

**REPORT OF THE
WORKING GROUP
ON
NEW AND RENEWABLE ENERGY
FOR
XITH FIVE YEAR PLAN (2007-12)**



**GOVERNMENT OF INDIA
MINISTRY OF NEW AND RENEWABLE ENERGY
DECEMBER 2006**

**XITH PLAN PROPOSALS
FOR
NEW AND RENEWABLE ENERGY**

**MINISTRY OF NEW AND RENEWABLE ENERGY
GOVERNMENT OF INDIA
DECEMBER 2006**

CONTENTS

CHAPTER-I	:	BACKGROUND
CHAPTER-II	:	REVIEW OF PERFORMANCE DURING 10 TH PLAN
CHAPTER III	:	GRID-INTERACTIVE AND DISTRIBUTED RENEWABLE POWER
CHAPTER-IV	:	RENEWABLE ENERGY FOR RURAL APPLICATOINS
CHAPTER-V	:	RENEWABLE ENERGY FOR URBAN, INDUSTRIAL & COMMERCIAL APPLICATIONS
CHAPTER-VI	:	RESEARCH, DESIGN & DEVELOPMENT
CHAPTER-VII	:	SUPPORTING PROGRAMMES
CHAPTER-VIII	:	SUMMARY OF PLAN PROPOSALS
CHAPTER-IX	:	PERSPECTIVE PLAN 2022
ANNEXURE-I	:	TERMS OF REFERENCE OF THE WORKING GROUP
ANNEXURE-II	:	TERMS OF REFERENCE AND COMPOSITION OF SUB-GROUPS
ANNEXURE-III	:	INCENTIVES PROVIDED FOR RENEWABLE POWER IN OTHER COUNTRIES
ANNEXURE-IV	:	ESTIMATED RENEWABLE ENERGY POTENTIAL

CHAPTER-I

BACKGROUND

1.1 Constitution of Working Group

1.1.1 A Working Group under the Chairmanship of Secretary, MNRE was constituted by the Planning Commission through O.M. No.P-11072/02/2006-RE/P&E dated 20 April 2006 for the formulation of 11th Five Year Plan (2007-2012) proposals for Non-Conventional Energy Sources, viz., New and Renewable Energy. The Terms of Reference (ToR) of the Working Group are given in Annexure-I. In order to assist the Working Group in its task, four Sub-groups were constituted in keeping with the ToR through MNRE O.M. No. 1/4/2006-P&C dated 19 June 2006 as follows:

- i) Renewable Power
- ii) Renewables for Urban, Industrial and Commercial Applications
- iii) Renewables for Rural Areas
- iv) Research & Development in Renewable Energy

The Terms of Reference and Composition of these Sub-groups are given in Annexure-II.

1.1.2 The Reports submitted by the Sub-Groups are annexed separately in Volume II of this report.

1.2 NEED & PROSPECTS FOR NEW AND RENEWABLE ENERGY:

1.2.1 Energy 'self-sufficiency' was identified as the major driver for new and renewable energy in the country in the wake of the two oil shocks of the 1970s. The sudden increase in the price of oil, uncertainties associated with its supply and the adverse impact on the balance of payments position led to the establishment of the Commission for Additional Sources of Energy in the Department of Science & Technology in March, 1981. The Commission was charged with the responsibility of formulating policies and their implementation, programmes for development of new and renewable energy apart from coordinating and intensifying R&D in the sector.

1.2.2 While apprehensions about supply and price of oil and their impact on the economy were recognized as the key issues, the broad areas assigned to the Commission, which include solar, wind, biomass and other new sources, tended more towards replacement of coal rather than oil. Accordingly, deployment achievements of MNRE (earlier DNES upto 1992) so far in renewable energy have done more for replacement of coal than oil.

1.2.3 Even so, these achievements have been worthwhile considering that the country today is an importer of coal. Projections made in the Integrated Energy

Policy Report (IEPR) reveal that to achieve its development goals, the country would need to rely increasingly on imported oil, gas and coal in the medium-term (2032).

1.2.4 In this backdrop the role of new and renewable energy assumes added significance, irrespective of whether it replaces coal or oil. In this regard, IEPR recognizes *'the need to maximally develop domestic supply options as well as the need to diversify energy sources ...'* although renewables are likely to account for only around 5-6 per cent of the primary commercial energy-mix by 2032. It is an imperative of the development process that this energy in the longer term will substantially increase its share in the fuel-mix.

1.2.5 Continuing to support the growth of new and renewable energy is in the country's long-term interest. Although, the development process may warrant selection of least-cost energy options, strategic and environmental concerns may, on the other hand, demand a greater share for new and renewable energy even though in the medium-term this option might appear somewhat costlier. Thus, a balanced approach for new and renewable energy that factors in the need to develop domestic and inexhaustible sources of energy has to be adopted.

1.3 APPROACH DURING 10TH PLAN

1.3.1 The approach for deployment of new and renewable energy systems/devices during the 10th Plan and before focused on a mix of subsidy, fiscal incentives, preferential tariffs, market mechanism and affirmative action by way of legislation and policies. Subsidies have attracted criticism from the Planning Commission on the ground that they *'... should be linked to outcomes (energy generated) and not just outlays (capacity installed).'* In this regard, IEPR has observed that there could be cases where subsidy might have even adversely impacted market growth.

1.3.2 Subsidies during the 10th Plan have been extended to renewable power (except wind and subsequently solar power) and stand-alone off-grid systems/devices. Financial support has also been extended to R&D, information & publicity and other support programmes. The targeting of subsidy has been questioned only in the case of renewable power and an alternate approach in the form of Tradable Tax Rebate Certificate (TTRC) based on actual electricity/energy certified as having been actually supplied has been suggested in IEPR.

1.3.3 While questions are being raised about subsidies in this country, many developed countries have increased the level of incentives for renewable energy. Solar power is incentivised through feed-in tariffs in Germany, Spain, France and a large number of European countries. Similar incentives are being extended in several states of the United States. A chart showing the incentives provided in

some of these countries is at **Annexure-III**. Hence, it would not be prudent to do away with subsidies altogether although there may be a case for tapering them over time as the sector grows and replacing them with fiscal incentives.

1.3.4 Tax credits, whether tradable or otherwise, for renewable power have been introduced in a few countries. Their introduction in this country has been taken up with the Ministry of Finance.

1.3.5 Keeping in view the contention that subsidy in renewable power sector (except wind and solar) for removal of barriers is unavoidable, the same needs to be linked to some form of desired outcomes. A beginning in this direction has somewhat been made during the 10th Plan in small hydro where subsidy is sought to be given only in cases where the installed equipment conforms to International Electromechanical Commission (IEC) standards. The desirability of linking subsidies to project equipment conforming to IEC standards or national standards harmonized with international standards has been felt necessary in order to make available in the market equipment of desirable quality apart from making Indian new and renewable energy industry competitive, in keeping with the strategic aim of the Ministry.

1.3.6 Subsidy for off-grid stand-alone systems/devices has been provided to make them more affordable so as to increase their penetration for attainment of the national goal of Energy for All by 2012. Even in such cases subsidy needs to be linked to equipment conforming to IEC standards or national standards that are harmonized with international standards. Financial Support to Research, Design & Development activities was continued in keeping with the aim of making new and renewable energy industry in the country competitive.

1.4 APPROACH FOR 11TH PLAN

1.4.1 Programmes of the Ministry for 11th Plan have been drawn up in the light of recommendations made by CASE, Planning Commission and those made in IEPR. Accordingly, it is proposed to rationalize development and deployment strategy and in the former give a thrust through a sector-based approach in place of individual technology approach adopted during the 10th Plan. The approach adopted hitherto, it was said, was somewhat lacking in focus, suffered from lack of effective coordination, even led to duplication of efforts in some cases, with the result that desired outcomes and impact might have been somewhat affected at times. These shortcomings are sought to be overcome through well defined aims, target areas, integration of efforts and proper coordination among different programmes. Towards this end, the existing programmes are proposed for rationalization with several being rationalized or clubbed together for effective targeting and operational ease. The 5 Programmes proposed are:

- (i) Grid-Interactive and Distributed Renewable Power;
- (ii) Renewable Energy for Rural Applications;
- (iii) Renewable Energy for Urban, Industrial & Commercial Applications;
- (iv) Research, Design & Development for New & Renewable Energy;; and
- (v) Supporting Programmes.

1.4.2 Deployment activity is proposed to be carried out through 3 Programmes, namely, Grid-Interactive and Distributed Renewable Power; Renewable Energy for Rural Application; and Renewable Energy for Urban, Industrial & Commercial Applications. Distributed renewable power would include that for captive use in industry. All Research Design and Development activity is also proposed to be brought under a single umbrella programme. This activity is sought to be made product development oriented, with industry as lead partner and with clear well defined outcomes. Deployment and Development activities are sought to be given a multiplier effect through supporting programmes.

1.4.3 Deployment activity is further sought to be made market driven, as suggested in IEPR and subsidies are not proposed for inducing a supply driven approach. Further, as also suggested in IEPR, it is proposed to make use of subsidies to focus on desired outcomes through removal of barriers, while at the same ensuring that outlays are strongly correlated with outcomes.

1.4.4 Since wind power has not been receiving subsidy but only fiscal incentives, the same approach is proposed for continuation during the 11th Plan as well, and work simultaneously for introduction of tax credits as above. Distributed solar power - whether through rooftop systems or otherwise - needs to be promoted when the technology improves and unit cost of generation come down to competitive levels. Solar power, like wind power, could be promoted through fiscal and other measures like feed-in tariff, where there is an effective demand backed by an ability to pay for such systems and not merely induced through affirmative action. Further, because of apprehensions in certain states that forest wood might have been diverted to biomass power projects, subsidy is proposed only for non-fuel wood biomass power unless projects can demonstrate that at least 50 per cent of fuel-wood requirement would come from dedicated plantations, specially raised for the purpose.

1.4.5 Subsidy for distributed/decentralized renewable power generation in electrified/to be electrified areas is proposed on the ground that such power might lead to enhanced economic activity in an environment of electricity scarcity. Accordingly, subsidy is proposed to be confined to projects that spur and/or sustain economic activity and where there is an effective demand for such systems backed by financial incentives. Further, it needs to be ensured that such systems are capable of meeting the life-line access norm of

1kWh/day/household apart from providing adequate power for economic, community and educational needs.

1.4.6 Subsidy for some stand-alone off-grid systems cannot be done away with at this juncture even with an enhanced level of fiscal concessions. Wherever, fiscal concessions alone can suffice, subsidy has not been proposed.

1.4.7 Subsidy level in deployment programmes is sought to be kept within 25 per cent level of total system/device cost, except where positive affirmative action warrants otherwise. Cases requiring such action are proposed to be limited to Remote Villages and in MSW to Energy. In Special Category States, the aforementioned subsidy level in deployment programmes is sought to be kept within 33 per cent. In cases where subsidy level were to exceed 25/33 percent, as the case may be, these would be brought under an extension programme, where deployment would aim to play only a catalytic role and accordingly would be limited. SPV system/device deployment on a limited scale would be effected through this programme, alongwith some other RE systems/devices to be displayed in dominant public places, including parks/gardens and institutions-educational and religious.

1.4.8 Subsidy is not proposed for O&M expenses in deployment programmes which in the first instance have to be designed to ensure sustainability of systems/devices provided by duly factoring in economic/social profiling of targeted beneficiaries. Sustainability has to take into account, among others, ability to (i) absorb technology; (ii) overcome barriers to community participation in the running of the systems; (iii) generate income from energy provided; and (iv) use part of savings on O&M expenses on systems/devices provided. However, for systems/devices provided to BPL families and in Remote Village an inbuilt provision for O&M expenses for 5 years could be provided as a part of the cost of the system/device. Even in such cases, without integration with other programmes of the Government that could provide income generation through energy supplied, sustainability might become doubtful. Hence, integration of MNRE deployment programmes with those of other Ministries is considered essential for income generation through energy obtained for ensuring sustainability.

1.4.9 Since SPV home-lighting systems would not be in a position to meet the lifeline supply norm of 1kWh/household/day, as given in the Rural Electrification Policy -REP (2006), the same is required to be treated as an interim solution for villages not likely to receive grid-connectivity or DGS under RGGVY, in keeping with the recommendations of the GOM in its meeting held on 19 May 2006 to consider REP. Such systems would be provided in villages during the 11th Plan, where neither grid-connectivity nor DGS are being provided under RGGVY or where deployment of RE-DGS is either not feasible or

cost-effective. It may be stated that biomass, including biofuel DGS systems are currently only in technology demonstration phase and have not yet attained commercial maturity for deployment which narrows down the choice to SHP systems alone, since solar power is also ruled out at this juncture because of its cost-ineffectiveness. Situation may change during the course of the plan period with technological breakthroughs and lowered costs.

1.4.10 MNRE has been providing SPV home-lighting systems since 2001-02, the terminal gear of the 9th Plan and under the RVE programme during the 10th Plan, when it underwent several rounds of rationalization. First, its coverage from the close of 2002-03 was to be limited to villages not likely to receive grid-connectivity by 2012. Going by this definition, a list of 25,000 'remote' villages was compiled on the basis of information furnished by the states. Subsequently, with the announcement of the CMP (2004) proclaiming provision of electricity to all households by 2009, and RGGVY (2005) which intends to achieve this aim in respect of rural households, the list of 25,000 'remote' villages to be covered by SPV home-lighting systems became obsolete. REP(2006) which required provision of minimum life line supply of 1kWh/household/day made this list totally redundant, since SPV systems are just not in a position to meet the lifeline consumption norm in a cost-effective manner. Hence, provision of SPV home-lighting systems to villages not covered by RGGVY has to be treated as an interim solution pending provision of life-line supply to such villages. As regards possible renewable energy DGS solutions, only small hydro, as stated above, can be considered in such of those villages where feasible and cost-effective for the present. Accordingly, coverage of villages not covered by RGGVY is proposed to be limited to 10,000 during the 11th Plan, of which not more than 1000 might be provided RE-DGS.

