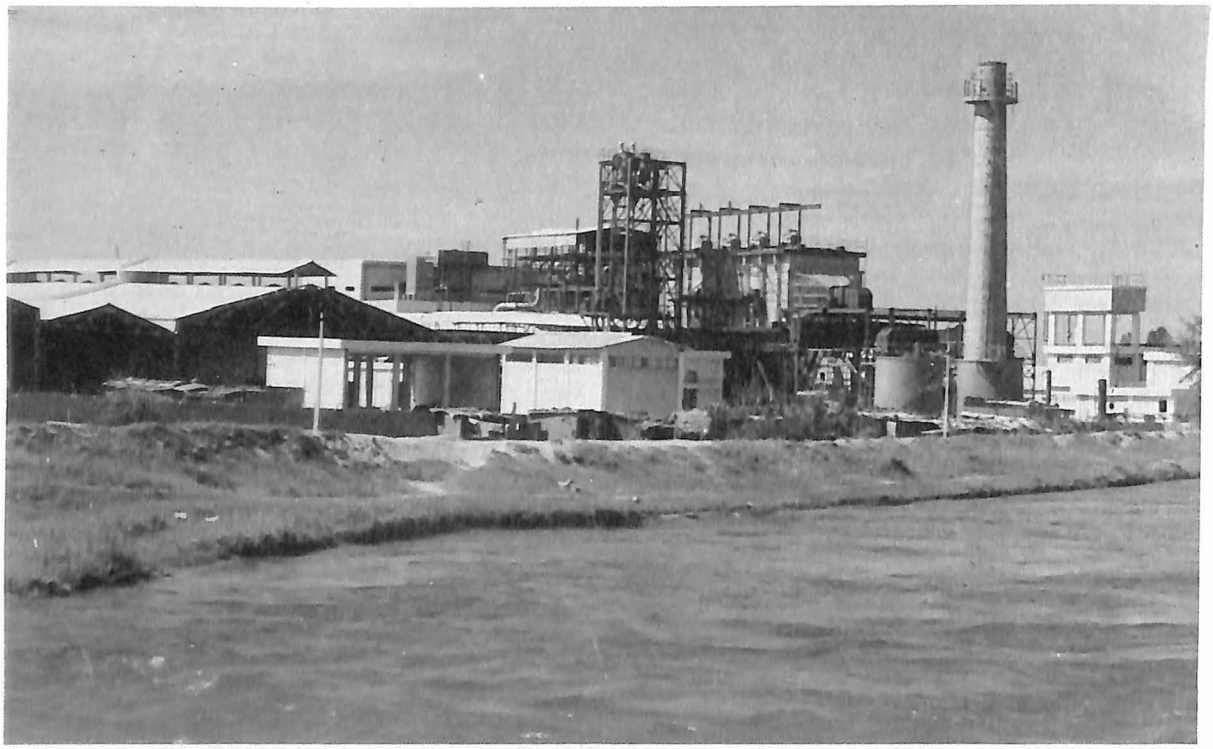
11.6 The indigenous USAB technology developed for treatment of distillery effluent at Daurala Sugar Works, U.P. led to installation of 1500 cu.m./day full-scale plant at the Daurala distillery. Likewise, one 10 cu.m. per day capacity plant designed and erection has been commissioned by NEERI, Nagpur at a distillery in Ghitali in Maharashtra.

11.7 Another pilot project undertaken by NEERI for treatment of hospital waste water with fixed film reacter technology has been commissioned at Govt. Medical College, Nagpur. It is hoped to provide an alternate to conventional activated sludge process for treatment of sweage. Design parameters has been finalised by NEERI for setting up a demonstration plant of 60 cu.m./day capacity of Ambur, Tamil Nadu on fixed film technology for treatment of tannery waste water.

11.8 Studies on two solid waste landfill sites at Nagpur indicated that biogas could be recovered from shallow landfills even after five years of the completion of landfill activity. Biogas recovery rates varied from 5-9 cu.m./hour using 50 mm diameter well points drilled to depth of 3-5 m. The solid waste characteristics in India indicate that the theoretical gas generation potential to range between 150-250 cu.m./tonne.

11.9 Keeping in view the objectives of the programme and R&D efforts the Department proposed to setting up of more pilot plants on cost sharing basis. The thrust areas identified for the Eighth plan are as follows:-

i) Mechanised dairy and cattle waste recycling systems—2 different sizes of treatment capacities of 20 tonne/day and 50 tonne/day for 2000 and 50000 cattle heads dairies respectively located on outskirts of metropolitan cities.
ii) High rate pilot plant for anaerobic treatment of



10 MW Rice straw based power project, Jalkheri. Punjab.

sewage for 10,000 persons in decentralised locations.

iii) Aquaculture based sewage treatment plant for energy recovery for decentralised locations/ settlements of 10,000 persons.

iv) 10 TPD pilot plant for biomethanation of fruits and vegetable market waste.

v) Pilot plant for scrubbing of CO_2 from biogas and compression and storage of methane for cogeneration in distilleries/sugar industry.

vi) Return of primary treated distillery effluent to sugarcane plantations for minerals and fertilisers recovery through pipeline distribution system to obviate need for power intensive secondary treatment.

vii) 5 TPD recycling system for slaughter house waste, and high rate recycling of 900 cu.m. of slaughter house waste water.

viii) 600 TPD Municipal Solid Waste (MGW) beneficiation pilot plant for resource recovery into bio-degradables combustibles and inerts streams with anaerobic digestion of biodegradables.

Thermal Energy Recovery

11.10 To recover thermal energy from agro-industrial and urban waste the Department has taken pilot projects (a) through incineration of municipal solid wastes and rice straw and (b) cogeneration of surplus power in process industries having captive power and steam generation plant. The progress achieved is as follows:-

(i) *10 MW Rice Straw based power project*

The rice straw based 10 MW power plant at Jalkheri in Punjab has recently been completed. This project is financed by DNES and the Punjab State Electricity Board and set up by BHEL on turnkey basis. The success of this plant could also be extended to sugar mills for burning rice straw and saving the high value baggase for more productive uses.

(ii) *Cogeneration of power in industry*

A 7.5 MW cogeneration project has been completed at M.R. Krishnamurthy Coop. Sugar Mill at Chidambaram, Tamil Nadu. A similar project is under execution of Cheyyar Coop. Sugar Mill in Tamil Nadu. A proposal for 25 MW cogeneration system at Mysore Sugar Mill, Mandya, to supply 18-20 MW surplus power to the grid is under examination. A technical economic study on cogeneration of power in the State of Punjab has been completed. The study identified 82 units in the state as possible candidates for cogeneration plants with a potential of 256 MW.

Human and Animal Energy

The draught Animals serve human society by providing essential draught power in agricultural operations, rural/semi-urban transportation and other allied industries. Besides providing valuable organic manure, milk and so many other by-products, animals also offer significant employment and income opportunities to small and marginal farmers and agricultural labourers. About 80 million draught animals in India can generate 40 million horse power.

12.1 Apart from the low work efficiency co-efficient, important aspect of the utilisation of drought animal power system is the extent of under utilisation. According to National Commission of Agriculture, utilisation of bullock power on an average is 15.9 per cent in West Bengal, 16.9 per cent in Orissa, 23 per cent in Madhya Pradesh, 37.3 per cent in Punjab and 44.7 per cent in Uttar Pradesh. Looking at these factors it is imperative that if the potential productivity of existing draught animal population is fully exploited in our country, it can meet energy requirement of the rural sector, particularly of the small and marginal farmers, to a considerable extent.

12.2 For transportation of goods between villages of unpaved roads between village and market places etc., animal drawn vehicles seems more economic. When animals are kept for plying the recurring cost for rural transport is only the incremental maintenance cost on the animals. Thus, animal drawn vehicles become complemental to DAP plying with a little additional cost, making DAP more viable. The general observation and experience indicate that draught animal power is not being utilised optimally in the country, improvement in the utilisation of existing capacity will lead to increased productivity.

Human Muscle Power

12.3 Besides animal power, the human muscle power (HMP) is also used in Indian economy to a sizeable percent. It is a general observation that human muscle power systems presently in use in agriculture, domestic and transport sectors are inefficient. There is, therefore, a need to improve upon the efficiency of human driven systems which would increase the poductivity and reduce the drudgery of the people associated with this system.

12.4 This department has been supporting the projects on development of efficient, productive and income generating human and animal energy systems and devices through R&D, demonstration and extension of these systems and devices for various categories of users in rural tribal, semi-urban areas of our country. CARTMAN, Bangalore, has developed about 15 improved designs of carts of various parameters like less tare weight draught capability, more carrying capacity and with reduction in neck load of DA's etc. Five of them have become popular among the farmers of Karnataka and Tamil Nadu.

