

Renewable Energy Research and Development Priorities (updated on the basis of Expert Committee 'recommendations)

Area	Technology Gap	Research Areas
Solar Photovoltaic	<ul style="list-style-type: none"> • Import dependence for wafers, cells and modules. • Mass manufacturing of cells and modules. • Availability of alternative options in emerging technologies. 	<ul style="list-style-type: none"> i. Indigenous PV cell technology with globally competitive prices and performance; ii. Cutting edge manufacturing techniques for indigenous manufacture; and iii. Next generation PV technologies including Perovskites, roll to roll, Thin films, Multi-Junction Solar Cells, Dye induction photovoltaics, Agri RE tech and PV-CSP-wind-storage hybrid organic/inorganic composites etc. iv. Development of cost competitive packages for applications beyond grid electricity, including cooking, lighting, water pumping, irrigation etc.
Solar Thermal Applications	<ul style="list-style-type: none"> • Import dependence for solar field components. • Conversion efficiencies derive 	<ul style="list-style-type: none"> i. Improving conversion efficiencies and reducing costs through improved designs, new materials, manufacturing processes, deployment of higher conversion temperatures, alternative heat transfer fluids etc. ii. Commercial scale PV CSP hybrid with storage cost of CSP iii. Thermal storage systems integrated with power, heating or cooling applications iv. Potential for integration of existing coal based power plants with CSP for pre-heating, hybridization. v. Solar thermal with supercritical CO2 Brayton cycle vi. Indigenizing Reflector materials with good outdoor durability, high solar reflectivity, good mechanical resistance.
Waste to Energy	<ul style="list-style-type: none"> • Lack of standardization of process leads to 	<ul style="list-style-type: none"> i. Technologies for efficient utilization of urban, farm and

	unfavourable economics.	industrial waste for power generation at minimum economic and environmental costs
Wind Energy	<ul style="list-style-type: none"> • Import dependence for technologies for offshore wind deployment. • Modelling and simulation to ensure accurate forecasting. 	<ol style="list-style-type: none"> i. Cost reduction and indigenization of wind turbine components and sub-systems; ii. Development of materials, techniques and technologies for offshore wind energy deployment; iii. Modelling and simulation including high-performance computing (HPC) to improve generation forecasting, and performance analysis. iv. LiDAR installations and Horizontal/Vertical Axis turbine v. offshore wind installation to power Indian islands as well as drinking water by desalination.
Hydrogen and Fuel Cells	<ul style="list-style-type: none"> • Availability of hydrogen of desired purity at viable costs. • Import dependence for hydrogen storage materials. • Import dependence for fuel cell components and stacks. • Lack of infrastructure for transportation/distribution of hydrogen to end user locations. 	<ol style="list-style-type: none"> i. Increasing efficiency and indigenous content of electrolyzers; ii. Indigenous development of type III and type IV cylinders, as well as hydride and carbon materials for hydrogen storage; iii. Development of indigenous catalysts, membranes, balance of system components and stack assemblies; iv. Development of Fuel cell based applications for power generation, transportation, logistics etc; and v. Development of hydrogen distribution networks through pipelines, and dispensing stations. vi. Hydrogen infrastructure that includes storage cylinders, Carbon composite cylinders ii. Combined Heat, Power and Cooling running on Fuel cells for distributed generation with fuel cells and Small Distributed Generation applications such as