1.4.11 Research, Design, Development, as already stated, has to be product development oriented and even basic and fundamental research has to eventually aim for the same. This actively needs greater focus and intensification in order that domestic industry is in a position to provide the market with cost-effective state of the art quality and reliable products and services without excessive reliance on imports. Further, new and renewable energy industry has to export in order to atleast pay for its imports with the aim of becoming a net foreign exchange earner in the shortest possible time. The market for this sector during the 11th Plan is estimated at around Rs.75,000 crore mostly in grid-interactive renewable power, especially wind.

1.4.12 An intensified industry led RD&D effort is proposed with the level of subsidy upto 100 per cent of project cost to public R&D institutions and universities for achieving well-defined specific outputs. The support level to industry is proposed at 50 per cent. In case where the time horizon for maturation of technology is relatively higher, the support level to industry could

be enhanced in the initial stages, on case by case basis and tapered down to 50 per cent, when product development is in sight. R&D efforts would also be encouraged in product upgradation, introduction of standards, etc.

1.4.13 Generally RD&D support would be available for industry which has a dominant Indian equity holding and support to foreign companies in this regard, if any, would be an exception to be given only in cases where a larger national interest is visible and is served. However, if industry were to select a foreign institution for carrying out a part of RD&D activities, support could be considered on a case by case basis, only when it is not feasible to carry out such activities in the country in the available time and cost.

1.4.14 In this regard, IEPR has observed that R&D is critical in the energy sector to augment energy resources, to meet long-term energy needs apart from raising energy security and delivering energy independence. IEPR has gone to the extent of considering R&D as a public good and made a case for its financing by the Government. IEPR has recommended, among other, Technology Missions for R&D in solar, bio-energy, alternate fuel and storage technologies.

1.4.15 R&D component is being decoupled from deployment in all the schemes and brought under separate programme on Renewable Energy RD&D.

1.4.16 Support programmes have also been rationalized as several have been either dropped and/or clubbed together in 7 programmes, which are as follows:

- (i) Information, Publicity and Extension
- (ii) International Relations
- (iii) HRD & Training
- (iv) Plan Secretariat
- (v) IREDA, and
- (vi) Support to Industry
- (vii) Assistance to states for meeting liabilities incurred during 10th Plan on ongoing programmes apart from strengthening their delivery mechanism.

1.4.17 The Integrated Rural Energy Programme (IREP) was initiated in the Planning Commission during 7th Plan and was transferred to MNRE in 1994-95. Support was/ has been extended under this programme for preparation of state/ district level energy plans, limited extension of renewable energy systems/ devices, establishment of 5 regional training centers, and staff salaries/ administrative expenses at the state / district / block levels. It was decided to continue this programme upto 10th Plan whereafter the same was to be merged with any existing programme, from the 11th Plan onwards. Since this extension programme has already demonstrated its objectives, a provision for only 10th Plan spillover liabilities is being proposed. Further, a provision for one time grant to states for the 5 training establishments has also been made.

1.4.18 It is necessary to enhance the capability of states especially in implementation of renewable energy programmes. The present system of a skeletal set up in the form of State Nodal Agencies with either a few or no field level officers has not been too effective. It would be necessary to encourage states to strengthen the administrative set-up and get local self-government institutions like Municipalities and Panchayats involved in planning and implementation process. Accordingly, existing provision for surcharge to State Nodal Agencies (SNAs) on subsidies routed through them is proposed to be rationalized. Further, support to SNAs in the North East Region towards construction of office building and establishment/ manpower expenditure is not proposed during the 11th Plan, since the same was approved for a period of 3 years, which is already over and has largely served its purpose.

1.4.19 Regional Offices (ROs) of the Ministry have already attained the objectives for which they had been set up. Further, with the establishment of SNAs, the need for ROs has substantially diminished. It is, therefore, proposed to close down all ROs during the course of the 11th Plan, and scientists posted therein will be redeployed and supporting staff, which is on deputation, will be repatriated. Accordingly, budget for this will be reviewed during the 11th Plan.

1.4.20 In order to effectively implement the proposed 11th Plan programmes, it might become necessary to augment the strength of officers and supporting staff in the Ministry and its three technical institutions-SEC, C-WET & NIRE. The strength of manpower in each technical institution would need to be enhanced to handle the stepped up RD&D activities being proposed during the plan period. A provision is being proposed in this regard.

1.5 PROPOSALS FOR 11th PLAN

1.5.1 The Working Group on New and Renewable Energy for the 11th Plan set up by the Planning Commission worked within the TOR assigned to it. It set up four (4) Sub-Groups on areas listed above (except Supporting Programmes) to assist it in its task of formulating proposals for the 11th Plan, in keeping with the TOR. The Reports submitted by the Sub-Groups are annexed and have immensely helped the Working Group in its task of preparation of this Report. The Sub-Groups and the Working Group have had the benefit of various recommendations and suggestions pertaining to this sector which have been made by the Expert Group on IEP and in MTA for the 10th Plan.

1.5.2 Review of performance during 10th Plan and programme-wise proposals are given in Chapters II-VI.

CHAPTER-II

REVIEW OF PERFORMANCE DURING 10TH PLAN

2.1 10TH PLAN OUTLAY

2.1.1 29 schemes of which 25 central schemes and 4 centrally sponsored schemes were approved for the 10th Plan with an outlay of Rs.2767 crore apart from Rs.400 crore for North-East, Rs.330 crore for 4 MNRE institutions, Rs. 15 crore for spill over liabilities for schemes transferred to states, and Rs.466 crore for externally aided projects (EAP), thereby yielding a gross budgetary support (GBS) of Rs.4000 crore. In addition, Rs.3167 crore was allocated for internal and extra budgetary resources (IEBR), thus leading to a total outlay of MNRE of Rs.7167 crore for the 10th Plan.

2.2 10TH PLAN EXPENDITURE

2.2.1 The likely expenditure during the 10th Plan based on actuals upto 31.9.2006 is Rs.4000 crore against the plan outlay of Rs.7167crore.

2.3 10TH PLAN PERFORMANCE REVIEW

2.3.1 The major reasons for lower actual expenditure against GBS are:

- (i) Rationalization of subsidies for grid-interactive renewable power which were brought down substantially without sacrificing physical targets and consequently around Rs. 350 crore is likely to be incurred as against the plan provision of Rs. 895 crore. While the plan target for installed capacity is 3075 MW the actual achievement is likely to be in excess of 6000 MW. However, subsidy for grid-interactive solar power was totally withdrawn on the recommendation of CASE since the unit cost of generation was considered very high and therefore unviable. Further, MSW to Energy Programme received a set back on account of the Supreme Court granting an interim stay on provision of subsidy on the basis of a Public Interest Litigation filed by an NGO claiming superiority of the composting option.

- (ii) In Village Electrification Programme for remote villages/hamlets an expenditure of Rs. 250 crore is likely against the plan provision of Rs. 735 crore. The chief reason for under utilization in this programme has been that it had to go through several revisions in order to align it with RGGVY aims and purposes and thereafter with those of the Rural Electrification Policy. Further, progress under the revised programme is linked with identification of remote villages, the responsibility for which has been assigned to REC. Around 2500 remote villages identified by REC have been/are being provided mostly with SPV home-lighting systems for meeting only basic lighting needs since States have been unable to furnish proposals for distributed generation and supply.

- (iii) Expenditure on the biogas programme is likely to be around Rs. 170 crore s against the plan provision of Rs. 415 crore, mainly on account of downscaling the physical target for family type biogas plants from 10 lakh to 5.52 lakh, based on the need to cut back on the programme and to refocus expenditure on high-tech areas.
- (iv) The Plan provision for SPV Demonstration and Utilization Programme, Solar Thermal Programme and SPV Water Pumps is Rs.617 crore as against which the likely expenditure is Rs.300 crore, mainly because of rationalization of subsidies and downscaling targets based on recommendations of CASE and the Planning Commission to the effect that provision of subsidy for SPV systems in electrified areas was not warranted as the same amounted 'double-dipping', i.e., providing the same benefit twice over for the same service. Alongside, it was recognized that the current situation with regard to electricity supply might continue for some more time and there might be a need for deployment of alternate systems in such areas.
- (v) While under IREP the Plan provision is Rs.145 crore, an expenditure of only around Rs.40 crore is likely mainly because the Planning Commission was recommending transfer of this scheme to the states. As a result in 2005-06 there was no provision for the scheme. In 2006-07 the provision is only Rs.18 crore, with the proviso that this programme would continue only upto 10th Plan and may be merged with any existing programme from the 11th Plan onwards.
- (vi) The plan provision for MNRE institutions of Rs. 80 crore could not be fully utilized since there were some procedural delays in processing the case for revised cost estimate of NIRE. Further, the provision for SEC could also not be fully utilized since adequate proposals could not be generated on account of shortage of manpower in the Centre.
- (vii) While the Plan provision for RD&D on New Technologies is Rs.150 crore, the likely expenditure would be under Rs.25 crore on account of operational and other reasons. RD&D provisions in other technologies too have not been fully utilized for similar reasons.
- (viii) The provision for the 140 MW Integrated Solar Combined Cycle plant at Mathania, Rajasthan could also not be utilized on the basis of a review that recommended a more cautious approach towards deployment of grid-interactive solar projects at this juncture in view of the very high unit cost of generation of solar electricity apart from technological and commercial reasons.

2.3.2 The expenditure against IEBR is also likely to be lower at around Rs.2107crore. This is mainly due to shortfall in allocation of tax free bonds, extension of utilization of IDA-II & IBRD LOC upto 31st March 2008 and lower domestic borrowings due to high costs thereof.

2.3.3 Physical performance, on the other hand, in grid-interactive renewable power has been more than what had been planned for. The major physical achievements w.r.t renewable energy during first four years of the 10th Plan (2002-03 to 2005-06) are indicated below:

- Over 4630 MW of grid interactive renewable power capacity was added during the first four years of the 10th Plan against an aim of 3075 MW for the Plan period. Of this, 3684 MW has come from wind power, 387.83 MW from small hydropower, 581 MW from bio-energy and 25.15 MW from waste to energy.
- 2237 remote unelectrified villages and 594 remote hamlets have been electrified through renewable during the first 4 years of the 10th Plan against a target of 5000 villages, irrespective of the fact that they would eventually receive grid-connectivity or not, for Plan period.

2.4 10TH PLAN ACHIEVEMENT (UPTO 30 SEPTEMBER 2006)

2.4.1 Cumulative achievements under different programmes and year-wise details of achievements during the plan period as on 30.9.2006 are given in Table 2.4.1.1 and Table 2.4.1.2 respectively.

Table 2.4.1.1: Cumulative achievements under different renewable energy programmes as on 30.09.2006:

Grid-interactive renewable power:	Installed capacity (in MW)
Bio Power	466.50
Wind Power	6070.20
Small Hydro Power (up to 25 MW)	1849.78
Cogeneration-bagasse	571.83
Waste to Energy	34.95
Solar Power	2.74
Total	8996.00
Distributed renewable power:	
Biomass / Cogen.(non-bagasse)	11.50
Biomass Gasifier	75.85
Energy Recovery from Waste	11.03
Total	98.38
Remote Village Electrification	2237 / 594 (villages / hamlets)
Family Type Biogas Plants	3.89 million
Solar Photovoltaic Systems	
i. SPV Street Lighting Systems	54659 nos.
ii. SPV Home Lighting Systems	301603 nos.
iii. SPV Lanterns	483058 nos.
iv. SPV Power Plants	1859.80 kWp
v. SPV Pumps	7068 nos.
Solar Thermal Systems	
i. Solar Water Heating Systems	1.50 million sq.m. collector area
ii. Solar Cookers	0.60 million
Small Wind Energy Systems	
i. Wind Pumps	1141 nos.
ii. Aero-generator /Hybrid Systems	520 kW

Table 2.4.1.2:
[EXCEL sheet- to be inserted]

CHAPTER III

GRID-INTERACTIVE AND DISTRIBUTED RENEWABLE POWER

3.1 INTRODUCTION

3.1.1 Power generation from renewable sources, mainly small hydro, wind and bio, requires exploitation to supplement conventional power. The aim is that at least 10 per cent power generation installed capacity in the country, with 4-5 per cent share in the electricity mix, should come from renewables by the end of the 11th Plan. Out of the overall target of 70,000 MW power generation installed capacity addition during the 11th Plan period, 14,500 MW (about 20%) capacity addition is proposed from renewables.

3.1.2 A bulk of the proposed renewable power capacity addition is expected through private investment, for which a suitable policy environment would need to continue. Alongside, measures would need to be taken to reduce capital cost of renewable power projects, increase capacity factors, with the aim of reducing the unit cost of renewable power generation. Eventually, since renewable power would need to compete with conventional electricity, the challenge is to align it in terms of reliability, quality and cost, which can be achieved to a large extent by addressing the aforesaid issues.

3.2 RESOURCE ASSESSMENT

3.2.1 The currently estimated resource-wise renewable energy potential is detailed in Annexure-IV.

3.2.2 The ongoing exercise for resource assessment/ mapping of all renewable energy sources on a GIS platform is proposed for continuation. The resource assessment exercise may also include classification of potential sites based on capacity factors, certainty ratings, available infrastructure, evacuation facilities etc. A budget provision of Rs.25 crore has been proposed for this activity under the RD&D Programme for the 11th plan.