12.5 R&D Division of Glass Fibre Technology Centre, (GFTC) Hyderabad has taken up the design and development of prototype of improved bullock cart with pneumatic tyres and fibre reinforced plastics for a pay load from 1.25 to 3.5 tonnes. The main features of the FRP carts with pneumatic tyres indicate that there is a low tare weight, higher pay load capacity, needs minimum maintenance, less rattling, superior hauling ability, less damage in case of accident, high strength, enhanced life, aesthetic appeal and greater employment for labour. These models are being currently field tested by CARTMAN, Bangalore, Central Institute of Agricultural Engineering and KCP Sugar Industries in Vayour (AP).

12.6 Maharashtra Energy Development Agency had demonstrated the use of improved models of bullock carts in Wardha District. The users of the improved carts have shown good interest in the improved designs of carts with newer materials like iron/steel which reduces the tare weight of the cart and increase the pay load capacity for transporting various commodities from one palce to another.

Other Devices

12.7 The agency has also demonstrated the use of multi-tool carrier viz Tropicultor in four districts of Maharashtra. The device is liked by the farmers as it helps them to do a number of agricultural operations and can also be used as a bullock cart in addition to eliminating the operators drudgery.

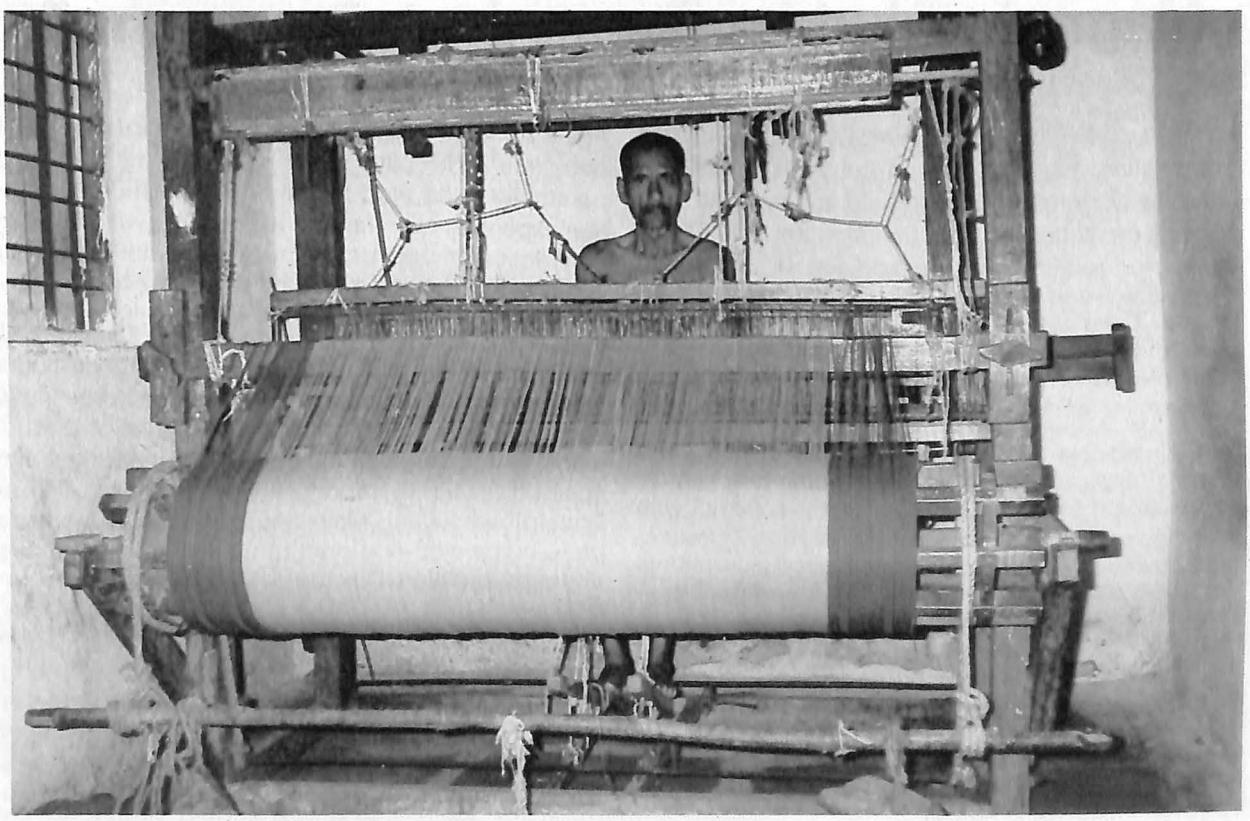
12.8 In another project, CARTMAN, Bangalore has initiated the study of existing designs of human muscle power devices viz. hand carts, wheelbarrows, cycle rikshaws with the object to find out difficulties in the existing designs and carry out suitable improvements/modifications and develop an improved proto type for reducing the pulling/pushing load of the operators.

An improved bullock-cart for 1.5 tonnes pay-load.

12.9 Economic Group, Madras has conducted a study in techno-economic profile of handloom sector in Karnataka and Uttar Pradesh with a view to study the efficiency of different types of looms, increase in productivity, increase in weavers earnings and manufacture, marketing and use of improved looms. The preliminary findings indicate that:- (i) majority of looms in operation are pit looms, frame looms, semi-automatic looms are found only in a few areas; (ii) the handloom activity in the past is highly homogenous in character with similar type of looms and cloth variety dominating the same; (iii) the activity being a traditional one, weavers tend to specialise in the production of cloth variety and operation of a particular loom type resulting in a low scale and low productivity and low wage syndrome; (v) weavers are reluctant to shift to any new fabric range or accept modification or introduction of new looms where human energy is less consumed; (v) potential in terms of production and from the point of view of use of improved looms, is yet to be exploited and a few of the improved looms in operation are yet to get a wider acceptance in view of their high financial cost.

12.10 Institute of Engineering and Rural Technology, Allahabad had developed a few models of improved cycle trailers, which could meet most transport requirements in rural areas. The rural and semi-urban areas fall within the range of 10 to 150 kg. pay load to be moved every distance of 1 to 25 km. The Centre at Allahabad has transferred the cycle trailer technology to nearby rural areas in Allahabad District. These cycle trailers are being field tested for their suitability for transportation of vegetables, grains, husk crops, fertilisers, liquids, like water, kerosine etc. on paved/ unpaved roads and sharp curbs efficiently. The trailer can be attached and detached with the help of hith mechanism and does not affect the usefulness of the bicycle. Due to its low centre of gravity, there is no toppling tedency even when it carries low density material viz. wood/paddy/wheat straw etc. There are more chances of buckling wheels even when it is roughly used because its wheels are made of angle iron which are quite rebust and economical too. Fabrication of the Cycle Trailer is quite simple and can be done with the help of simple workshop tools in any village. The cycle trailer has also openables backwall which facilitates in loading and unloading of material.

12.11 Extensive testing of improved models of various cycle trailers is being carried out in Allahabad District through different types of users i.e. hawkers, porters, farmers, vegetable sellers and various types of vendors who would use this trailer for increasing their occupational productivity; thereby improve their economic status. However, the initial feed back received so far reveals that the cycle trailer is of



An improved loom for higher productivity and variety in weaving.

rebust and durable design which enables substantial loads to be moved efficiently and safely and saves Rs. 30 to 100 per month incurred on other modes of transport. Being detachable, it does not effect the usefulness of the bicycle for personnel transport and can also be used in fields/villages as hand cart. This institute is creating awareness through different types of publicity materials in Hindi.

12.12 Under the Regional Centre for Draught Animal Power for Orissa, Orissa Renewable Energy Development Agency, Bhubeneswar has identified five human muscle power (HMP) devices viz. leaf stitching machine, leaf cup and plate making machines, rope making machines, sullabh pumps and improve tendas, modified them according to the local needs and demonstrated and popularised among the potential users.

Magneto Hydro Dynamics Programme

In case of Magneto Hydro Dynamic (MHD) power generation, the movement of conducting combustion plasma across magnetic field is employed. The plasma generated at high temperature (3000°K) is further ionized through the addition of potassium carbonate. High intensity magnetic fields are employed along with high gas velocity in the MHD channel wherein DC power is produced. Subsequent to the production of DC power, the enthalpy of the gas is extracted through a steam bottoming plant.