3.3 PROGRAMME COMPONENTS

3.3.1 The renewable power generation programmes are envisaged to have following main components:

- (a) Grid-interactive Renewable Power Projects
- (b) Distributed / Decentralized Renewable Power Systems (including captive generation)

3.3.2 Grid-interactive Renewable Power Projects

3.3.2.1 Grid-interactive renewable power projects imply centralized power generation facilities with grid inter-connection at transmission line side for power export. Such facilities are envisaged to directly add to the installed grid power capacity.

3.3.3 Distributed / Decentralized Renewable Power Systems

3.3.3.1 Distributed/decentralized power implies dispersed generation of electricity characterized by:

- Generation capacity ranging from kW to MW levels.
- Generation at Distribution Voltages (11kV or below).
- Grid inter-connection at distribution line side for power import and/ or export
- Inter-connected to a local grid, or
- Totally off-grid, including captive

3.3.3.2 Distributed/decentralized renewable power facilities are envisaged to supplement power generation requirements in electrified/ to be electrified areas. While it is recognized that the unit cost of such generation is likely to be on the higher side due to reverse economies of scale and lower capacity factors, it is expected that on account of lower line losses, the higher generating cost of such systems could be somewhat offset.

3.3.3.3 Distributed/ Decentralized Renewable Power Systems (DRPS) would cover small hydro power, bio power and wind power or in any combination thereof in hybrid mode.

3.3.3.4 DRPS for remote villages (not likely to receive grid-connectivity under the RGGVY) are being covered in the Chapter on Rural Energy for Rural Applications.

3.4 PHYSICAL TARGETS AND RESOURCE REQUIREMENTS

3.4.1 Physical targets and resource requirements for grid-interactive and distributed/ decentralized renewable power are detailed below.

3.4.2. **Physical Target:** A physical target of 15,000 MW is proposed for grid-interactive and distributed/ decentralised renewable power generation installed capacity for the 11th Plan as per the following resource-wise break-up:

<u>Resource</u>	<u>Capacity (in MW)</u>
Wind	10,500
Small Hydro	1,400
Non-fuel wood biomass, Cogeneration and Waste to Energy	<u>2,100¹</u>
	14,000
DRPS	<u>1000²</u>
	15,000

1. *subsidy for biomass power is sought to be supported only where sustainability of biomass supplies can be demonstrated since there have been apprehensions about over drawl of forest resources with fuel wood so obtained being diverted for some such projects. Further, biomass ceases to be renewable unless a project can demonstrate its sustainability through dedicated plantations specially raised for the purpose.*
2. *Including 50 MW Solar Power. There may be a case for support to solar power provided technology improves and costs come down with unit cost of generation becoming at par with small hydro power. Incidentally, the present unit cost of SPV power is around Rs.20/kWh (without battery back-up) and Rs.30/kWh (with battery back-up). Incentivising could be done on the basis of feed-in tariff, fiscal concessions and some subsidy. .*

3.4.3 **Resource Requirement:** A provision of Rs.3925crore is proposed as subsidy for grid-interactive and distributed renewable power, including captive power which would save conventional power. This subsidy would be leveraged for introducing standards for renewable grid power equipment and would be available only for such projects that use equipment manufactured to IEC or national standards that are harmonized with international standards. Preferably, subsidy ought to be restricted to projects with CUF above specified threshold limits and linked to maximum permissible project costs. A higher level of subsidy is proposed for projects in special category states. The proposed subsidy pattern for different project categories is detailed in Para 3.5.

3.5 SUBSIDY PATTERN

3.5.1 The following pattern of subsidy is recommended for grid-interactive/distributed renewable power including cogeneration and captive power projects:

Renewable Source	Special Category States (NE Region, Sikkim, J&K, HP & Uttaranchal)	General Category States
Small Hydro Power	Rs 1.00 crore X (C MW) ^{0.7}	Rs 0.67 crore X (C MW) ^{0.7}
Biomass Power *	Rs 0.75 crore X (C MW) ^{0.7}	Rs 0.50 crore X (C MW) ^{0.7}
Cogeneration - Bagasse	Rs.1.00 crore X (C MW) ^{0.7}	Rs.0.67 crore X (C MW) ^{0.7}
- Other biomass*	Rs.50,000/kW	Rs.50,000/kW
Municipal Waste to Power ▪ Combustion/ Incineration	Rs 1.50 crore X (C MW) ^{0.7}	Rs 1.00 crore X (C MW) ^{0.7}
▪ Gasification/ pyrolysis/ plasma arc / biomethanation	Rs 3.00 crore X (C MW) ^{0.7}	Rs 2.00 crore X (C MW) ^{0.7}
Industrial Waste to Energy ▪ Combustion/ Incineration	Rs 0.75 crore X (C MW) ^{0.7}	Rs 0.50 crore X (C MW) ^{0.7}
▪ Biomethanation, etc.	Rs 1.50 crore X (C MW) ^{0.7}	Rs 1.00 crore X (C MW) ^{0.7}
Solar Power	Rs.30,000/kW _p Rs.50,000/kW _p	Rs.30,000/kW _p ** - for residential/ commercial purposes Rs.50,000/kW - for community/ institutional purposes

C: In case of grid-interactive projects – surplus power generation installed capacity in megawatt for export to grid.

* Including fuel wood based projects provided the same are backed by at least 50 per cent of dedicated plantation required @ 876 ha/MW assuming fuel wood yield @ 7MT/ha with a calorific value of 4000 kCal/kg, system efficiency of 21.5 per cent, and 70 per cent PLF. Projects incorporating 105 bar pressure boilers and steam turbines. Subsidy level to come down proportionately for lower pressures.

** Subsidy per household limited to Rs.50,000/-.

3.5.2 In the case of bagasse cogeneration in cooperative sugar mills and urban waste to energy projects, one-half of subsidy amount is proposed to be given by way of upfront support and the balance one-half on successful completion of the project, since developers in these areas are by and large unable to develop bankable projects.

3.5.3 **Support for Demonstration Wind Power projects:** A provision of Rs.75crore is being kept for demonstration wind power project in States where there is sizable potential but no commercial activity has commenced. Support is proposed to be limited to 1 per cent of technical potential or 5 MW per state, whichever is lower @ Rs.2.5 crore/ MW.

3.6 SUMMARY OF SUBSIDY REQUIREMENT

3.5.1 The investment requirement for setting up 14,500 MW renewable power capacity is estimated at around Rs.60,000 crore. Subsidy is proposed only for SHP, Non fuel-wood biomass (fuel-wood, if backed by dedicated plantations) Bagasse cogeneration, Non-basasse cogeneration, and Municipal, Industrial waste to energy, solar power when mature for which its requirement is estimated at Rs.3900 crore. Provision of Rs.200crore has been kept for subsidy for solar power (grid-interactive and distributed/ decentralized) that will be provided when technology improves, costs come down and unit costs of generation is at par with small hydro power.

3.6.2 The above provision includes DRPS (other than solar) with an aggregate capacity of 950 MW, with an estimated cost of around Rs.8000 crore for which subsidy provision of Rs.1900 crore is proposed.

3.7 STANDARDS & TESTING

3.7.1 In order to ensure the project quality/ performance, a continuing requirement would be adherence to IEC standards or national standards harmonized with international standards for equipment. Existing BIS standards, if any, would be harmonized with international standards. Department of Commerce has already expressed apprehensions that developed countries might use standards in future for creating non-tariff barriers and have advised that Indian industry must watch these developments and adopt relevant international standards for becoming competitive. In this context, harmonization of national standards with international standards becomes imperative apart from laying down such standards where none exist. A provision of Rs. 25 crore has been proposed for this activity under the RD&D Programme.

3.8 PERFORMANCE TESTING

3.8.1 Projects supported by subsidy would require to be tested for their performance w.r.t. DPR norms by an independent agency. Such testing will ensure that projects are established as per DPR norms and those that are not would not receive subsidy support. A provision of Rs.25 crore is proposed for activity.

3.9 SUMMARY OF PHYSICAL TARGETS AND PROPOSED OUTLAY FOR THE 11TH PLAN:

3.9.1 A physical target of 15,000 MW with an outlay of Rs.3,925 crore is proposed for grid interactive/ distributed renewable power generation for the 11th Plan. The total investment required would be about Rs.60,000 crore, which amounts to leveraging 15.5 times the proposed budgetary support. This includes 1000 MW targeted from distributed renewable power systems with an outlay of Rs.2,100crore, and Rs.25 crore for performance testing. The detailed break-up is given below:

S.No	Programme Component	Physical Target (MW)	Proposed outlay (Rs. in crore)
1	Wind Power	10,500	75 *
2.	Small Hydro	1,400	700
3.	Co-generation Biomass Power	1,200 500	600 200
4.	Urban waste to energy	200	150
5.	Industrial waste to energy	200	75
	Sub-total (A)	14,000	1,800
6.	Solar Power (Grid-interactive/DRPS)	50	200**
7.	DRPS (excluding Solar)	950	1,900
	Sub-total (B)	1,000	2,100
	Total (Renewable Power) (A+B)	15,000	3,900
8.	Performance Testing	-	25
	Grand Total	15,000	3,925

* For demonstration projects in states where there is sizable potential but no commercial activity has commenced.

** Subsidy limited to Rs.50,000 per household.

CHAPTER-IV

RENEWABLE ENERGY FOR RURAL APPLICATIONS

4.1 INTRODUCTION

4.1.1 A large and growing gap exists between rural energy requirement and supply. Non-commercial energy consumption accounts for around 30% of the total energy consumption. Non-commercial energy sources such as fire-wood, agricultural and animal wastes account for a large proportion of energy in rural areas. Despite efforts made for more than two decades, renewable energy systems meet less than 1% of the rural energy needs.

4.1.2 The Ministry has been supporting various renewable energy programmes for the promotion of biogas plants, solar thermal systems, photovoltaic devices, biomass gasifiers, etc. as well as the Integrated Rural Energy Programme, for several years. A few new programmes such as the Remote Village Electrification, Biomass gasification programme, Biogas power generation and the Village Energy Security Programme were introduced during the 10th Plan. Most programmes have undergone modifications in keeping with the feedback received apart from developments in various technologies and operating conditions that have taken place over the years. However, affordability continues to remain the main barrier in rural areas and most systems / devices require appropriate support for their promotion.

4.2 RURAL ENERGY PROGRAMME FOR 11TH PLAN

4.2.1 During the 11th Plan, it is proposed to take up a comprehensive Rural Energy Programme, which would include two sub-programmes, namely, Remote Village Renewable Energy Programme (RVREP), and Grid-Interactive Village Renewable Energy Programme (GVREP). While proposing these programmes, the committed liabilities of IREP have been taken into account.

4.3 REMOTE VILLAGE RENEWABLE ENERGY PROGRAMME (RVREP) - for villages not likely to receive grid-connectivity under the Rajiv Gandhi Gramen Vidyutikaran Yojna (RGGVY).

4.3.1 RVREP will have two components, viz.:

(a) Village Energy Security Programme (VESP) that will aim to provide renewable energy services of cooking, lighting and motive power to remote villages / hamlets identified by REC. It will have the following two sub components:

- Distributed Renewable Power systems (DRPS), wherever feasible and cost-effective. Cost-effectiveness would be established through unit cost of electricity generation from such systems not exceeding that from diesel

generation and the capacity of the system to provide electricity access @ 1 kWh / household / day, throughout the year.

- Renewable energy systems/devices for cooking and supplementary motive power.

(b) Remote Village Solar Lighting Programme (RVSLP) that will provide only lighting service through SPV home-lighting devices in remote villages where DRPS under VESP or DGS under RGGVY is not feasible and cost-effective.

4.3.2 The responsibility for identifying a remote villages/hamlet has been assigned to REC, the nodal agency responsible for implementing RGGVY. RVREP will be implemented only in remote villages/hamlets identified by REC and implementation under it will be completed during the 11th Plan itself.

4.3.3 It is proposed that only such of those villages which are not provided with grid-connectivity or DGS under RGGVY would be provided with DRPS, provided the same are feasible and cost-effective. The capital cost of such systems is placed at around Rs.20,000 - 1,00,000/household with unit cost of electricity ranging between Rs. 5-30/ kWh.

4.3.4 In case REC were to drop its cost-effectiveness criteria altogether in the light of the above, it is likely that the number of remote villages/hamlets would not exceed 5,000 - 10,000. For planning purposes, however, it is assumed that there might still be around 10,000 remote villages/hamlets that might not be covered under RGGVY and would be covered under RVREP.

4.3.5 On the basis of experience gained in implementing RVE during the 10th Plan, it is unlikely that state governments will come forward with many proposals for setting up DRPS in remote villages. Most DPRs for remote villages received from states have proposed SPV home-lighting systems as the favored option. DRPS have several drawbacks. First, capital cost could vary anything between Rs.20,000-1,00,000 / household, Second, unit cost of electricity from such systems varies between Rs.5-30 / kWh. Third, DRPS are location specific and therefore cannot be deployed everywhere. Fourth, in the case of biomass several operational issues still need to be addressed. Fifth, DRPS are not fully reliable to provide electricity round the clock 365 days a year. Thus, DRPS should be considered as an option of last resort. It is, therefore, assumed that not more than 10 per cent of remote villages/hamlets identified by REC would be provided with DRPS, which works out to around 1000 remote villages/hamlets and this figure too might turn out to be a bit optimistic.

4.3.6 It is likely that even during the 11th Plan SPV home-lighting systems might remain the preferred option of states for addressing the needs of remote villages/hamlets. However, as per the Rural Electrification Policy (2006) a

minimum life-line access to electricity of 1 kWh/household/day has to be assured. SPV home-lighting systems would not be in a position to fulfill this assurance. Accordingly, provision of such systems to remote villages/hamlets would not lead to a village being classified as having been electrified and therefore has to be considered only as an interim measure. Eventually, even these villages/hamlets would need to be provided normative electricity access in order to be classified as electrified.