13.1 Under this programme, an experimental 5MW (thermal input) MHD plant was commissioned at Tiruchirapalli in March 1985 by BHEL & BARC with scientific cooperation from Institute of High Temperature, Moscow. The plant exhibited good operational capability as an integrated unit. The following important parameters were achieved:-

(1)	Maximum Thermal Input	: 5 MW
(2)	Maximum Combustion Product Mass Flow Rate	: 1 kg/S
(3)	Maximum Plasma Temperature	: 2850°K
(4)	Maximum Plasma Electrical Conductivity	: 12 mho/m
(5)	Maximum Magnetic Field	: 2 Tesla
(6)	MHD Power Output	: 3 KW
(7)	Duration of Power Generation	: 2 Hours
(8)	Duration of Plasma Generation	: 25 Hours
(9)	Total duration of Pilot Plant Operation	: 986 Hours
(10)	Maximum Hot Oxidizer Temperature from Air Pre Heaters	: 1520°C
(11)	Maximum Top Bed Temperature of the Air Pre Heaters	: 1750°C

13.2 So far 16 major Runs of the pilot plant have been completed. These Runs had an objective of optimizing the design configuration and other parameters as a individual unit and as an pilot plant as a whole.

13.3 Further Pilot Plant Runs were intended to test the seed recovery unit performance, evaluate the performance of airpreheaters and indigenous high alumina pebbles beds on a continuing basis. Indigenous pebbles withstood a top bed temperature of 1750°C for 60 cycles and post run observations indicated pebbles to be in good condition without deterioration.

13.4 The completion of three major runs during this year is considered to be a very significant achievement. During this period it was possible to operate the complete MHD pilot plant system at the full rated parameters and produce MHD power. The optimization experiments of the Air Pre Heater have also given confidence to operate the Air Pre Heater system to achieve the desired parameters for any subsequent power runs. The application of airpreheaters for Steel Industry is being pursued vigorously. Successful operation of airpreheaters for more than 2000 hours has given sufficient data and experience to use these airpreheaters for steel plants. After series of discussions, SAIL has given clearance for preparing a site specific feasibility report on demonstrating APH at Bhilai/Bhadrawathi. Major design calculations have been completed and draft of the feasibility report is under preparation. Discussions were held with Senior Representatives of TISCO and ICICI regarding application of pebble bed airpreheaters in TISCO Blast Furnaces and the initial response was favourable.

Slagging Coal Combustor

13.5 Development of Slagging Coal Combustor has been taken up for perspective application to Industrial furnaces and boilers as well. A test facility for the development of Slagging Coal Combustors has been commissioned and the first series of experiments have been completed. Experiments in Slagging Coal combustor using lignite and Jamadoba Middling A were conducted. Thermal input of 1.5-2.2 MW with adequate slag fusion and uniform thin layer of slag coating in both stages of combustor were achieved for the first time. Cold flow test rig has been commissioned for simulating slag flow behaviour.

MHD Retrofit Programme

13.6 A number of alternative schemes for retrofitting a 20 MW(e) system to an existing 60 MW(e) power plant at Ennore, near Madras have been worked out. The required feasibility report and other documents for getting clearance from the Government agencies have been prepared.

Superconducting Magnets

13.7 It has been proposed to construct a model superconducting magnet to gain experience in the construction of these magnets. Necessary preliminary calculations and concepts have been worked out.

Hydrogen Energy Programme

This programme covers the following main R&D activities:-

(i) Production of Hydrogen by photoelectrolysis of water.
(ii) Solid polymer electrolyte electrolyser development.
(iii) Production of Hydrogen by blue green algae and by certain bacterial species.
(iv) Storage of hydrogen through metal hydrides.
(v) Problems relating to utilisation hydrogen as fuel e.g. development of suitable engines.

14.1 Banaras Hindu University has been focussing on photovoltaic and photoelectrochemical electrolysis and emphasis has been placed on development and optimization of new photoelectrode materials e.g. TiO_2-In_2O_3 which can lead to production of solar hydrogen at viable efficiencies for from the problem of photoelectrode corrosion. Successful studies have been conducted on the micro organisms belonging to morphological and physiological groups which have ability to use wide range of visible light spectrum to split water into Hydrogen and oxygen. Particular attention has been paid in regard to the following:

(i) Hydrogenase-containing eukaryotic green algae.
(ii) Cell free chaloroplast system supplemented bacterial hydrogenase.
(iii) Blue green algae (eynobacteria growth and utilisation by bacterial in the raw materials e.g. domestic, agricultural industrial wastes for hydrogen production).
(iv) Development of solid polymer electrolyte electrolyser is being undertaken at Macromolecular Research Centre, Jabalpur.

14.2 Hydrogen reacts readily with many metals and alloys to form metal hydride. Storage of hydrogen in the form of metal hydride has an advantage like compact storage and safety. So far BHU has synthesized and optimized the RNi, FeTi and Mg La inter metallic storage systems. The optimum hydrogenations behaviour of misc. metal has been achieved by tailoring related materials $MnNi_{4.5}\ Al_{0.15}\ H_{5\text{-}6}$.

14.3 Another area being explored is the incorporation of hydrogen into thin film form at university of Rajasthan, Jaipur. These thin film hydrides provide large surface area with fast charging and discharging rate for hydrogen, low critical pressure and temperature, better heat transfer etc. The activation of thin film hydride is possible by coating a layer of catalytic material.

14.4 The hydride material developed and synthesised by BHU has been used to run a commonely available with suitable modifications (4 stroke, 100CC, 1 HP) on the road upto 25 Kms. At IIT Delhi, long term performance and emission data along with material deterioration studies have been conducted on hydrogen fuelled small horse power engine utility systems. At IIT Madras, the project on design and development of metal hydride heat pumps, heat transformers and their hybrids is progressing satisfactorily. They have been able to develop:

(i) Nomograms to obtain the performance characteristics of MHHP and MHPP devices at different operating conditions and for different pairs of alloys.
(ii) Design aspects of metal hydride systems based on heat and mass transfer aspects.
(iii) A simple design procedure to calculate the heat exchanger surface areas, operating temperatures, pressures, hydrogen concentrations etc. for fabrication of reactors.
(iv) A thermodynamic design to find the amount of metalhydrides required for a given output, pressures involved and the effect of container materials.
(v) An experimental set up to test individual reactors for heat and mass transfer.

14.5 In the coming year the following activities would be taken up based on the availability of funds:

(i) Development of solid state hydrides from indigenously available metals.
(ii) Modification of hydrides to act as fuel sources.
(iii) Development of heat exchanger hydride containers (Tanks) Development of Technology for use of Hydrogen as Fuel in the I.C. Engines for:
  a) Stationary Applications
  b) Dynamic Applications.
(iv) Viability of Storage mode of Hydrogen as a fuel for Fuel Cells.

Chemical Sources of Energy

A coordinated research programme called Trapping of Solar Energy through Chemical Routes sponsored by the Department covers the following three specific routes:-

(1) Photoelectrochemical;
(2) Photocatalysis;
(3) Photosynthesis (biomimetism).

15.1 Vigorous worldwide research during the past two decades has led to significant advances in all these three areas. This is an area of long term interest and therefore the Department has been supporting these programmes on a smal! scale. At the international level, two types of semiconductor-based photoelectrochemical cells (PECs) have so far been investigated; liquid junction solar cells (LJCs) which can convert solar energy into electricity with efficiency of upto 20% and photoelectrosynthetic (PES) cells which can utilize solar energy to dissociate water into Hydrogen with upto 13% efficiency.

15.2 Photocatalysis employs solar energy to facilitate several energetic reactions and thus brings about a reduction in fossil fuel use. Reactions amenable to photocatalysis include those which lead to the production of value added products from abundant raw materials such as water, carbon dioxide and nitrogen, and detoxification of industrial pollutants such as eyanides.

15.3 Plant and bacterial photosynthesis is also an efficient solar energy conversion method. Consequently, research in biominetism has been actively pursued all over the world. Several of the mechanisms involved in photosynthesis have been understood, but as yet, there are no viable models for solar energy trapping systems and for the coupling between the energy transduction unit and the reaction centre unit.

15.4 The Department had sanctioned as many as 19 research projects in this area with the following tasks and objectives:-

(i) To achieve efficiencies in liquid junction solar cells comparable with that reported from outside India and to determine the conditions under which these can be obtained.
(ii) To identify new electrode materials, electrolytes and methods of stabilizing electrodes.
(iii) To develop a rechargeable solar cell.
(iv) To study from basic science angle the factors that determine the efficiency of a PEC device.
(v) To construct and test artificial models for mimicking photosynthesis to gather and utilize solar energy efficiently.
(vi) To understand hydrogen production by algae, bacteria and chloroplasts and to develop hydrogenases with greater stability.

15.5 With Liquid Solar Junction cell have been able to achieve efficiency upto 17% at the Lab. scale with certain materials which can be used in rechargeable solar batteries. In the area of PEC cells efficiencies of 7 to 8% have been achieved. Extensive research work will be needed to develop a cost effective solar rechargeable batteries as hydrogen generation system and practical applications are expected in the long run. Former systems can be used for powering remote installations in conjuction with PV systems while the latter can provide hydrogen which can be converted efficiently on demand into electricity (through fuel cell) or motor powering (through I.C. Engines).

15.6 The following R&D activities are proposed to be taken up subject to the funds availability:-

(i) Scaling up of preparation, fabrication, performance test and stability tests on well-established materials.
(ii) Large area deposition of the above on suitable substrates.
— Vacuum evaporation,
— Spray Pyrolysis,
— Electrodeposition,
(iii) Crystal growth (large area) and thin films of WSez and related layer compounds and reproducibility tests for 17%.
(iv) Septum cells,
(v) PEC Rechargeable cells; Some progress made; More effort needed,
(vi) Search for new materials (SC electrodes) for PEC; particulate systems, polymer coatings on SC etc.,
(vii) Fundamental aspects of charge transfer etc.

Fuel Cells

15.7 Essentially, fuel cells are primary cells that will supply electric current for as long as they are provided with active materials or reagents that they equire.

15.8 In India, during the last three years efforts have been made to develop and strengthen infrastructural facilities needed for basic research in this area and few base line studies and State of Art papers have been prepared in respect of phosphoric acid fuel cells, molten carbonate fuel cells, solid oxide fuel cells etc. Work in TERI has focussed on the development of fuel processors which converts renewable fuels such as biogas and methanol into hydrogen, and efficient hydrogen utilisation in a phosphoric acid fuel cell. A demonstration unit of biogas PAFC, system coupling has been developed by TERI under a DNES project. This demonstration will go long way towards generating data and obtaining the operational and maintenance experience necessary for the future development and expansion of such systems. BHEL is currently involved in stack engineering; its main research objectives being to design and fabricate the basic fuel cells which can be ultimately incorporated into full scale PAFC power plants. At University of Hyderabad, Bio chemical fuel cells with immobilized enzymes electrodes are being developed. A nationally coordinated multi-institutional R&D programme and a test facility in this area has been envisaged involving following institutions:-

Organisation	**Task allotted**
BHEL, Hyderabad	Development of stack/processor/ auxillaries for 10 KW PAFC module with methanol fuel.
CECRI, Karaikudi	i) Evaluation procedures and long range testing. ii) Development of better electrodes.
TERI, New Delhi	Development of Better electrodes/ PTFE bonded bi-polar plates.
NPL, New Delhi	Development of glassy carbon bi-polar plates.
IICT, Hyderabad	Development of Alloy catalyst for cathodes.

Storage Batteries

15.9 The programme on storage batteries is for development of storage systems needed for intermittent energy sources like Solar, Wind etc., and for vehicular use. These batteries store excess electrical energy during off-peak hours. Amongst all the commercial batteries currently available lead acid battery seems to hold attractive position. However lead resources in India are rather limited. In other battery systems such as Nickel Cadmium, Silver Zink, Nickel Hydrogen etc. materials and construction methods are too expensive to find applications. As such, iron Air Secondary Battery is the system which can use virtually inexhaustible raw materials and provide a long charge and discharge life even under low maintenance conditions. Under a project at IISc, Bangalore, iron air batteries have been developed and tested. The energy per unit weight of the battery is satisfactory but its volumatic energy is comparatively low.

15.10 For a vehicle battery range is limited by energy density and acceleration is limited by the power density of the battery. Sodium Sulphur battery is a potential candidate. A DNES funded project on "Development of Sodium Sulphur Batteries" suitable for electric vehicles, statelite communications, photovoltaic Energy Storage and submarine power etc. has been undertaken at Central Electrochemical Research Institute, Karaikudi and NPL, New Delhi. CECRI, Karaikudi, has tested sodium sulphur individual cells of 10wh capacity.

Alternate Fuels for Transport, Ocean and Other Energy

Alternate Fuel for Surface Transportation

The Department is endeavouring to develop alternatives to reduce consumption of diesel and meter spirit through use of alcohols, methanol, ethanol, C.N.G. and Battery Operated Vehicles. Ocean and Geothermal Energy also offer potential alternate sources of energy.

Alcohol Usage Programme

16.1 A demonstration project for diesel replacement through dual-fuel system of Ethanol-Diesel has been taken up to run a fleet of 25 DTC buses in Delhi. The project has been undertaken for checking the performance of the vehicles, effects on the components and diesel substitution under actual commuting conditions. Upto November '91, the 25 vehicles had covered more than 20 lakh kms. and 9 to 14 per cent diesel replacement was achieved. Effects on engine deposits, lub-oil degradation oil consumption were normal with no adverse effects. A demonstration programme is being started for running Delhi Administration cars with petrol-alcohol mixture to quantify operational parameters with the objective of achieving about 10 per cent petrol replacement. The draft safety rules and codes of practice for handling methanol fuel in diesel vehicles has been submitted by the sub-group constituted, and the same is under examination.

Programme for use of Compressed Natural Gas (CNG)

16.2 A project sanctioned to IIT, Kharagpur to study the use of CNG in diesel and petrol engines under laboratory conditions is being continued. DNES propose to undertake a technology adaptation and demonstration project for use of CNG in diesel vehicles in Tripura Road Transport buses on dual-fuel mode. The project will be managed by the Indo-Burma Petroleum Company, Calcutta on a cost sharing basis.

Battery Operated Vehicles

16.3 DNES encourages promotion of Battery Operated Vehicles (BOV) by giving subsidy to Government and private organisations under the BOV Demonstration Programme. BOVs have inherent advantages of no-requirement of petroleum fuels, no noise and smoke pollution free operation.

Battery operated Vans avoid pollution.

Demonstration

16.4 BOV Demonstration Programme has been started at Delhi, Lucknow and a few other places. Delhi Energy Development Agency (DEDA) has the largest fleet of 99 vehicles and is operating on 16 routes carrying about 14,000 commuters daily. The Department is also providing an inter-Office Shuttle Mini Bus Service, operated by DEDA under a contract, between CGO Complex and North Block in New Delhi servicing various offices enroute. This service carried about 2.22 lakh passengers during January-December, 1991.

16.5 Similar but smaller scale demonstration programmes have also been taken up in Bharatpur National Park, Rajasthan, BHEL offices at Delhi, Haridwar, Jhansi, Lakshadweep administration; Pimpri Chinchward Municipality, Maharashtra Electricity Board, Bhatinda and Ropar Thermal Power Stations in Punjab, Andhra Pradesh State Electricity Board, M.P. Electricity Board etc. For movement of goods battery operated TOW Tractors also are being used at Hindustan Prefeb, New Delhi, International Airport Authority of India, New Delhi and Northern Railway under the demonstration programme.

Research & Development

16.6 BOVs are manufactured in the country by BHEL, Bhopal and Chatelec Vehicles India Ltd., Pune. BOVs have tended to suffer breakdown when everloaded as seen in the crowded areas of old Delhi. This in turn adversely affects their operational availability. To meet the problem BHEL has developed new Thyristorised Chopper Controller with indigenous raw material. To begin with 15 numbers of such choppers have been fitted in DEDA vehicles which have shown higher operational availability. BHEL has been commissioned to develop 40 passenger capacity battery bus, the prototype to which is likely to be available during 1992. The R&D efforts to improve performance of chopper controller, traction battery sets, vehicles chasis, body and other components/systems are being continued.

Ocean Energy

16.7 Ocean Energy is one of the important potential renewable sources of energy. Although in the present context this may not be viable in economic terms, research and development programmes for ocean energy should continue as it does not require any fossil fuel and is pollution free.

8 MW OTEC Plant at Andamans

16.8 The potential for Ocean Thermal Energy Conversion in Andaman & Nicobar Islands is high. As almost entire demand of power of A&N Group of Islands is met through DG sets, OTEC is likely to be techno-economically viable in these Islands. However, feasibility of this project has to be ascertained before undertaking the same.

Research & Development

16.9 The experimental project relating to extraction of energy from sea waves has been completed. The trials showed that conversion of kinetic energy into mechanical one was feasible. A project of material testing in ocean environment has been completed. Electro-chemical techniques were used for assessment under ocean environment for various metals and alloys. Experimental techniques were standardised for potentiostatic polarisation, potentio dynamic polarisation, Tefel plots, Linear polarisation measurements etc.