4.3.7 It is a moot point whether provision of SPV home-lighting systems to remote villages/hamlets not provided with DRPS would supplement RGGVY. Further, the cost of this option is placed at around Rs.15,000/household but could be brought down to around Rs.8000/household in case a single light were to be provided or even Rs.4000/household if a solar lantern were to be considered. These costs might come down even further with the introduction of light emitting diodes (LEDs) in place of CFLs. For planning purposes, however, 100 per cent household coverage, inclusive of community needs, with a single light SPV system is proposed for the 9000 remote villages/hamlets proposed for coverage under RVSLP, wherein the average number of households per remote village/hamlet is assumed to be 100.

4.3.8 In addition, all the 10,000 remote villages/hamlets are proposed to be provided with renewable energy systems/ devices for cooking and additional motive power needs @ Rs.10,000/household.

4.3.9 Subsidy level under RVREP is proposed at 90 per cent level of actual system/device cost or the threshold subsidy limit, whichever is lower, with BPL households being provided with a free household electricity connection in instances where DRPS are being established, in keeping with a similar provision in RGGVY for free grid electricity connection to BPL households. The total budget requirement for RVREP for the plan period is thus estimated at **Rs.1,775 crore** as per the break-up given in paragraph 4.6. In rural schemes, it is expected that Panchayati Raj Institutions would be involved in both implementation, monitoring and maintenance of assets created.

4.4 GRID-CONNECTED VILLAGE RENEWABLE ENERGY PROGRAMME (GVREP)- for villages that are grid-connected or likely to receive grid-connectivity under RGGVY.

4.4.1 This programme will have the following two sub components:

- (a) Solar Thermal for cooking, hot water, and drying applications.
- (b) Biogas plants- family type, for cooking applications.

4.4.2 Under GVREP subsidy is not sought to be provided for SPV systems/devices in keeping with the approach that such systems/devices should be promoted through fiscal concessions only in electrified or to be electrified areas.

4.4.3 Subsidy level under GVREP is proposed at a maximum level of 25 per cent of normative system/device cost, being enhanced to a maximum of 33 per cent in special category States. The need for a higher level of subsidy for special category states has been addressed in Chapter - I. Subsidy levels for renewable energy systems/ devices envisaged to be set up under GVREP are proposed as under:

(a) Solar thermal systems:

- For hot water @ Rs.1500/m²

- For cooking & drying applications @ Rs.1250/ m²

- For concentrating cooker applications @ Rs.2500/ m²

(b) Biogas Plants:

- Family type biogas plants for cooking applications @ Rs.1250/m³, subject to a maximum of Rs.4000 /plant.

4.4.4 The proposed physical targets for the plan period are total collector area of 1 million m² of solar thermal systems for hot water and 0.5 million m² for cooking & drying applications, and 1 million family and community type biogas plants for cooking applications. The corresponding budget requirement for GVREP for the plan period thus works out to **Rs.475 crore** as per the break-up given in paragraph 4.6.

4.5 SUBSIDY RATIONALE

4.5.1 The chief reason for proposing subsidy for renewable energy systems/devices in electrified/to be electrified rural areas is to make them affordable in a situation of low household paying capacity and for attaining the national goal of Energy for all by 2012. Provision of renewable energy services is expected to go a long way in maintaining the fragile ecological balance and raising the level of living of targeted population. Fossil fuel based commercial energy options are not only unaffordable and require a higher level of subsidy as in the case of kerosene but their availability too is also a major issue. Thus, renewables emerge as the natural choice but like kerosene would require subsidy till such time as the level of living of rural households can be raised.

4.6 PROPOSED PHYSICAL TARGETS AND FINANCIAL QUALITY

4.6.1 The proposed physical targets and financial outlays for various Rural Energy Programme components for the 11th Plan are summarized below:-

S. No	Programme Component	Physical Target (in Nos. of remote villages/ hamlets)	Proposed outlay (Rs. in crore)
1.	<p>RVREP VESP : DRPS in 1000 remote villages / hamlets 90 % of actual system cost or Rs.22.5 lakh/system/village, whichever is less, per village of 100 households.</p> <p>RVSLP : Single light SPV system for 9000 remote villages / hamlets @ 90% of actual system cost or Rs.7200/system/ household, whichever is less, per village of 100 households.</p> <p>c) <u>Common component for cooking/ supplementary motive power for all remote villages / hamlets:</u> RE systems / devices for all 10,000 remote villages/ hamlets @ 90% of actual cost or Rs.9,000/ household, whichever is less, per village of 100 households.</p>	<p>1000</p> <p>9000</p> <p>10,000</p>	<p>225</p> <p>650</p> <p>900</p>
		Sub-total (A)	1,775
2.	<p>GVREP: Subsidy @ upto 25% of normative system / device cost; and @ upto 33% in Special Category States.</p> <p>a) <u>Solar thermal systems :</u> - flat plate collectors for hot water: @ Rs.1500/m² [*] - cooking & drying applications @ Rs.1250/ m² [**] (box type cookers & flat plate solar collectors) - concentrating type cooker applications @ Rs.2500/m² [***]</p> <p>b) <u>Biogas Plants</u> - Family type for cooking applications @ Rs.1250/ m³/ day [****].</p>	<p>Collector area:</p> <p>1 million m²</p> <p>0.5 million m²</p> <p>0.1 million m²</p> <p>2 million m²</p>	<p>150</p> <p>50</p> <p>25</p> <p>250</p>
		Sub-total (B)	475
		Total	2250

* @ Rs. 1250/m² for general category states and Rs.1650/m² for special category states

** @ Rs. 1125/m² for general category states and Rs.1500/m² for special category states

*** @ Rs. 2250/m² for general category states and Rs.3000/m² for special category states

**** @ Rs. 1125/m³ for general category states and Rs.1500/m³ for special category states

CHAPTER-V

RENEWABLE ENERGY FOR URBAN, INDUSTRIAL & COMMERCIAL APPLICATIONS

5.1. INTRODUCTION

5.1.1 While solar water heating, solar passive architecture industrial waste to energy, and MSW-to-energy have attained a fair degree of technological maturity, their greater deployment and diffusion still requires subsidy in order to make them affordable/viable. Focus on deployment in these areas is proposed to be continued during the 11th Plan through the following components:

- Solar passive architecture
- Solar thermal systems / devices
- Energy recovery from urban wastes
- Energy recovery from industrial wastes
- Akshay Urja Shops
- Renewable energy /solar /eco/ green cities

5.2 SOLAR PASSIVE ARCHITECTURE

5.2.1 Energy efficient buildings can be designed through solar passive architecture concepts so that energy requirements of heating and cooling could be reduced. The real estate boom in the country has presented an opportunity for the introduction of such concepts and devices.

5.2.2 Solar buildings which cost an additional 5-10 per cent have the potential of saving upto 30-40 per cent energy. A scheme for promotion of solar buildings is being implemented under which subsidy is being provided for preparation of DPRs, construction of such buildings, awareness/promotion, training and documentation. A rating system for solar buildings is being developed on the pattern of LEEDs that will be more suitable for Indian conditions. Subsidy for preparation of DPR & construction of such building is proposed for continuation during the 11th Plan @ Rs.100/m² of covered area for which a provision of Rs.50crore is proposed.

5.2.3 In addition, Rs.25/ m² is proposed for training and another Rs.25/ m² for information and publicity for which a subsidy provision of Rs.12.5crore has been reflected in Chapter VII.

5.3 SOLAR THERMAL SYSTEMS / DEVICES:

5.3.1 Flat plate type

5.3.1.1 Solar hot water systems: The overall potential for solar thermal installations in India is estimated at 140 million sq. m. collector area. About 1.5 million sq. m. solar collector area has already been installed during the past two decades. Solar hot water systems have become popular, especially in some, cities/towns of the Deccan plateau and the sub-Himalayan region, where climatic conditions favor use of such systems more or less throughout the year. These systems which cost around Rs. 7500/m² have the potential of conserving energy, as per one estimate, of upto 1000 kWh/ m² /annum, depending on location and use thereby yielding a payback period of 2 1/2 years..

5.3.1.2 Against a physical target of 5 lakh m² for the 10th Plan, 8.5 lakh m² has already been installed during the first four years of the Plan period, taking the cumulative installed collector area to 1.5 million m². Subsidy is being provided for these systems @ about Rs. 1175/m² or 15.6 per cent of system cost. The deployment target proposed for the 11th Plan is 9.5 million m² of which 2.5 million m² that would be established during the first 2 years of the Plan is proposed for subsidy after which subsidy would be discontinued. Subsidy levels are proposed for enhancement to Rs. 1500/ m² during the 11th Plan, for which a subsidy support of Rs.375 crore is proposed.

5.3.1.3 Solar air heating/ drying systems: Solar air heating/ drying systems are being deployed in agro and food processing industries that require hot air at temperatures ranging between 50-80°C for drying products such as tea leaves/ coffee beans and for processing fruits, vegetables spices, cereals, papad, seafood etc. Such low temperature hot air is also required in industries such as leather, textiles, chemicals, rubber, paper, pharmaceuticals etc. Solar thermal drying systems have the potential to save a significant amount of energy, apart from possibly improving the quality of the end product. About 10,000 m² flat plate collector area for solar drying has been installed in about 50 industries so far in the country. The physical target for the 11th Plan is 0.25 million m² with a subsidy level of Rs. 1250/ m² or 25 per cent of system cost (against Rs. 2125/ m² during the 10th Plan) for which a subsidy support of Rs. 31.25 crore is proposed.

5.3.2 Concentrating Type

5.3.2.1 Solar concentrating systems: Solar concentrating systems, including parabolic/ Scheffler dishes, are being used for steam generation and for heating oil/ air for industrial and commercial applications where heat requirement is above 80°C. Such systems are also being deployed to generate steam for cooking purposes, especially in community kitchens. The world's largest such system at Tirupati is capable of cooking food for 15,000 persons/ day. 16 solar concentrating systems of different capacities aggregating 5000 m² dish area have

been installed in the country so far. The target for the 11th Plan is 0.25 million m² with a subsidy level of Rs. 2500/ m² @ 25 per cent of system cost for which a subsidy support of Rs. 62.50 crore is proposed.

5.3.2.2 An incentive @ Rs. 200/m² is proposed for providing institutional/programme support (Rs.100/ m² for motivators and Rs.100/ m² for financial institutions/Banks). Accordingly,Rs.50crore is proposed for institutional / programme support as a special case. Further, a provision of Rs.10 crore is proposed as an incentive to 100 Municipal corporations @ Rs.10lakh each for amending bye-laws for installation solar hot water systems.

5.3.2.3 A greater thrust is required to develop standards, testing and certification of solar thermal systems. Such standards need to be incorporated in the proposed Energy Conservation Building Code, where applicable. Introduction of Evacuated Tube Collector (ETC) water heating systems needs to be encouraged. Manufacturers in the SME sector would need to develop a network of dealerships for easy availability and servicing of their products and services.

5.3.2.4 Efforts would also need to be made for exempting manufacture and installation of solar thermal systems from VAT and service tax. Efforts need also be made to maintain a complete data-base of solar water heating systems installed in the country and a Management Information System (MIS) in this regard would be developed.

5.4 ENERGY RECOVERY FROM URBAN WASTES

5.4.1 Worldwide, about 130 MMT/annum of Municipal Solid Waste (MSW) is combusted in over 600 facilities having an aggregate installed capacity of 12,000 MWe for combined heat and power.

5.4.2 There are presently 4378 urban agglomerations and towns in the country (although census 2001 data show 5161 towns) of which 423 towns and cities have a population exceeding 1 lakh. Of these, there are 35 urban agglomerates and cities with a population of over 1 million. Urban households generate 42 MMT/annum of solid waste @ 0.115MMT/day and 6000 million cubic metres/annum of liquid waste.

5.4.3 The estimated potential of Municipal Solid Waste (MSW) to Energy is given below:

Period	Projected MSW Generation (TPD)	Potential for Power Generation (MWe)
2007	148000	2550
2012	215000	3650
2017	304000	5200

5.4.4 Main technology options for setting up waste-to-energy projects include Anaerobic Digestion/ Biomethanation; Combustion/ Incineration; Pyrolysis; Gasification; Landfill Gas Recovery; and Densification/ Pelletization for waste preparation. Such projects offer the following advantages:

- Quantity of waste is reduced by nearly 60%-90%, depending upon waste composition and technology deployed;
- Demand for land, already scarce in cities, for land filling is substantially reduced;
- Cost of transportation of waste to landfill sites gets reduced;
- Net reduction in environmental pollution; and,
- In biomentation process, waste slurry could be used as compost, depending upon waste composition.

5.4.5 Barriers to the growth of this sector have been on account of the following:

- Segregated Municipal Solid Waste is generally not available due to a low level of compliance of MSW Rules 2000;
- Municipal Corporations/Urban Local Bodies unable to generate bankable proposals.
- Cost of projects, especially those based on biomethanation route, is high.

5.4.6 Since the Twelfth Finance Commission has recommended grants to states to support cost of collection, segregation and transportation of MSW, segregated waste availability is likely to be higher in future. The JLN National Urban Renewal Mission is also expected to give a boost to waste management in 63 large cities. Projects based on segregated wastes would, therefore, cost less.

5.4.7 For making MSW based projects financially viable, subsidy would need to continue during the 11th Plan as well. It is proposed to set up projects creating 200 MWe for energy recovery from urban wastes (100 MW from MSW, 30 MW from biogas at STPs and 70 MW from other urban wastes such as vegetable market waste, kitchen waste and cow-dung generated waste in urban areas). A subsidy support of Rs.150 crore is proposed for urban waste to energy as per the subsidy levels proposed in Chapter III.