Geothermal Energy

16.10 Geothermal manifestations are widespread in India, in the form of 340 hot spring localities, many of them having temperature around near boiling point at their places of occurrence. At present we have following on-going R&D projects:-

5 KW Pilot power plant at Manikaran

(i) For effective utilisation of Geothermal Energy, a 5 KW pilot power plant based on closed loop Rankine cycle using F-113 as working fluid, was sanctioned to National Aeronautics Ltd. (NAL) and GSI Lucknow. The plant was successfully test run at full load of 5 KW under simulated conditions at NAL, Bangalore GSI had drilled the hot water holes. The plant has been installed at Manikaran by NAL and test run in August, 1989. It produced maximum gross power of 6.7 KWe from which if auxillary's power deducted, we got 5.2 KWe at turbine of 3000rpm. The plant was run successfully for 10 hours, and performance was demonstrated to HPSEB and GSI officials. A detailed check list showing the problems encountered had been prepared. It would again put on test run for another six months under NAL before handing it over to HPSEB. Detailed documentation on various aspects of the plant including its operation and maintenance is being prepared.

Geothermal Assessment Project

(ii) Geothermal energy manifests itself in the Puga Valley, Ladakh (J&K) located at distance of 180 Km from leh in the form of hot springs and pools with temperatures upto 81°C. The exploration activities carried out by Geological Survey of India (GSI) since 1973 have yielded valuable data on the geothermal potential at Puga.

(iii) The surface manifestations are spread in the eastern part of the Puga Valley over an area of 4 Km_2 (5 km×0.8 km). The electrical resistivity surveys and audio magnetotelluric (AMT) surveys have delineated a shallow reservoir extending over 4 Km and pointed towards the presence of a deeper reservoir over 6.5 km towards the southern ridge of the Puga Valley.

(iv) With a view to determining the parameters of deeper geothermal reservoir, intermediate depth geothermal drilling has been taken up as a part of Puga Geothermal Assessment Project. The first borehole was terminated at a depth of 384m in view of the difficulties encountered by GSI.

International Cooperation

The area of new and renewable sources of energy (NRSE) is receiving serious attention worldwide for a variety of enduses. India has been receiving requests from time to time from developing countries in Asia, Africa and Pacific Region to provide assistance to them in the field of NRSE. Some of the countries who had earlier approached India in this regard are Afghanistan, Angola, Bangladesh, Bhutan, Ghana, Indonesia, Malaysia, Mauritius, Tunisia Vietnam, Mongolia, Syria, Senegal, Madagascar, Uganda, Sri Lanka, Zimbabwe and the UN African Regional Centre for Solar Energy, etc.

17.1 A 3-member delegation from Ghana visited India from September 22 to October 1, 1991. The delegation was led by Hon'ble Minister of Energy, Republic of Ghana. The delegates visited Central Electronics Ltd., Masudpur Energy Complex, and BHEL, Bhopal among others.

17.2 The Government of Maldives is interested in cooperating with the Government of India in the field of new and renewable sources of energy. An expert from India is being deputed to Maldives to assist that country in regard to identification of projects/potential areas for possible cooperation between the two countries.

17.3 Two experts from Vietnam are obtaining training at IIT, Delhi in the field of NRSE under Indo-Vietnamese bilateral technical cooperation. The duration of the training is six months starting from August 1, 1991.

Delegation from Ghana holding discussions on N.R.S.E. at D.N.E.S., New Delhi.

17.4 A group of five experts was deputed by UNDP/ Govt. of Afghanistan to India for study tour for about two weeks in November, 1991.

17.5 A 13-member delegation was deputed to India from 7 to 15 September, 1991 by the African Regional Centre for Technology, Dakar. The delegates visited DNES and held discussions on 13.9.91 regarding NRSE. The delegates were from member States of the Centre in Africa. The delegates also visited Masudpur Energy Complex.

17.6 Delegates of the 37th Commonwealth Parliamentary Conference which was held in India from 19 September to 2 October, 1991 visited Masudpur Energy Complex on 27th September, 1991.

17.7 A senior officer from the Department was deputed by the Ministry of External Affairs is to Namibia from June 5 to 20, 1991 to assist that country in identifying potential for biogas and other renewable energies.

17.8 A group of four experts from the Republic of China visited DNES and held discussions to apprise themselves of the renewable energy developments in India.

17.9 A World Bank/UNDP mission visited India from June 24 to July 23, 1991 to hold discussions with DNES on technical and financial assistance requirements of various projects in NRSE posed for Global Environment Facility (GEF) funding. Another mission visited India from November 13-18, 1991 to follow-up the progress of project preparation work for mini-micro hydropower and alternate energy project for co-financing arrangements.

17.10 A meeting of the Group of Experts from G-15 countries was held in India from September 23 to 25, 1991 to discuss and finalise projects identified by the Heads of the State/Government of G-15 countries at a meeting held at Kuala Lumpur in June, 1990. These projects are on the establishment of a Gene Bank for medicinal plants and herbs in developing countries and solar energy applications. The meeting was attended by experts and senior officials from Algeria, Argentina, Brazil, Egypt, Indonesia, India, Malaysia, Mexico, Nigeria, Peru, Venezuela, Yugoslavia and Zimbabwe.

17.11 As part of the collaborative projects/activities with United States, Denmark and France, some

renewable energy devices/equipment were obtained for the purposes of carrying out their field trials in Indian conditions. Some Indian scientists obtained training, and technical assistance was made available for the Indian implementing institutes.

17.12 The details of assistance as part of the collaborative projects in the form of equipments instruments, technical assistance, training/study tours etc. are given in Annexure-I.

17.13 Some of the important on-going activities/ programmes or those under consideration include:-

(i) Availing external assistance to DNES projects (from World Bank/UNDP, USAID, GEF, Commission of the European Communities, etc.,)
(ii) Participation in International Exhibition in developing countries (for spread of Indian technology/equipments etc. and international cooperation).
(iii) Organising International Conferences/ Workshops on NRSE in India.

17.14 Officials from DNES participated in the following major technical meetings/training courses/ seminars, etc.:-

(i) Seminar on solar power systems held in Alustha, Soviet Union from April 22-26, 1991.
(ii) Conference and exhibition on Hydroenergia '91 held in Nice, France from June 12-15, 1991.
(iii) Technical Advisory Group Meeting organised by the World Bank/UNDP in Washington, DC from July 20-26, 1991.
(iv) Meeting of Intergovernmental Group of Experts on Renewable Sources of Energy held in New York from August 26-30, 1991.
(v) Training on Energy, Environment and Sustainable Development held at Copenhagen from April 10 to July 6, 1991.
(vi) Solar World Congress held at the University of Reading, UK from August 19-23, 1991.
(vii) European Wind Energy Conference and Exhibition held in Amasterdam from October 10-19, 1991.
(viii) Workshop on Solar Thermal Collector Testing held in Amman, Jordan from January 4-13, 1992.

17.15 A separate International Cooperation Division of DNES is coordinating all programmes, projects and other activities such as meetings, training, etc. in the field of new and renewable sources of energy.

DEPARTMENT OF NON-CONVENTIONAL ENERGY SOURCES

Annexure-I

Externally-Aided Projects/Schemes

Donor Agency/ country	*Project/ Scheme*	*Duration*	*Financial Indian input*	*Details External input*	*Current status*
DANIDA/Denmark	Non-Conventional Energy Pilot Project	June 87 to Dec. 90		DKR 21.3 M+2.62 M (Amt. disbursed/ utilised DKR 20.365 M)	12 solar thermal ice pack freezers; 3 solar thermal milk chilling plants; 10 SPV deepwell PV pumps; and 6 Wind machines. Wind turbines and SPV sub-projects completed; Solar thermal sub-project ongoing.
DANIDA/Denmark	Wind Mill Farms Project (20 MW)	December 1987 to Sept. 1991.	Rs. 11.98 crores by state agencies on local site works+Rs. 65 lakhs for customs duty by DNES for cranes towers etc.	DKR 180 M (amount disbursed/utilised DKR 177.30 M)	Project completed on schedule in May 90. Final taking over by state agencies/state electricity board planned for May 92, after completion of 2 years Defect Liability Period. (10 MW) Lamba, Gujarat; Kayathar (TN) completed on 31.3.90 (6 MW); and Muppandal (TN) completed on 1.4.90 (4 MW)

Grant in Aid by Govt. of Germany	Establishment of solar thermal test facility at solar energy centre	Oct. 90 to Sept. 93	Rs. 20,00,000	DM 4 Million	Construction of building to house solar simulator in progress; German side placed order for equipment.
Grant in Aid by Govt. of Germany á (GTZ)	Solar thermal pumps project (Phase-III) á	1988-92	Rs. 76,00,000	DM 1.19 Million	Technical drawing of solar thermal pumps have been given to BHEL; one pump and ásome ácomponents áawaited áfrom Germany.
KFW/Germany	For preparing a feasibility report for 30 MW solar thermal power plant project	July, 89 (For 6 months)		DM 501,900	Feasibility report has been received by Solar Energy Centre; comments awaited from CEA.
Aid to IREDA by the Govt. of Netherlands				17 M Dutch guilders; 7 M Dutch guilders grant in aid received by IREDA in August, 91.	The grant-in-aid was for maintaining revolving funds to provide loan assistance to project promoters
UNDP	Solar Energy Centre Project (Phase-II)	Initially approved for 3 years; extended for one year (March, 88-March 92)	Rs. 3,18,19,000	US $ 15,10,000	Some equipment obtained and scientists from the Solar Energy Centre obtained training abroad under this project.
UNDP	Development of Amorphous Silicon solar cells	5 years (Aug., 87-July, 92)	Rs. 1,22,40,690	US $ 29,44,200 (Amount disbursed/ utilised $ 26,69,478)	Deposition and characterisation equipments obtained and installed at IACS, Calcutta; project staff obtained training in USA.
UNESCO	For the promotion of cooperative programmes in the field of solar energy in Asia	(Mar., 89-Dec., 90)	—	US $ 12,000	Some activities initiated.
USAID/USA	R&D studies on Woody-biomass species for the arid marginal lands. (Mudurai Kamraj University and Bharathidasan University)	Initially approved for 3 years from 17.5.85; further extended till 31.7.92.	Rs. 18,28 lakhs	US $ 5.40 lakhs The aid was given in the form of equipment and for training to Indian Scientists in USA	Entire allocation utilised; equipment procured and installed by the Indian institutes for this projects. Scientits working in the project obtained training is USA.
USAID/USA	Production of Woody-biomass under sub-standard soils (NBRI, Lucknow)	Initially approved for 3 years from 12.12.84; further extended till 31.3.92.	Rs. 29,08 lakhs	US $ 4.60 lakhs The aid was given in the form of equipment and for training to Indian Scientists in USA.	—do—
USAID/USA	Establishment of National PV Test Facility (at Solar Energy Centre, Gwalpahari)	Till June '92	Rs. 1.38 crores	US $ 5,92,000 for equipment (Amount disbursed/utilised $ 3,86,373.09)	Four scientists obtained training in USA. Equipments have started arriving in India for the project.
USAID/USA	PACER	Aug., 87-June, 93; extended till June 96	$ 12 Million by way of revolving funds from Indian Entrepreneurs	$ 20 million (amount disbursed/utilised $ 1.516 million)	22 projects in energy sector taken-up

Planning and Promotional Incentives

During the year, Eighth Five Year Plan draft document (1992-97) on New and Renewable Sources of Energy (NRSE) programmes was prepared based on the recommendations of the Working Group set up by the Planning Commission under the chairmanship of Secretary, DNES. For preparation of Eighth Five Year Plan and Annual Plan 1992-93 on NRSE—active interactions were made with various State/UT governments and Planning Commission. Annual Action Plan 1991-92 for various NRSE programmes was prepared. Computerised data base on the achievements in the area of NRSE in various States/UTs was set up during the year. The Planning Commission have recommended an outlay of Rs. 128 crores for the Annual Plan 1992-93 due to resource constraints.

Thrust Areas

18.1 (i) Wider coverage and users' involvement in the National Programmes of Biogas development and Improved Chulhas.

(ii) Energy supply through NRSE systems and devices for remote, non-grid areas etc.

(iii) Extension of solar assisted water heating systems in the domestic, industrial and commercial sectors.

(iv) Development of mini/micro hydel power and other sources, especially decentralised systems for meeting local energy needs.

(v) Wide publicity for public information and awareness.

Special Component Plan

18.2 Programmes of new and renewable sources of energy are intended to provide energy for cooking, heating and lighting in rural areas in a decentralised manner. The National Programme on Improved Chulhas already provides benefits to about 30 per cent beneficiaries from SC/ST community. Higher rate of subsidy than applicable to general categories have been provided for Biogas for SC/ST beneficiaries under the National Project on Biogas Development.

Under the programme of Solar Photovoltaics, various photovoltaic systems, like street lighting systems, water pumping sets, community/TV lighting systems etc. are being earmarked for SC/ST communities. Similarly, appropriate allocations for Wind Mill and Urjagram projects are being made for the benefit of these communities.

Promotional Incentives

18.3 The scheme for promotional incentives to the State Governments and Union Territories introduced in 1984 for popularising new and renewable sources of energy systems and devices has been modified by including award of special shields for the implementation of such programmes for the welfare of SC/STs and for the development of hilly and farflung areas. Certificates of Appreciation are given to States standing second and third. From the year 1989-90, it has been decided to give rolling shield for overall best performance in various programmes. Cash prizes are awarded under the National Programme of Biogas Development. Under National Programme on Improved Chulha (NPIC), cash prize will also be awarded effective from the year 1991-92 for best product and best Technical Back-up Units. In addition, Cash prize is given to the best young scientist in the area of gasifiers and stirling engines. Names of States recommended for the awards for the year 1990-91 for various programmes are given in the table, at he end of the chapter. In addition, cash prizes were awarded to the States for excellent performance in Biogas & Wind energy programmes.

Fiscal Incentives

18.4 The Union Government continued to extend various incentives to industries engaged in manufacture and utilisation of NRSE systems and devices in respect of central taxes like income tax, customs and central excise etc. Various State governments also continued to allow concessions/exemptions under States' Sales Tax on the sale of NRSE systems and devices. All State governments/Union Territories were requested to continue exemption of Sales Tax/Central Sales Tax on NRSE systems and devices in the larger interest of the industry as well as users considering the infancy of most of these programmes.

18.5 Under the recent Industrial Policy announced on 24th July, 1991, industries engaged in manufacture of Alternate Energy Systems like Solar, Wind etc. and

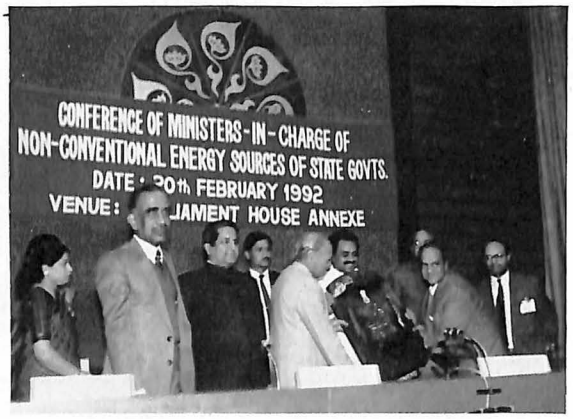
equipment therefore have been granted automatic approval of foreign technology agreements including 51% foreign equity.

Ambedkar Centenary Celebrations

18.6 Twenty villages have been adopted by DNES for the implementation of renewable energy programme under the *Ambedkar Centenary Celebrations* on the directives of the Prime Minister. Some of these villages do need some solar thermal devices also which have been in principle agreed to be installed in these villages.

Presentation to the Prime Minister

18.7 Department made a presentation to the Prime Minister on 30.12.91 regarding various activities of NRSE programmes. During the discussions, the Prime Minister envinced keen interest in various programmes and suggested greater role of NRSE in meeting energy needs in rural areas and contribution to overall power production. The Prime Minister was kind enough to address the State Ministers conference on Non-conventional Energy Sources on 20.2.92 at New Delhi. In his address the Prime Minister urged the State Governments, Scientists and Technologists to promote renewable energy technologies which are cost effective and suiting to rural masses in varying geographic regions. The Prime Minister also gave away Shields and Certificates to the States for the best performance.



The Prime Minister is giving away a Shield.

Data Bank

18.8 The Data Bank Unit has computerized various information systems for the Department. The computer facilities available in the department have been enhanced. A database has been created on the NRSE installations in the country. The power generation data from different wind farms are computerized. A management information system has also been developed for the NPIC. The software for preparing Wind Farm Power generation data was released to Wind Farms during the Wind Energy Coordination meeting held on 22nd Aug. 1991.

18.9 A special training programme for the officers of the Department on computer systems was held in January, 1992. It is envisaged to give basic training to most of the officiers/officials in the current year.

Award of Shields & Certificates for 1990-91

S. No.	*Programme*	*Main Shield (First place)*	*Special Shield (SC/ST/Hilly/ Farflung areas)*	*Certificate of Appreciation (Second and third place)*	*Rolling Shield (Overall best performance)*
1.	Improved Chulha	Kerala	Sikkim	Goa & Punjab	Gujarat & Tamil Nadu
2.	Bio gas	Gujarat	—	—	—
3.	Solar Thermal Energy	Maharashtra	Meghalaya	Delhi & Haryana	—
4.	Solar Cooker	Madhya Pradesh	Manipur	Punjab & Himachal Pradesh	—

Administration & O.M.