5.4.8 Recent advances in Research indicate that the biogas generated through biomethanation method could be purified and compressed so as to be used in applications where CNG is used for thermal applications and motive power. This is an area where suitable incentives are called for to make the projects financially viable. Appropriate schemes would be worked out but within the subsidy support indicated above.

5.6. ENERGY RECOVERY FROM INDUSTRIAL WASTES

5.6.1 Large quantities of wastes, both solid and liquid, are generated in processing sugar, pulp, paper, food sago / starch and in distilleries, dairies, tanneries, slaughterhouses, poultries, etc, which could be utilized for energy recovery.

5.6.2 The estimated installed capacity potential for recovery of energy from industrial wastes is currently around 1300 MWe which is expected to rise to 1600 MWe by 2012 and 2000 MWe by 2017. Industry-wise estimated installed capacity potential for recovery of energy is as follows:

Sector	Potential (MWe)		
	2007	2012	2017
Sugar	363	453	567
Pulp & Paper	58	72	90
Sago/Starch	24	30	37
Maize Starch	105	132	164
Distillery	503	628	785
Dairy	69	77	96
Others	165	206	258
Total	1287	1598	1997

5.6.3 21 projects for energy recovery from industrial wastes with an aggregate capacity of 26 MWe have been set up in the country. Further, 6 projects aggregating 21.75 MWe are under implementation.

5.6.4 Provision of subsidy for Industrial Wastes to Energy is proposed for continuation during the 11th Plan as per subsidy levels given in Chapter III. Subsidy is proposed to be limited to Rs.5 crore/project and would phased out by the end of the 11th Plan.

5.6.5 A target of 200 MWe installed capacity for energy recovery from industrial wastes is proposed for which subsidy support of Rs. 75 crore is proposed, which is reflected in Chapter-III.

5.7. AKSHAY URJA SHOPS:

5.7.1 The Ministry has been providing subsidy for the establishment of Aditya Solar Shops, renamed Akshay Urja Shops, with a view to facilitating availability of solar energy products. During the 10th Plan, subsidized soft loans, a recurring grant and a turnover incentive for first two years of the shop's operation are being provided. 222 such shops have been set up/sanctioned so far. The target for the 11th Plan is 2000 Akshay Urja Shops for which a subsidy of Rs.48.00 crore is proposed @ Rs.2.40 lakh per shop besides another Rs.7.00 crore towards interest subsidy on loans to be taken by the entrepreneurs for setting up these shops. A total subsidy provision of Rs.55 crore is accordingly proposed. This will be linked with actual VAT payments by these outlets to facilitate monitoring.

5.8.0 RENEWABLE ENERGY/SOLAR/ECO/ GREEN CITIES

5.8.1 It is proposed that certain cities should be developed as Renewable energy/Solar/Eco/Green cities through concentrated deployment of renewable energy systems/devices for supplementing conventional energy.

5.8.2 Subsidy for 100 such cities is proposed @ Rs.50 lakh/city for preparation and implementation of a Master Plan. Accordingly, the financial outlay on this scheme is estimated at Rs.50 crore.

5.9 DEPLOYMENT OF SPV SYSTEMS

5.9.1 It is also envisaged to promote deployment of SPV systems/ devices for various applications through the market route, driven mainly by fiscal incentives and other measures. Subsidy would be considered only when technology improves, costs come down, and unit cost of generation is at par with small hydro power.

5.10 PHYSICAL TARGETS & FINANCIAL REQUIREMENTS FOR 11TH PLAN

5.10.1 The proposed physical targets and associated financial requirements (for provision of capital and interest subsidy) under various UICA programme components for the 11th Plan are given below:

Programme component	Physical target	Subsidy level	Financial requirements Rs. in crore
Solar thermal systems/ devices	10 million. m ² collector area		521.55 Say 522.00
- water heating	9.50 million m ²	1550/m ² *	375.00
- drying	0.25 million m ²	1250/ m ²	31.25
-other (steam generation)	0.25 million m ²	2500/ m ²	62.50
- instl./prog. support	-	-	50.00**
- mun. corpns. - incentive	100 nos.	@ 10lakh each	10.00
Energy-efficient buildings	5 million m ² floor area	Rs.100/ m ²	50
Akshay Urja Shops	2000 nos.	Incentive + recurring grant : Upto Rs.2.40 lakh/ shop + interest subsidy	55
Solar Cities	100 nos.	Rs. 50 lakh / city	50
			684.20 ~ 685

* Subsidy for only 2.5 million m² targeted during first 2 years of the Plan.

** @ 200/ m² to motivators and banks for 2.5 million m² water heating systems targeted with subsidy during first 2 years of the Plan.

CHAPTER-VI

RESEARCH, DESIGN & DEVELOPMENT IN RENEWABLE ENERGY

6.1. INTRODUCTION

6.1.1 The Integrated Energy Policy Report, prepared by the Planning Commission, has recognized that "From a long term perspective and keeping in mind the need to maximally develop domestic supply options as well as the need to diversify energy sources, renewables remain important to Indian's energy sector. It would not be out of place to mention that solar power could be an important player in India attaining energy independence in the long run. With a concerted push and a 40 fold increase in their contribution to the primary energy, renewables may account for only 5 -6% of India's energy mix by 2031-32. While this figure appears small, the distributed nature of renewables can provide many socio-economic benefits." This will call for extensive RD&D efforts to make renewable energy technologies more reliable, long life and cost effective.

6.2. RDD THRUST AREAS FOR 11TH PLAN

6.2.1 While continuation of support for development of various new and renewable energy technologies is proposed keeping in view deployment aims, it would be necessary to focus on specific technologies during the 11th plan that would need to be pursued more vigorously. With a view to accelerate RD&D efforts in such technologies, viz., Solar energy, Wind energy and Alternate Fuel Systems/Devices time-bound and focused RD&D efforts will be required. RD&D thrust areas for the 11th plan are given in **Appendix-I**.

6.3. MEDIUM TERM (2032) DEPLOYMENT AIMS

6.3.1 RD&D activities need to be oriented towards meeting system/equipment requirement for the following deployment aims:

- I. Grid-interactive renewable power: 10 per cent share in grid power installed capacity by 2012 and 15 per cent by 2032.
- II. Alternate Fuels - bio-fuels, synthetic fuels and hydrogen: Substitution upto 10 per cent oil by alternate fuels in transport, portable and stationary applications by 2032. Alternate Fuel systems for the same.
- III. Energy recovery from municipal waste: 423 class-I cities including 107 municipal corporations, where suitable waste of requisite quantity is available by 2032.

- IV. Energy recovery from industrial wastes: where suitable waste is available by 2032.
- V. Solar water heating/pre-heating systems - 50 million m² by 2032.
- VI. Cogeneration - 5000 MWe by 2032.
- IX. Cooking energy and motive power in electrified villages: Complete supplementation by 2032.
- X. Lighting/ electricity in un-electrified census villages/hamlets: 10,000 remote villages/hamlets by 2012.

6.4. RD&D APPROACH

6.4.1 Increased investments and a dynamic Public-Private partnership are expected to revitalize RD&D programmes, leading to new products and services in furtherance of the aim of energy security.

6.4.2 In order to bring sharper focus to RD&D efforts, it is proposed to solicit proposals from industry, supported by SEC, C-WET, NIRE, research institutions, and universities through open advertisements. Wherever necessary and feasible the task would be divided among research groups in keeping with their area of expertise. A lead industry would be identified for coordination among research groups. The Ministry will prepare detailed technology plans based on technology mapping and technology benchmarking to take up RD&D in identified thrust areas through short listed industry and/or research institutions.

6.4.3 In addition, feed back from industry that requires assistance for making new products or improving existing ones, raising quality and reliability levels or effecting cost reductions would be an additional source for identifying areas for RD&D support.

6.4.4 The following further steps would be useful in giving a boost to public-private partnerships:-

- 1) Acquisition fund for Indian companies to acquire technology intensive foreign companies;
- 2) Venture and Risk Capital for creating scientific entrepreneurs;
- 3) RD&D facility sharing between companies;

6.5. STANDARDS & TESTING

6.5.1 It is important that industry makes products as per international standards, specifications and performance parameters which would require adoption of standards and setting up testing facilities. Partial financial support from the Government for this activity is considered necessary. The Ministry will aim to provide a package of fiscal and financial incentives to industry to encourage (i) set up world class testing facilities, (ii) obtain international product certification and (iii) raise investment level in RD&D in new & renewable energy industry to make products of international standards, specifications and performance parameters.

6.6. RESOURCE ASSESSMENT

6.6.1 The ongoing exercise for resource assessment/ mapping of all renewable energy sources on a GIS platform is proposed for continuation. The resource assessment exercise may also include classification of potential sites based on capacity factors, certainty ratings, available infrastructure, evacuation facilities etc. A budget provision of Rs.25 crore has been proposed for this activity for the 11th Plan.

6.7. BUDGET ESTIMATE FOR 11TH PLAN

6.7.1 An amount of Rs.1500 crore is required to support RD&D on different aspects of new and renewable energy technologies, as per details given in **Appendix- II.**

RD&D THRUST AREAS & MAJOR ACTIVITIES FOR 11TH PLAN

1. **Bio-energy**

It is proposed to take up focused RD&D projects in bio-energy conversion to energy through combustion, pyrolysis, atmospheric and high pressure gasification, plasma arc and bio-methanation.

(i) Bio-energy Resource

Resource Atlas for Bio-energy potential covering crop residues, forest residues, MSW, industrial wastes etc.

(ii) Biomass Conversion

- a) Design and development of MW-scale fluidized bed biomass gasifier, hot gas clean up system and integration of the system on the principles of Integrated Gasification Combined Cycle (IGCC).
- b) Design and development of poly-generation facilities for the production of liquid fuels, chemicals and hydrogen in addition to power generation through IGCC route and establishing the concept of a Bio-refinery.
- c) Raising efficiency of atmospheric gasification power generation systems to 25-30% alongwith safe disposal of wastes.
- d) Raising efficiency of small (kw to 1 MW) combustion and turbine technologies to 20% plus.
- e) Design and development of high rate anaerobic co-digestion systems for biogas/ synthetic gas production.
- f) Design and development of gasifier systems based on charcoal / pyrolysed biomass.
- g) Design and development of systems for coupling with Stirling engine or turbines.
- h) Design and development of high efficiency kilns/ systems for charcoal production/ pyrolysis of biomass.
- i) Laying down standards for various bio-energy systems.

(iii) Bio-energy Utilization

- a) Design and development of engines: Stirling engine and micro-turbines for biogas/ producer gas/ bio-syngas.
- b) Design and development of direct gas fired absorptive chillers, driers, stoves, etc., and improvement in biomass furnaces, boilers etc.
- c) Design and development of improved processes/ de-watering systems for drying of digested slurry.
- d) Improving/ upgrading biogas and syngas quality.

- e) Design and development improved Pelletisation/ Briquetting technology for RDF.
- f) Design and development of driers for MSW and industrial solid wastes.
- g) Design and development of systems for waste segregation.

2. **Bio-Fuels**

- a) Develop technology for production of ethanol from sweet sorghum and sugar beet.
- b) Develop technology for production of ethanol from ligno-cellulosic materials such as rice straw and other agricultural and forestry residues.
- c) Engine design optimization for petrol with more than 10% blend of ethanol.
- d) Physico-chemical properties of potential non-edible oils to be aligned with those of diesel for application in transport, stationary and portable applications.
- e) Development of efficient chemical/catalyst conversion processes.
- f) Development of bio-catalyst and heterogeneous catalyst for production of bio-diesel.
- g) Production of bio-diesel from all possible feed-stocks.
- h) Response of different available additives and their dosages on the bio-diesel.
- i) Optimizing engine design for different feed-stock based bio-diesels/and verifying blends thereof for transport, portable and stationery applications.

3. **Solar Photovoltaic Energy**

Research, design and development efforts during the 11th plan are proposed to be focused on development of silicon and other materials, efficient solar cells, thin film materials, concentrating PV technology, PV system design with the objective of significantly reducing the ratio of capital cost to conversion efficiency. Thrust areas for RD&D support in solar photovoltaic technology:

3.1. **Silicon and other Materials**

- a) R&D and pilot scale development of process to make poly silicon material using alternative methods to make solar grade silicon to achieve direct electricity consumption of about 125 kWh/kg of material produces, with trace impurities of heavy metals to sub ppb level and carbon and boron limited to ppb level.
- b) Improvements in the process to make poly silicon material using conventional deposition technique for reducing the direct electricity

consumption of about 125 kWh/kg of material produces, with trace impurities of heavy metals, carbon and boron limited to ppb.

3.2. Crystallize Silicon Solar Cells

- a) Crystalline silicon solar cell efficiency in commercial production to be increased to average 17 -18% and more
- b) Facilitate industry to develop and adopt indigenous technology to produce multi crystalline silicon ingots and solar cells with conversion efficiency of 17% and more in commercial production
- c) R&D on alternative device structures to make crystalline silicon solar cells to demonstrate high efficiency (22 - 24% on small size laboratory devices)

3.3. Thin Film Solar Cell Modules

- a) Development of large area integrated poly crystalline thin film modules using different materials (12% efficiency and long life)

3.4. New Materials based Solar Cells

- a) Design and development of new thin film device structures using dye sensitized, organic and nano materials (solar cell efficiency 5 -10%)

3.5. Concentrating Solar Cells & Modules

- a) Design and development of concentrator solar cells and modules (25 - 30%) and testing of MWp scale systems.
- b) Development of two axis tracking system.

3.6. PV Systems; storage, Balance of System, Modules, Designs

- a) Improving the effective PV module life to 25 years and more, with total degradation within 10% of the initial rating.
- b) Development of long life storage batteries (>5 - 10 years) suitable for PV applications
- c) Development and testing of new storage systems up to MW scale
- d) Design, development and testing of grid connected PV systems and components
- e) Upgrading the testing and characterization facilities for PV materials, devices, components, modules and systems
- f) Study and evaluate new materials, device structures and module designs etc.

4. Solar Thermal Energy

For the 11th Plan, activities on research, design and development leading to deployment and commercialization of various solar thermal technologies for power generation, industrial process heat systems, solar cooling are proposed, in addition to the continuing efforts to develop technologies for improvements for

various low temperature applications viz. solar water heating, solar cooking. The major thrust areas include the following:

(i) Solar thermal power generation

The proposed activities would cover design and development of concentrating solar thermal power systems including parabolic troughs, central receiver systems, heat storage systems and dish/ engine systems.

A) Parabolic Trough technology

Design and development of systems having performance characteristics of internationally available technology. This will include

- a. Components viz. receiver tubes for operating temperature range of about 400 C., parabolic reflector, tracking system and structures.
- b. heat transfer medium, such as, oil, water and room temperature ionic fluids for receivers.
- c. 1 MW capacity system; higher capacity system based on proven technology may also be considered

B) Central Receiver Technology

Research, Design and development of:

- Components such as heliostats, tracking mechanism, tower structure, receiver etc.
- 2 MW capacity system with provision of storage

C) Dish/ Engine/ Turbine Technology

The following focus areas are envisaged for dish/ engine technology for solar thermal power generation:

- a) Large area solar dish with Stirling and other engines to produce power in kW-range.
- b) Design and development of dish/ Stirling engine power plants for distributed generation in the capacity range of 100 kW and above.
- c) Design and development of Stirling engines, having capacity in the range of 500 W to 1500 W (suitable for family, community and distributed power generation) along with appropriate balance of systems including solar dish and controls.
- d) Design and development of other solar compatible power generation technology like Brayton cycle turbines.

(ii) Solar Heat (upto 250o C) for Industrial Processes

The efforts will be made at to develop advanced solar collectors with optical efficiency greater than 75% and overall heat loss coefficient reduced to 4.0 W/m²K (or lower) for flat plate collectors. For industrial process heat applications, the development of high performance solar concentrating collectors and systems will also be undertaken. It is proposed to undertake up to 20 R&D installations, each of about 50 kWth capacity based on the developed technology in different industries with a view to fine-tune the technology as well as technology validation.

(iii) Low Temperature Applications

(a) Solar cooking Systems

Newer, more efficient and cost effective designs of solar cookers will be developed to suit different cooking habits of the people. Studies related to storage of heat in solar cookers are also envisaged. The concept of multipurpose use of Solar Cookers to work as a cooker/ dryer/ water pasteuriser is to be tested to make it more useful there by reducing energy consumption. Training programmes and pilot demonstration projects for newer technologies/ concepts are also proposed to be taken up.

(b) Solar Distillation/ Water Purification Systems

There is a need to develop high yield designs of solar distillation system with a view to produce practical installations of the capacity ranging 1000 litres per day and above for water purification for variety of applications.

(c) Solar Air Heating, Drying and Food Processing Systems

The research activities to produce standardized and cost effective designs of solar air heating and drying systems for different products viz. agricultural produce, fruits, vegetables, tea, spices, fish, bagasse, urban & industrial wastes and fuels etc. are proposed to be taken up.

(d) Solar cooling

Development of cooling systems in appropriate capacity ranges for space cooling as well as applications in cold storages with active involvement of industry is proposed. For establishing the technology, installation of about 500 ton capacity systems is proposed for monitoring, evaluation, and design optimization studies.

(e) Solar Architecture

The work in the area of solar assisted energy efficient architecture is proposed to be continued, especially, with regard to the following:

- a) To evaluate performance of such buildings with a view to disseminate the information on a wider scale.
- b) To develop advance components viz. smart windows, building integrated solar devices etc.
- c) To develop rating procedures for buildings based on energy efficiency and commensurate with the Indian climate and uses.

(f) Solar Detoxification of Wastes

It is proposed to continue studies in the area of solar detoxification of different type of wastes with the objective to develop suitable catalysts and the processes for solar detoxification of wastes. A few pilot demonstration plants are envisaged in industry.

(g) Development of Low Cost Materials

For manufacturing of various types of solar collectors, there is a shortage of low cost and suitable materials along with development of new fabrication processes such that bulk use of materials is reduced and production process is automated to achieve cost reduction goals. It is proposed to take up R&D projects in this area during the 11th Plan.

(iv) Development of performance standards and support to RTCs

Development of performance standards for new range of products will be undertaken. The Regional Test Centres for testing of solar thermal devices and systems, which have been supported by the Ministry and have been accredited by BIS, will continue to be supported and strengthened to undertake testing of new products as per requirement of the industry.

5. Wind Energy

- a) Design, development and manufacturing capability for MW-scale Wind Electric generators (WEGs) for low wind-regimes.
- b) Design, development and manufacturing capability for small WEGs upto 25 kW capacity for low wind-regimes.
- c) RD&D on materials used in MW scale WEG systems.
- d) RD&D on high efficiency electronics for protecting, controlling, optimizing performance, power management & conversion and establishing connectivity with the grid to export and/or import power.

6. Small Hydropower Development

It is proposed to launch a coordinated research and development programme led by industry and in conjunction with universities and research institutions addressing the following areas:

6.1 E&M Works

- a) Adaptation of high pole permanent magnet excitation generators to small hydro.
- b) Development of low speed generators (direct-drive low-speed generators for low heads).
- c) Development of submersible turbo-generators.
- d) Development of high efficiency turbines in kW range.
- e) Flexible small hydro turbines for low head (<5 m).
- f) Development of screening systems for downstream and upstream migrating aquatic life.
- g) Development of standardized control and monitoring systems.
- h) RD&D for development of technology packages for Mini/ Micro hydro systems fitted with suitable electronics and optional maintenance-free-rechargeable batteries for their use for lighting and other small power applications in capacity range of 200W to 5 kW for highly decentralized and dispersed applications.

6.2 Civil Works

- a) Development of software that carries out efficient civil work design.
- b) Development of standardized/ systemized hydraulic structures.
- c) Development of efficient desilters with high head intakes of self-cleaning water intakes, and of trash racks.
- d) Guide on design of power houses.

6.3 Others

Development of good-practice design guidelines for developers and engineers.

Development of control procedures for small hydro projects.

Guidelines for improved methods for in-stream flow and hydrological assessment methods and improved sedimentation management.

Standards for small/ mini/ micro hydro power equipment.

7. Hydrogen and Fuel Cells

7.1 A broad based research and development programme covering different aspects of hydrogen energy, including its production, storage, transportation, delivery, applications and safety aspects needs to undertaken through industry in conjunction with national laboratories, universities, IITs, NITs and other research organizations. The focus of RD&D efforts in this area will be directed towards development of new materials, processes, components, sub-systems and systems.

7.2 It is proposed to set up a Hydrogen and Fuel Cell Facility in the premises of Solar Energy Centre of the Ministry. This facility will undertake and co-ordinated RD&D on hydrogen and fuel cell technologies with other R&D groups and industry in the country.

7.3 Hydrogen Production/ Supply

- a) By-product/ spare hydrogen.
- b) Design and Development of skid-mounted small scale steam methane reformers (SMR) for distributed generation of hydrogen.
- c) Design and Development of high efficiency water electrolyzers, including solid polymer electrolyte water electrolyser (SPEWE), for distributed hydrogen production.
- d) Purification, pressurization and storage.
- e) Design & Development of small reformers for on-site and on-board reformation.
- f) Pilot scale generation of hydrogen by biological processes.
- g) Pilot scale demonstration of hydrogen production from carbohydrate bioorganic waste by different processes.
- h) Pilot scale demonstration of low temperature water splitting by biological route.
- i) Pilot scale demonstration of production of hydrogen and synthetic liquid fuel using IGCC technology for Indian coal and biomass.
- j) Design and development of high temperature steam electrolysis (HTSE) systems.
- k) Design and development of 1 Nm³/hr HTSE and 5 Nm³/hr SPEWE.
- l) Design and development of solar water splitting systems.

7.3 Hydrogen Storage

- a) Development of inter-metallic hydrides with storage efficiency: 5 wt% & cycle life of 1,000 cycles.
- b) Development of high pressure (~500 bar) gaseous cylinder.
- c) Development of Nano-materials, including carbon nano-tubes/ nano-fibres.
- d) Development of alanates, including Na and Mg alanates.
- e) Exploration of unusual storage modes like depleted mines.

7.4 Hydrogen Delivery

- a) Decentralized distribution through high pressure (>200 bar) gaseous cylinders employing trucks.
- b) Decentralized distribution through hydrides canisters.
- c) Decentralized distribution through high pressure (500 bar) gaseous cylinders employing trucks.
- d) Pipeline network.

7.5 Hydrogen Application in Transport, Power Generation & Other Applications

IC Engine Route

a) Design & Development of hydrogen IC engines for transport, portable and stationery applications.

Fuel Cell Route

1. Low Temperature Fuel Cells

(i) Design and development of PEMFC.

- a) Low-cost 'proton exchange' membranes as a substitute to costly imported membrane.
- b) Low-cost bipolar plates (graphite based, high conductivity, impervious) preferably with flow grooves incorporated during molding itself.
- c) Higher CO tolerant anode catalyst.
- d) Cheaper cathode catalyst.
- e) Electrode support substrate (graphite paper).

(ii) Design and development of AFC:

- a) Compact, low-power electrolyte re-circulating system.
- b) Low cost CO₂ scrubber & alkali-water heat exchanger.
- c) Low-cost catalysts (Ni-Co spinel, MnO₂/ C).
- d) Low-cost, resin based mono-polar plates/ cell enclosures.
- e) Regenerative CO₂ scrubbing system.

(iv) Optimization of design of various components (bipolar plates, MEAs etc for PEMFC and electrode frames, seals, CO₂ scrubbing/ electrolyte re-circulating systems for AFC).

(v) Assembly and testing of the stacks.

(vi) Integration of AFC and PEMFC stacks with other subsystems.

(vii) Design & development of micro power rating/ size fuel cells (like pencil cells/ batteries) for small/ micro power applications for laptops, mobile phones and other small power requiring gadgets/ systems.

2. High Temperature Fuel Cells

(i) **Design and development of SOFC (5 kW) and MCFC (10 kW) stacks:**

- a) Decide which SOFC technology is to be pursued (Planar or Tubular);

- b) Development and optimization of component and stack design for SOFC and MCFC. Identify fuel to be used.
- a) Development of various components (electrodes, electrolyte, seals) including identifying the materials to be used & processing techniques to be adopted. Design inter-connects (between adjacent cells) and overall current collectors.
- b) Design of mechanical systems (clamping / stacking arrangements, flow field design etc.) Finalize stack assembly & testing procedures. Integrate the complete system and test.
- c) Design of C&I and inverter systems incorporating safety systems.
- d) Design of skid mounted sub-assemblies/ systems for ease of transportation to site.
- e) Install, Commission & test the integrated system.

8. Battery Operated and Hybrid Vehicles

- a) Development of high energy density low weight batteries for BOVs and HEVs.
- b) Design and development of ultra capacitors.
- c) Design and development of electronic control systems and drive systems.
- d) Design and development of chassis.
- e) Development of BOVs with operating range of 400 km.
- f) Development of HEVs based on IC engine and high density low weight storage batteries with performance characteristics matching those of IC engine vehicles.
- g) Development of HEVs based on IC engine and fuel cells with performance characteristics matching those of IC engine vehicles.

9. Geothermal Energy

340 hot spring sites have been identified in the country with a maximum recorded surface temperature of 92°C. Magneto-telluric studies are being conducted through the National Geophysical Research Institute, Hyderabad to assess the potential at Puga Valley in Jammu & Kashmir.

During the 11th Plan resource assessment for estimating potential of geothermal for power generation will be continued using magnetotelluric techniques. Chemical analysis of hot springs where power generation is feasible will also be carried out. Power plants utilizing low grade steam and water would be developed indigenously.

10. Tidal Energy

RD&D for the design and development of 3.65 MW tidal power project at Durgaduani Creek in Sunderbans in West Bengal is proposed. In addition, resource surveys will be carried out.

11 Solar Energy Centre (SEC)

All activities listed in paragraphs 3& 4 are to be carried out by SEC in association with other organizations during the 11th Plan. SEC will also continue system and component testing activities for RD&D purposes.

12. Centre for Wind Energy Technology (C-WET)

12.1 Proposed major RD&D projects of the Centre during the 11th Plan are:

Design, Development and facilitating manufacturing capability of MW-scale WEGs for low wind regimes.

Component and System Testing

Standards development.

12.2 Resource Assessment: Wind resource assessment is proposed to cover the entire country, including offshore.

13. National Institute of Renewable Energy (SSS NIRE)

The Sardar Swaran Singh National Institute of Renewable Energy (SSS NIRE) is being established as an autonomous institution at Wadala Kalan, Distt. Kapurthala, Punjab with an approved outlay of Rs.37.68 crore. Buildings are expected to be completed by 2007-08. Scientific and Technical Advisory Committee (STAC) is being reconstituted to prepare a road map for various activities of NIRE.

NIRE will focus on:

- a) RD&D in bio-energy bio-fuels and synthetic fuels.
- b) Bio/sym fuel systems for transport, portable and stationery applications.
- c) Bio-energy/ bio-fuel synthetic fuel component and system testing.
- d) Development of standards for bio-energy and bio-fuel based products, systems and devices.
- e) Bio-energy resource assessment.