The Department of Non-Conventional Energy Sources was set up on September 6, 1982. On the formation of Ministry of Power & Non-Conventional Energy Sources Shri Kalp Nath Rai took charge as the Minister of State (Independent Charge) w.e.f. June 26, 1991. Shri K. Venkatesan took charge of the post of Secretary of the Department from November 1, 1991.

19.1 The following mandate is assigned to this Department under the Allocation of Business Rules:

i) Research & Development of Biogas programme relating to biogas units.
ii) Commission for Additional Sources of Energy.
iii) Solar Photovoltaic devices, including their development production and applications.
iv) Mini/Micro Hydel Projects of and below 3 MW capacity and Geo-thermal energy.
v) Programmes relating to Improved Chulhas and Research & Development thereof.
vi) Indian Renewable Energy Development Agency.

Welfare of Weaker Sections

19.2 The instructions issued by the Government regarding reservation in service for Scheduled Castes, Scheduled Tribes, Ex-Servicemen and Welfare of Minority Communities are being followed in the Department scrupulously.

Work Study and O&M

19.3 An Assessment Team as prescribed in respect of Scientific Department was constituted with the approval of the Secretary, D.N.E.S. to conduct Work Measurement Study of Scientific and non-Scientific posts in the Deptt. The Team was further sub-divided into sub-teams and a specific area for assessing the staff strength was allotted to each sub-team.

19.4 The Work Study in respect of Regional Offices/ Monitoring Cells, Parliament Section, Library, Administration Sections including Record Section, and Vigilance Unit has been completed and draft report prepared.

19.5 Chairman of the Assessment Team had discussions with various sub-teams. Work Study in respect of other areas is in progress.

Use of Hindi

19.6 During the year 1991-92, a number of measures were taken for accelerating the pace of implementation of the Official Language Policy in the Department. Special emphasis was laid on improving percentage of correspondence in Hindi with offices/ individuals in Regions 'A' & 'B'. Almost all the Typists and Stenographers were either imparted or were nominated for training in Hindi typing and Shorthand. In addition, nine officers/employees were also nominated for the various courses (Probodh, Praveen and Pragya) under Hindi Teaching Scheme for learning Hindi.

19.7 The provisions contained under Section 3(3) of the Official Language Act, 1963, as amended from time to time, are strictly followed. Notwithstanding the high technicality involved in the work of this department, efforts were made to spread the use of Hindi in certain specified areas like noting and drafting and during the year under review, cash awards were also given to officials for carrying out maximum work in Hindi under the incentive scheme for Hindi noting/ drafting in official work.

Hindi Committees

19.8 Meetings of the Departmental Official Language Implementation Committee are held regularly to review the progress made in the implementation of the official language policy in the department.

Hindi Day

19.9 With a view to creating awareness and accelerating the use of Hindi as official language, 'Hindi day' was celebrated in the Department on the 16th September, 1991 and a number of competitions were conducted to mark this occasion. The participants excelling in their performance were given prizes and certificates.

Jayanti Programmes

19.10 Under this programme, the department celebrated a series of "Jayanti's" of great personalities in which officials expressed their views in Hindi. The Non-Hindi-speaking officials were also encouraged to participate. The Jayanties of Gautam Budha, Kabir Das, Tulsidas and Guru Nanak Dev were celebrated and the participants were awarded prizes.

Hindi Literature and Publications

19.11 During the year, publication of Urja Bharti, a Hindi Journal has been recommenced. Booklets on Biogas, Improved Chulha and Solar Cooker are under publication in Hindi.

Indian Renewable Energy Development Agency

Indian Renewable Energy Development Agency Ltd., (IREDA) a public sector undertaking was set up in March, 1987 to promote, develop and commercialise technologies relating to New & Renewable Sources of Energy by arranging and extending soft term financial assistance.

Resources

20.1 The Seventh Plan allocation of Rs. 10 crores was released to IREDA as equity captial. In addition, IREDA also received grant-in-aid amounting to 10 million guilders (equivalent to Rs. 7.60 crores) from the Government of Netherlands for financing NRSE technologies in specified areas. To strengthen its resources base, the Government allowed IREDA to raise Rs. 25 crores from the capital market through 9 per cent tax free Bonds. A plan allocation of Rs. 4 crores has been made for IREDA for the year 1991-92. On the basis of recommendation of Indo-Dutch Evaluation-cum-Formulation Mission, the Government of Netherlands have reportedly agreed to provide additional 30 million guilders to IREDA during the next three year's period. The first instalment of 7 million guilders is expected to be released during 1991-92. A number of foreign governments have shown interest in assisting IREDA to promote NRSE technologies in the country. Further IREDA is negotiating with the World Bank for grant of credit line to finance Mini/Micro Hydel and Wind energy projects in the country.

Operations

20.2 During the year 1991-92 IREDA received 40 applications for a team loan of Rs. 41.02 crores upto 30th November, 1991. It sanctioned 42 projects including old applications for Rs. 21.7 crores. The loan sanctioned during this period works out as 83% of the amount sanctioned during the full year of 1990-91. Loan has been disbursed to 19 projects for Rs. 3.33 crores, during the said period of 8 months.

Upto March 31, 1991 IREDA received a total of 251 applications involving the total cost of Rs. 473.07 crores. Against this, IREDA sanctioned 112 projects to the extent of Rs. 30.82 crores and disbursed Rs. 19.35 crores in respect of 66 projects.

Recoveries

20.3 Against dues of Rs. 1.87 crores as on 30th September, 1991 IREDA recovered Rs. 1.45 crores. It amounted to 78 per cent of the total dues.

Area and Scope of Cooperation

20.4 The project sanctioned during the current year related to various NRSE programmes in the country.

Energy Conservation

20.5 Projects financed by IREDA till 1990-91 are expected to save energy of the order of Rs. 42.49 crores per annum. The likely savings are estimated in terms of mineral, coal, furnace/diesel oil, wood and electricity.

Profitability

20.6 IREDA's financial performance in terms of profitability has been positive since the inception. Its profit before tax despite soft term lending increased from Rs. 15 lakhs in 1987-88 to Rs. 124 lakhs in 1990-91. Its gross profit is estimated at Rs. 94 lakhs in the first half of the year 1991-92, and this works out as 82 per cent of the estimated profitability of the company for the full financial year.

Information and Public Education

The package used during the year 1991-92 comprised of the electronic media, print media, exhibitions, films, audio visual and outdoor publicity. Steps have been taken to coordinate information and publicity work with the State Nodal Agencies by way of financial assistance, supply of literature, video films, exhibits, and sponsoring exhibitions. An incentive scheme for giving awards to the nodal agencies for best work in publicity has also been proposed from this year. The State agencies have also been advised on the publicity measures which may help in popularising the concept of NRSE, devices and applications.

Publicity through Electronic Media (Radio & TV)

21.1 Publicity through electronic media comprising Radio and TV has been given a thrust during the year. Radio jingles and spots on the programmes of biogas and improved chulha have been broadcast in Hindi and in regional languages from 29 Radio stations of All India Radio. Likewise, a video spot each on biogas and improved chulha are slated for telecast in Hindi and the regional languages from different Doordarshan Kendras.

Films and Audio Visuals

21.2 Publicity through films and audio-visuals by way of production of new titles, dubbing in regional languages and their distribution and display was continued. Films on improved chulha, biomass and power generation were completed during the year. The production of a new film entitled "Renewable Energy" as a benign source of power was also taken up. Conversion of a 35 MM documentary film on biogas in Hindi and 14 regional languages in 16 MM was done through the Films Division for screening through the country wide network of the Directorate of Filed Publicity, Ministry of Information and Broadcasting. Further, the work of making copy prints for four video films has been taken up for distribution to the State Nodal Agencies and other institutions.

Photo & Audio Visual Unit

21.3 The Photo Unit continued to meet day-to-day requirements of photographs, slides and audio visual material to the Department and outside users. A slide show was prepared and presented by the Department to the Prime Minister of India about various activities in December, 1991.

Exhibitions & Display

21.4 NRSE exhibitions put up by the Department have been in demand over the years as they provide display of indoor exhibits, photographic panels, working models and outdoor display of systems & devices in action together with supply of informative brochures and booklets to the visitors.

21.5 The annual target of 20 exhibitions has been achieved by the end of December, 1991. To meet the

An out-door view of N.R.S.E. exhibition.

An In-door view of N.R.S.E. exhibition.

additional requests for participation the Department is planning to organise 5 more exhibitions upto March, 1992. The Department bagged First Prize and Gold Medal at Gwalior exhibition during the year.

21.6 Additions and replenishment in exhibitions inventory have been planned for the year. Four sets of working models of biogas, wind mill, solar hut and solar water heating system are under production. The preparation of translites on various NRSE subjects is under progress.

Mobile Exhibition Vans

21.7 The mobile exhibition van is fitted with working systems and devices demonstrating actual operation to the viewers. It also provides for showing of films, audio-visual slides, distribution of literature, posters and brochures on renewable energy. The mobile exhibition van offers a number of advantages as it holds exhibition at a short notice with economy in the cost and time. Such vans are available at present with nodal agencies in the states of Maharashtra, Orissa, Madhya Pradesh, Gujarat, Tamil Nadu, Uttar Pradesh and Delhi. The Govt. of India invited proposals from various States/UTs for provision of at least one mobile van in a State/UT on cost-sharing basis (50% by DNES & 50% by State nodal agency).

21.8 The National Council of Science Museum is setting up Energy Hall at Pragati Maidan, New Delhi with the cooperation of other scientific departments. This department, one of the participants, has provided a set of 30 photographic panels and write-ups during the year and initially shared partly the cost of construction and maintenance of the Hall.

Publicity through Print Media

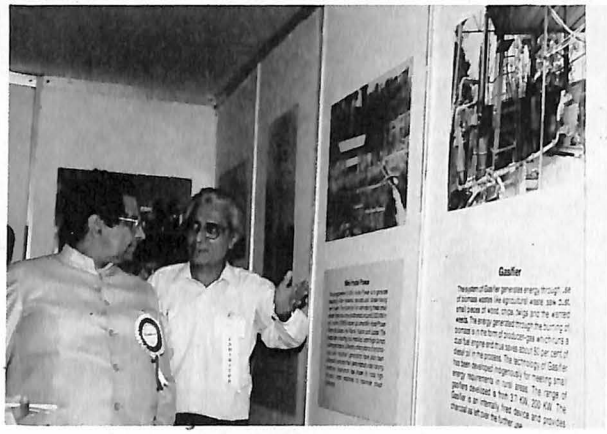
(a) Postal Stationery

21.9 To popularise national programmes of biogas and improved chulha, message on postcards/inland letters have been printed and are presently under distribution by the Department of Post.

(b) Publication Programme

21.10 The Division arranges for preparation and printing of Annual Report, booklets, folders, posters, etc., for dissemination of information to various agencies and public. During the year following publications have been undertaken:—

i) Annual Report 1990-91 (Hindi & English separately)



The Union Minister, Shri Kalpnath Rai visiting D.N.E.S. pavalion at Energy-91 exhibition, Madras.

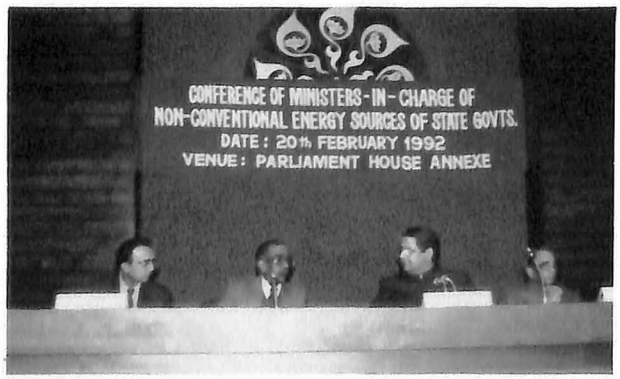
ii) Three folders in multi-colour on biogas, improved chulha and solar cooker in English & Hindi.
iii) The publication of Urja Bharati, a Hindi quartely, has been resumed during the year.
iv) A special number of Urja Bharati devoted to Mini Micro Hydel.
v) The technical journal Antika on Improved Chulha.
vi) Pamphlets and handouts for exhibitions.

Library and Documentation

21.11 The departmental library added 330 titles including 100 books in Hindi. The documentation services and supply of newspapers, clippings, literature, posters continued during the year.

Seminars, Symposia and Workshops

21.12 The objective of organising or supporting conferences, seminars, symposia and workshops is



An inaugural session of the Conference of Minister-In-Charge of Non-conventional Energy Sources of State Governments, at New Delhi.

to bring about mutual interaction, exchange of latest information in specialised fields of knowledge and create awareness among the people. The Department provides financial assistance for holding national and international conferences and holding seminars by Government, semi-governments, or autonomous organisations like universities, colleges, academic organisations, national and international professional societies and other non-Government bodies.

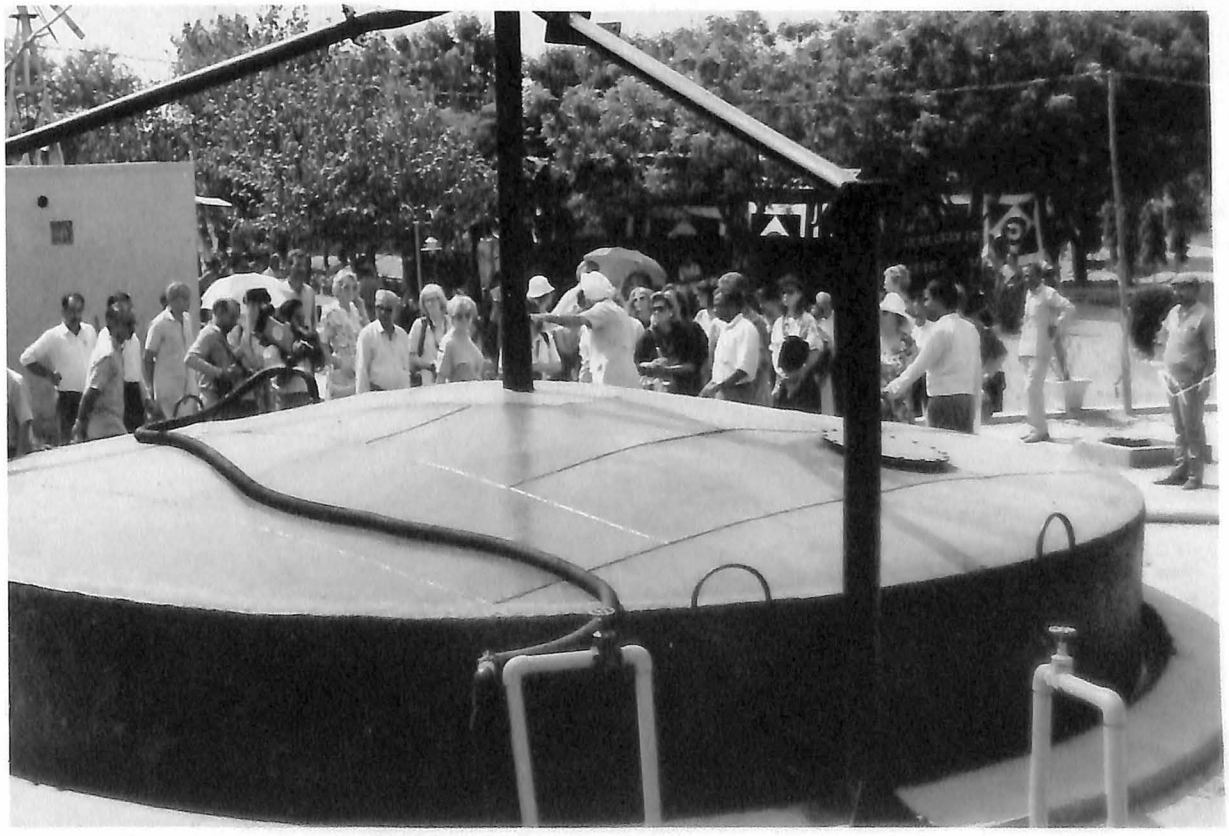
Manpower Development and Training

21.13 The objective of this scheme is multi-fold:

(i) To educate and train the scientists, engineers, technicians, users about NRSE devices and national programmes on NRSE.

(ii) To provide young scientists, engineers, technicians for visiting national institutes to enable them to participate in and contribute to the latest developments in the field of NRSE and use their experience and talent to strengthen our national programmes.

(iii) The financial support is extended scrupulously in keeping with directives of the Government.



Visitors from Commonwealth countries at NRSE Complex Masudpur

The Commission for Additional Sources of Energy (CASE)

List of Present Members

Chairman	* Secretary, Department of Non-Conventional Energy Sources, New Delhi.
Members	* Secretary, Department of Expenditure, Ministry of Finance, North Block, New Delhi.
	* Secretary, Department of Agriculture, Research & Education, Krishi Bhawan, New Delhi.
	* Secretary, Department of Power, Shram Shakti Bhawan, New Delhi.
	* Secretary, Department of Science & Technology, Technology Bhawan, New Delhi.
	* Secretary, Planning Commission, Yojana Bhawan, New Delhi.
	Sh. A.M. Thomas, 'Alunkal', Palimukh Wariam Road, Ernakulam, Cochin.

* Ex-officio