16. Renewable Energy Resource Assessment

It is proposed to focus on creation, updation and validation of database on Renewable energy resources during the 11th Plan through a systematic approach in association with expert and specialized institutions in addition to SEC, C-WET, NIRE and AHEC.

17. RD&D in Hybrid Renewable Energy Technologies

The nature of renewable energy sources is such that they are not able to meet 24x7 electricity supply. This has necessitated hybridization of two or more technologies for which suitable electronics, software and power management systems for automatic inter-connection of various renewable energy systems are required. This area of RD&D activity is to be provided an impetus and accordingly for the 11th Plan a separate budget provision has been proposed.

18. Energy Storage Systems

At present storage batteries are widely being used to store energy generated by various renewable energy systems, when used in decentralized mode. In addition, capacitors are also being used to store energy, specially in fuel cell vehicles. However, batteries require periodic replacement. Therefore, it is necessary to focus R&D efforts on development of improved storage techniques and develop alternate / additional methods of storage such as molten salt, super conducting bearing based fly wheel etc. It is proposed to study the prospects of new and improved methods of storage of energy from renewable energy sources. Collaborative research will be taken up in co-ordination with specialized R&D centres working in the country on different storage methods.

Appendix-II

Proposed Financial Outlay on Research, Design and Development in Renewable Energy for 11th Plan:

Sl. No.	Area	Amount (Rs. in crore)
1.	Bio-Energy:	150
	i) Bio-solid and gaseous Fuels	75
	ii) Bio-Liquid Fuels	75
2.	Solar Energy Centre:	400
	i) Centre	40
	ii) Solar Thermal	140
	iii) Solar Photovoltaic	220
3.	Wind Energy:	200
	i) Large WEGs	190
	ii) Small Aero-generators/Wind Pumps	10
4.	Small Hydro Power:	50
	i) Small Hydro Power	40
	ii) Mini/ Micro Hydro Power	10
5.	New Technology:	400
	i) Hydrogen/ Fuel Cells	100
	ii) National Hydrogen and Fuel Cell Centre at SEC	100
	iii) National Bio-fuel Board	20
	iv) Transport Applications	100
	v) Power generation	50
	vi) Geothermal Energy	10
	vii) Tidal Energy	20
6.	Hybrid Energy Systems	40
7.	Energy Storage	40
8.	Electricity from Animal Energy and other new concepts	25
9.	TIFAD	10
10.	NETCOF	7
12.	C-Wind Energy Technology	40
13.	National Institute of Renewable Energy	40
14.	Alternate Hydro Electric Centre	10
15.	Standard & Testing including setting up National Renewable Energy Certification Centre (NRECC)	25
16.	Renewable Energy Resource Assessment	25
	Total:	1500

CHAPTER-VII SUPPORTING PROGRAMMES

7.1 INFORMATION, PUBLICITY AND EXTENSION

7.1.1 Information, Publicity and Extension (IPE) aim at creating conditions for and facilitating deployment of new and renewable energy systems/devices. Sustaining, accelerating and extending outreach of deployment programmes is considered essential for increasing share of renewables in the energy-mix. Areas most likely to gain are rural, urban, commercial and industrial. Within these, deployment of solar thermal systems/devices can in particular be accelerated with adequate IPE support, not to mention of solar photovoltaics in niche applications and conversion of MSW to energy.

7.1.2 I&PA programme will cover support for Renewable Energy field level training institutions, Renewable Energy Clubs, Rajiv Gandhi Akshyay Urja Diwas celebrations, Publicity through Electronic and Print media, Publications (Aksya Urja etc.) and District Advisory Commtees (DACs). It will also cover support for BOVs/ Hybrids/ SPV devices / other RE devices on extension basis.

7.1.5 A budget provision of Rs.525 crore is proposed for the 11th Plan period as per the following break-up:

	<u>Rs./crore</u>
(i) SPV/ Hybrid/ SPV devices/ other RE devices	250
(ii) Solar Passive Architecture-Training & Publicity	12.50
(iii) Renewable Energy Clubs	50
(iv) Rajiv Gandhi Akshyay Urja Diwas	50
(v) Electronic, Print and Outdoor media	100
(vi) Publications (Aksya Urja etc.)	25
(vii) District Advisory Commtees (DACs)	<u>50</u>
	537.50 ,
	~ Rs.540 crore

7.2 INTERNATIONAL RELATIONS

7.2.1 International Relations (IR) programmes aim at obtaining leverage for the country in RE related activities at multilateral, plurilateral & bilateral levels. In pursuance of this aim, IR support covers, among others, the following:-

- (1) Multilateral/plurilateral/bilateral events;
- (2) Training for foreign scientists/technologists in the country;
- (3) Deployment of NRE systems/devices in other countries;
- (4) Technical consultancy to other countries;
- (5) Seminars/symposia/workshops etc. in the country;

- (6) Deputations abroad; and
- (7) Related activities.

Budget provision of Rs.50crore is proposed for these activities during the 11th Plan.

7.3 HRD & TRAINING

7.3.1 HRD & Training of scientists of the Ministry and elsewhere is considered essential for updating and creating new knowledge & skills, required for making Indian New & Renewable Energy Industry competitive. It is proposed to offer fellowships for undertaking doctoral / post doctoral research in relevant new and renewable energy areas that are required by industry and research institutions. This apart, training of MNRE scientists to keep them abreast of the latest developments is proposed in India and abroad.

7.3.2 A budget provision of Rs.50 crore for the plan period is proposed for this activity.

7.4 MONITORING AND EVALUATION

7.4.1 It has been suggested that periodic field level monitoring of this Ministry's programmes be carried out in order to receive feedback at first hand which is expected to facilitate correlating outlays with outcomes. Monitoring could be extended to programme evaluation as well. Accordingly, a budget provision of Rs.10 crore for these activities for the 11th plan period is proposed. Monitoring & Evaluation activities are proposed to be carried out mainly through professional organizations, specializing in the same.

7.5 PLAN SECRETARIAT

7.5.1 With the setting up of SNAs in most states/UTs, the need for this Ministry's Regional Offices (ROs) has been declining since most functions performed earlier by ROs are being undertaken by SNAs. Accordingly, it is proposed to wind up all ROs during the 11th Plan and the officers/ staff therein will be redeployed at MNRE HQrs/ SEC/ NIRE, and those on deputation will be repatriated to parent organizations.

7.5.2 As observed in Para 1.4.20 - Chapter-I, the Ministry requires up-scaling in terms of manpower so that RD&D activities as assigned to it can be carried out without any hindrance or obstacle. In addition, S&T equipment etc. are required to be placed in the Secretariat alongwith more powerful computers and other modern office management equipment. A budget provision of Rs.50 crore is proposed for Plan Secretariat during the 11th Plan.

7.6 IREDA

7.6.1 IREDA requires infusion of equity to not only lower its cost of funds but also increase its net worth so that it can borrow more from the market to sustain and increase its market share during the 11th Plan. A provision of Rs.250 crore is proposed for the purpose.

7.7 SUPPORT TO STATE GOVERNMENTS

7.7.1 It is proposed to give SNAs service charge @ 1 per cent of subsidy released through them in order that the service charge amount can be utilized to strengthen their delivery mechanism, since states are not coming forward to do the same. In this regard, an amount of Rs.50crore for the plan period is proposed on the assumption that around Rs.5000 crore subsidy would get routed through the SNAs.

7.8 SUPPORT TO INDUSTRY:

7.8.1 To facilitate Indian Industry in NRE becoming competitive it is essential that it manufactures products as per international standards, specifications and performance parameters. This will require setting up world class R&D, testing and quality assurance facilities apart from acquiring requisite machinery by the industry. Partial financial support is proposed for providing a package of financial incentives to industry to encourage (i) setting up facilities for the manufacture of products conforming to the aforesaid, (ii) setting up testing and quality assurance facilities, (iii) obtain product certification and (iv) accelerate R&D to make products required by the market.

7.8.2 Some additional incentives to Indian renewable energy industry also need to be provided as follows:

- (i) 150% accelerated depreciation to set up R&D Centres in the country in renewable energy, which must be recognized as R&D Centre by the Government
- (ii) Soft loan at 2 - 3 % annual interest rate, to be repaid in 8 - 10 years, for specified technologies, raw materials and components
- (iii) Grant support (50%) to seek international certificate for the purpose of exports.
- (iv) Grant / loan to encourage industry in setting up research facilities, pilot manufacturing facilities, to be identified by the Ministry from time to time.

7.8.3 It is proposed to extend Viability Gap Funding through IREDA for the setting up RE industry, especially in SEZs.

7.8.4 The above mentioned approach would help the Indian renewable energy industry in not only providing reliable and sustainable solutions for the growing

energy needs of the country, but also help in attaining a leadership role in the world renewable energy market.

7.8.5 Budget provision of Rs.700 crore is proposed for these components.

7.9 SPILLOVER LIABILITIES OF 10TH PLAN PROGRAMMES

7.9.1 As IREP is proposed to be discontinued w.e.f.1.4.2007, 10th Plan liabilities under it, if any, will be met from provisions under spillover liabilities of 10th Plan programmes, which include 5 training establishments being run by respective state governments.

7.9.2 The scheme for support to State Nodal Agencies was introduced in 2002-03 for a period of three years and has facilitated creation of necessary infrastructure in the NE and newly created States for facilitating implementation of various renewable energy programmes. As its purpose has been served, it is proposed to discontinue this scheme w.e.f. 31.3.2007. The spillover liabilities, if any, will be settled during the 11th Plan.

7.9.3 A budget provision of Rs.100 crore is proposed for the 11th Plan period towards the spillover liabilities of above mentioned and other programmes of 10th Plan.

7.10 SUMMARY OF PROPOSALS:

Support Programme	Outlay (Rs. in crore)
1. Information, Publicity and Extension	540
3. International Relations	50
4. HRD & Training	50
5. Monitoring and Evaluation	10
6. Plan Secretariat	50
7. IREDA	250
8. Support to State Governments	50
8. Support to Industry	<u>1000</u>
	2000
Spillover liabilities	
9. Spillover liabilities of 10 th Plan programmes	<u>100</u>
	2,100

CHAPTER-VIII SUMMARY OF PLAN PROPOSALS

8.1 The budget provision for 11th Plan for various renewable energy programmes/ activities proposed in the preceding chapters is summarized below:

	<u>Rs. in crore</u>
1. GRID-INTERACTIVE & DISTRIBUTED RENEWABLE POWER	3,925
2. RENEWABLE ENERGY FOR RURAL APPLICATIONS	2,250
3. RENEWABLE ENERGY FOR URBAN, INDUSTRIAL & COMMERCIAL APPLICATIONS	685
4. RESEARCH, DESIGN & DEVELOPMENT	1,500
5. SUPPORTING PROGRAMMES AND SPILL-OVER LIABILITIES	<u>2,100</u>
TOTAL	: 10,460

CHAPTER-IX PERSPECTIVE PLAN 2022

9.1 PERSPECTIVE PLAN FOR GRID-INTERACTIVE RENEWABLE POWER

9.1.1 In the installed renewable power capacity of 8088 MW as on 31.03.2006, which is around 6.47% of the total installed capacity of 1,25,000 MW, the resource-wise contribution is 5310 MW / 4.25% wind power, 1826 MW/1.46% small hydro power and 950MW/ 0.76% bio power. Renewable power capacity is likely to touch 10,000 MW by the end of the 10th plan.

9.1.2 The aim for the 11th Plan, as stated, is a capacity addition of 15,000 MW from renewables (14,000 MW grid-interactive and 1000 MW DPRS. By the end of the 11th Plan, renewable power capacity could be 25,000 MW in a total capacity of 2,00,000 MW accounting for 12.5 per cent and contributing around 5 per cent to the electricity mix.

9.1.3 A capacity addition of around 30,000MW is envisaged for the 12th and 13th Plans. Renewable power capacity by the end of the 13th plan period is likely to reach 54,000 MW, comprising 40,000 MW wind power, 6,500 MW small hydro power and 7,500 MW bio-power, which would correspond to a share of 5% in the then electricity-mix.

9.1.4 The perspective plan for grid-interactive renewable power is summarized in Table 9.1.

Table 9.1: Perspective plan for grid-interactive renewable power for 2022, i.e. end of 13th Plan period:

Resource	(capacity in MW)				
	Upto 9 th Plan	10 th Plan	11 th Plan	12 th and 13 th Plans	Total
Wind power	1667	5333	10500	22,500	40000
Small hydro power	1438	522	1400	3140	6500
Bio power	368	669	2100	4363	7500
Solar Power	2	1	-	-	3
Total	3475	6525	14000	30003	54003

9.2. PERSPECTIVE PLAN FOR RENEWABLE ENERGY FOR URBAN, INDUSTRIAL AND COMMERCIAL APPLICATIONS

9.2.1 The broad goals proposed for 2032 for applications in the urban areas and industry call for a significant scale-up over the next 25 years spanning five Plan periods. The major goals include 50 million m² of solar collector area for thermal applications, mainly solar water heating and 7500 MW of grid/captive power from bio resources, including urban and industrial wastes. Compared to the status in 2007, there is a massive build-up in capacity, which will require concerted action across various fronts, starting with the next Plan.

9.2.2 The targets proposed for 2012 and indicative goals for 2022 and 2032 are reflected in the perspective plan given in Table 9.2.

Table 9.2: Perspective Plan for renewable energy for urban, industrial and commercial applications:

Programmes	2012	2022	2032
Solar Energy			
Solar thermal systems/ devices	10 million m ² collector area	30 million m ²	50 million m ²
Energy-efficient Buildings	5 million m ² floor area (1000 buildings)	20 million m ²	40 million m ²
Akshay Urja Shops	2000 nos.	-	-
Energy Recovery from Urban & Industrial Wastes			
Urban Wastes	500 MW*	*	*
-MSW	400 MW (100 cities)		
-other wastes	100 MW		
Industrial Wastes	200 MW*	*	*

* included in the proposed targets for bio-power in Table 9.1.

TERMS OF REFERENCE OF THE WORKING GROUP

- (i) To review the Integrated Energy Policy Report and suggest measures to operationalise its recommendations during the Eleventh Plan.
- (ii) To recommend an industry structure that would enhance number of players, promote competition, provide a consistent and transmission, distribution and end use efficiency.
- (iii) To review the performance of existing MNRE programmes and suggest modifications and/or alternative approaches for greater effectiveness.
- (iv) To review the efficacy of the Village Energy Security Programme of MNRE.
- (v) To review the financial and physical performance of the MNRE programmes during the Tenth Plan in relation to the targets set in the beginning of the Plan and recommend measures to overcome the shortfalls.
- (vi) To estimate resource requirement for the Eleventh Plan and to identify the sources including the Centre, States and private participants.
- (vii) To suggest measures for mainstreaming mature renewable energy technologies and making their growth demand driven as opposed to being supply driven.
- (viii) To review the current pricing and subsidy regime for renewable energy programmes and to suggest measures to target subsidies to removing real barriers.
- (ix) To suggest measures to link available fiscal and financial incentives for renewable energy programmes to production of energy as opposed to the current practice of providing incentives linked to building renewable capacities.
- (x) To recommend policy guidelines for effective feed-in laws and/or feed in tariffs for grid connected renewable power so as to ensure a level playing field between the conventional and renewable alternatives.
- (xi) To suggest socially oriented renewable energy programmes to address community needs where considered more effective compared to programmes targeting individual needs/initiatives.
- (xii) To suggest ways to generate public awareness through effective dissemination of information about renewable energy devices and systems especially among the vast rural population.
- (xiii) To recommend measures for self-supporting and sustainable rural energy programmes with the involvement of grass root institutions like PRIs.
- (xiv) To recommend appropriate building laws mandating passive design features for energy efficient buildings, the use of solar water heater and other energy saving devices.
- (xv) To suggest and design of a labeling and certification mechanism for improving end use efficiency and to prevent proliferation of sub-standard conventional and/or renewable energy based gadgets/systems.

TERMS OF REFERENCE AND COMPOSITION OF SUB-GROUPS

1. SUB-GROUP ON GRID-INTERACTIVE RENEWABLE POWER & DISTRIBUTED GENERATION

Terms of Reference:

1. Plan for capacity addition during XI Plan.
2. Perspective Plan for capacity addition during XII & XIII Plans.
3. Need for fiscal and financial incentives and quantification thereof for (i) above.
4. Other related issues.

Composition:

- | | | |
|--|---|-------------|
| 1. Dr. T.L. Shankar, former Chairman, APSEB | - | Chairman |
| 2. Shri S.P. Sethi, Adviser, Planning Commission | - | Co-Chairman |
| 3. Shri V.S. Verma, Member, CEA | - | Member |
| 4. Shri Sunil Khatri, Jt. Secretary, MNRE | - | -do- |
| 5. Shri Arvind Jadhav, Jt. Secretary, MoP | - | -do- |
| 6. Jt. Secretary, MoEF | - | -do- |
| 7. Jt. Secretary, Do Exp. | - | -do- |
| 8. Adviser (Wind/Biomass), MNRE | - | -do- |
| 9. ED, C-WET | - | -do- |
| 10. MD, IREDA | - | -do- |
| 11. Prof. Rangan Banerjee, IIM-A | - | -do- |
| 12. Shri V. Raghuraman, CII | - | -do- |
| 13. Shri B. D. Sharma, IRADe | - | -do- |
| 14. Winrock India International | - | -do- |
| 15. Dir (P Saxena) / Dir (AK Varshney), MNRE | - | Secretary |

II. SUB-GROUP ON RENEWABLES FOR RURAL AREAS

Term of Reference:

1. Plan for Remote Village Electrification through renewables during XI Plan
2. Plan for supplementing energy needs of cooking, lighting and motive power of non-remote villages through renewables during XI Plan.
3. Perspective Plan (2012 - 2022) for (ii) above.
4. Need for fiscal and financial incentives and quantification thereof for (ii) above.
5. Other related issues.

Composition:

- | | | | |
|-----|--|---|-------------|
| 1. | Dr. S.K. Chopra, Sr. Adviser, MNRE | - | Chairman |
| 2. | Shri Arvind Jadhav, Jt. Secretary, MoP | - | Co-Chairman |
| 3. | Jt. Secretary, MoRD | - | Member |
| 4. | Jt. Secretary, MoEF | - | -do- |
| 5. | Dr. K. C. Khandelwal, Adviser, MNRE | - | -do- |
| 6. | Shri Sudhir Mohan, Adviser, MNRE | - | -do- |
| 7. | Director, REC | - | -do- |
| 8. | MD, IREDA | - | -do- |
| 9. | Development Alternatives | - | -do- |
| 10. | SWRC, Tilonia | - | -do- |
| 11. | SPRERI | - | -do- |
| 12. | SNA (AEDA) | - | -do- |
| 13. | SNA (OREDA) | - | -do- |
| 14. | SNA (NEDA) | - | -do- |
| 15. | Dir (AK Dhussa) / Dir (P Dhamija) | - | Secretary |

III. SUB-GROUP ON RENEWABLES FOR URBAN, INDUSTRIAL AND COMMERCIAL APPLICATIONS

Terms of Reference:

1. Plan for supplementary energy needs of urban, industrial and commercial sectors through renewables during 11th Plan.
2. Perspective Plan 2012-2022 for one above
3. Need for fiscal and financial incentives and quantification thereof for one above.
4. Other related issues.

Composition:

- | | | |
|--|---|-------------|
| 1. Shri Ajit K. Gupta, Adviser, MNRE | - | Chairman |
| 2. Joint Secretary, Ministry of Urban Development | - | Co-Chairman |
| 3. Joint Secretary, Ministry of Environment & Forests- | | Member |
| 4. Dr. T.C. Tripathi, Adviser, MNRE | - | Member |
| 5. Dr. N.P. Singh, Adviser, MNRE | - | Member |
| 6. MD, IREDA | - | Member |
| 7. Rep. of Bureau of Energy Efficiency | - | Member |
| 8. Managing Director, NEDCAP, Hyderabad | - | Member |
| 9. Director General, MEDA, Pune | - | Member |
| 10. Director, GEDA, Vadodara | - | Member |
| 11. Dir (A Raza)/Dir(DK Khare), MNRE | - | Secretary |

Co-opted Members:

1. Director, Haryana Renewable Energy Dev. Agency, Chandigarh
2. Lt. Col. Suresh Rege, Managing Director, Mailhem Engineers Pvt. Ltd., Pune
3. Dr. S. Dasappa, Indian Institute of Science, Bangalore
4. Dr. Sameer Maithel, Associate Director, TERI, Delhi.
5. Shri D.K. Mittal, CEO, IL&FS, Delhi
6. Municipal Commissioner, Thane, Maharashtra

IV. SUB-GROUP ON RESEARCH, DESIGN & DEVELOPMENT IN RENEWABLE ENERGY

Term of Reference:

1. Plan for Research, Design and Development activity in New and Renewable Energy during XI Plan.
2. Perspective Plan (2012 - 2022) for (i) above.
3. Plan for strengthening C-WET, SEC and NIRE during the XI Plan.
4. Need for fiscal and financial incentives and quantification thereof for (i) and (iii) above
5. Other related issues.

Composition:

- | | | | |
|-----|--|---|-------------|
| 1. | Dr. A. Ramachandran, former Secretary, DST | - | Chairman |
| 2. | Shri A.V. Singh, former Secretary, MNRE | - | Co-Chairman |
| 3. | Dr. S.K. Chopra, Pr. Adviser & Spl. Secy., MNRE | - | Member |
| 4. | Adviser (Energy), Planning Commission | - | -do- |
| 5. | Shri Sunil Khatri, Jt. Secretary, MNRE | - | -do- |
| 6. | Dr. T.C. Tripathi, Adviser, MNRE | - | -do- |
| 7. | Dr. B. Bandopadhyaya, Adviser, MNRE | - | -do- |
| 8. | Shri K.P. Sukumaran, Adviser, MNRE | - | -do- |
| 9. | Rep. - Deptt. of Science & Technology | - | -do- |
| 10. | Rep. - Deptt. of Bio-Technology | - | -do- |
| 11. | Rep. - Deptt. of Agricultural Research & Education | - | -do- |
| 12. | Rep. of DSIR | - | -do- |
| 13. | Rep. of DRDO | - | -do- |
| 14. | Rep. of BARC | - | -do- |
| 15. | Executive Director, C-WET | - | -do- |
| 16. | Head, AHEC | - | -do- |
| 17. | Dr. Natrajan - formerly in R&D Committee | - | -do- |
| 18. | Dir (AR Shukla)/ Dir (B Bhargava) | - | Secretary |

ANNEXURE-III

INCENTIVES PROVIDED FOR RENEWABLE POWER IN OTHER COUNTRIES@

International Feed-in Tariffs

Tariff in Rs./kWh**

	Conventional		Wind				Photovoltaics		Biomass		
	Domestic	Commercial		(Windy sites) ^b	(Non windy)		(Cap.<5 MW)		0-0.5 MW	0.5-5 MW	5-20 MW
Germany*	6.0 (2001)	2.3 (2002)	1st 5 years ^a	5.2	5.2		27.6		5.85	5.27	4.99
			Next 15 years	3.4	4.6		Guaranteed for 20 years ^c				
			(Cap. <12 MW)	Windy sites)	(Non windy)	(Intermediate)					
France	5.21 (2002)	1.83 (2002)	1st 5 years ^a	4.6	4.6	4.6	8.6	17.2			
			Next 15 years	1.7	4.6	3.4	(Mainland)	(Overseas)			
				(Cap.<50 MW) ^d			(Cap.<5 kW)	(Cap.>5 kW)			
Spain+	5.29 (2001)	2.00 (2001)	Fixed	3.6			22.7	12.4	3.5		
				OR					OR		
			Premium of	1.5			20.63	10.32	1.4		
Austria ^e	6.48 (2002)	2.54 (1995)		4.5			26.9 to 34.4		4.4 to 9.2		

* 2002 data

+ 2003 data

^a Since 2002 tariff reduced by 1.5% per year

^b Sites that achieve more than 150% of reference output

^c For new installation price reduced by 5%. The obligation to pay ends when total installed capacity reaches 1000 MW

^d Premiums and tariff set by Government

^e Uniform fixed price for 13 years (2003)

** Based on exchange rate of Rs.57.31 Per Euro (December-2003)

Source: T. Stenzel, T. Foxon, R. Gross (2003): Review of renewable energy development in Europe and the US, Report for the DTI Renewables Innovation Review, ICCEPT, Imperial College, London, October 2003.

@ SOURCE: IEPR August 2006, Planning Commission

ESTIMATED RENEWABLE ENERGY POTENTIAL

Sl. No.	Resource	Estimated Potential (in MWe)
1.	Wind Power	45,195 ¹
2.	Small Hydro Power (upto 25 MW)	15,000 ²
3.	Bio-Power (Agro-residues)	16,881 ³
4.	Cogeneration-bagasse	5,000 ⁴
5.	Waste to Energy : Municipal solid waste to energy Industrial waste to energy	1,700 ⁵ 1,000
	Total	84,777 ⁶

MW_e = Megawatt equivalent;

Note: -

- (1): Potential based on areas having wind power density (wpd) greater than 200 W/m² assuming land availability in potential areas @ 1 per cent and requirement of wind farms @ 12 ha/MW, not all of which may be technically feasible for grid-interactive wind power. In line with international practice for setting up grid-interactive wind power systems, potential would drop substantially if sites having wpd greater than 300 W / m² were to be considered. However, the lower end of the potential might be suitable for off-grid applications. Further, preliminary surveys do not at this juncture suggest a sizeable grid-interactive off-shore wind power potential.
- (2): Technically feasible hydro potential of all sites upto 25 MW station capacity, not all of which may be economically viable. Technically feasible potential of identified sites is placed at around 10,500MW.

- (3): Although the potential is based on surplus agro-residues, in practice biomass power generation units prefer to use fuel-wood for techno-economic reasons. A potential of 45,000 MW_e from around 20mha of wastelands assumed to be yielding 10MT/ha/annum of woody biomass having 4000 k-cal/kg with system efficiency of 30% and 75% PLF has not been taken into account. In order to realize this potential a major inter-Ministerial initiative involving, among others, Environment & Forests, Agriculture, Rural Development, and Panchayati Raj would be required. Further, a Biomass Atlas is under preparation which is expected to more accurately assess state-wise renewable energy potential from agro-residues.
- (4): With new sugar mills and modernization of existing ones, technically feasible potential is assessed at 5000 MWe, not all of which may be economically viable. Furthermore, several sugar companies/cooperatives are unable to develop bankable projects on account of their financial and liquidity positions.
- (5): With expansion of urban population post census 2001, current technically feasible municipal waste-to-energy potential is assessed at 1700 MWe, not all of which may be economically viable. However, subsidy disbursement under the municipal waste to energy programme has been kept in abeyance on the orders of the Supreme Court until final disposal of a PIL seeking composting as the preferred route for MSW disposal.
- (6): Not all of this renewable energy potential may be suitable for grid-interactive power for technical and / or economic reasons. Further, estimate excludes potential for solar power which is dependent on future developments that might make solar technology cost-competitive for grid-interactive power generation applications.