		telecom towers.
Energy Storage (All types)	<ul style="list-style-type: none"> • Limited experience with new energy storage technologies, like li-ion, sodium ion, sodium sulphur batteries. • Lack of standardized controls and interfaces. • Energy storage can provide multiple services and multiple technology choices are available, there is a need to benchmark performance and economic viability of various options in different application scenarios. 	<ul style="list-style-type: none"> i. Next Generation Energy storage devices for grid-scale storage at economic cost; ii. Standardization of controls and interfaces to allow flexible operation; and iii. Simulation and Modeling for evaluation of storage requirement for different applications including grid support, ancillary services, e-mobility, peak shifting etc, so that appropriate technology choices could be put implemented for each scenario.
Small hydro	<ul style="list-style-type: none"> • Indigenously available. However, need to develop modular systems. 	<ul style="list-style-type: none"> i. Modular turbines with reduced weight and higher conversion efficiency at lower cost.
Bio Gas	<ul style="list-style-type: none"> • large commercial project • compressed biogas • logistic supply and managements 	<ul style="list-style-type: none"> ○ Clean cooking fuel ○ Utilisation of surplus agri-residue biomass resources for energy production ○ improvement in process operations, microbiology of the digester, consortium design and dynamics

**GENERAL TERMS & CONDITIONS OF THE GRANT FOR R&D
TECHNOLOGY DEVELOPMENT PROJECT**

1. Approval of the R&D/ technology development project and the grant being released is for the specific project sanctioned and should be exclusively spent on the project within the approved time duration. The grantee organization is not permitted to seek or utilize funds from any other organization (government, semi-government, autonomous and private bodies) for this research project, unless specifically approved for joint funding. Any un-spent balance out of the amount sanctioned must be surrendered to the Government of India through an ECS/ crossed Demand Draft drawn in favour of Drawing & Disbursing Officer, MNRE payable at New Delhi.
2. Full infrastructure facilities by way of accommodation, water, electricity, communication etc. for smooth implementation of the project shall be given by the grantee organization(s) at their cost.
3. For permanent, semi-permanent assets acquired solely or mainly out of the project grants, an audited record in the form of a register. The term "Assets" include (a) the immovable property acquired out of the grant; and (b) movable property of capital nature where the value exceeds Rs. 50,000/-. The grantee organization is required to send to the MNRE a list of assets acquired from the grant. The grant shall not be utilized for construction of any building unless specific provision is made for that purpose.
4. Assets acquired in the project shall be shared proportionately between Government of India and grantee organization(s) in accordance with the cost sharing pattern of the project. The assets should not be disposed off or encumbered or utilized for purpose other than those for which the grant had been sanctioned, without the prior permission of this Ministry.
5. On conclusion/ termination of a project, the Government of India will be free to sell or otherwise dispose off its share of the assets, which are the property of the government. The grantee organization shall render to the Government of India necessary facilities for arranging the sale of these assets. The Government of India has the discretion to gift its share of assets to the grantee organization or transfer them to any other organization if it is considered appropriate.
6. The grantee organization/ PI will furnish Progress Report of the work carried out under the project on six monthly basis in the months of April and October during the project implementation period in a prescribed format given at 'R&D Formats' on home page of www.mnre.gov.in.
7. Officer(s) of MNRE and MNRE designated Scientist/ Specialist/ Expert Panel/Committee may visit the organization periodically to review the progress of the work being carried out and to suggest suitable measures to ensure realization of the objectives of the project. During implementation of the project, the grantee organization will provide facilities to such visitors in the form of accommodation, site visits, etc.
8. On completion of the project, final consolidated 'Project Completion Report' on the work done on the project will be prepared after incorporating suggestions, if any, from the reviewers of the project and 5 copies of the same will be submitted to the

MNRE in the prescribed format given at 'R&D Formats' on home page of www.mnre.gov.in, in physical as well as electronic forms.

9. The 'Project Completion Report' must include all relevant technical details/specifications, working drawings for designing of the systems/equipment, and an inventory of materials required, etc.
10. At the time of seeking further installment of grant and closure/ termination of the project, the grantee organization / PI has to furnish the following documents:
 - a. Utilization Certificate (U.C) for MNRE grant and 'Statement of Expenditure' (S.O.E.) for the total expenditure for the previous financial year (in original or copy if sent earlier) in enclosed formats given at 'R&D Formats' on home page of www.mnre.gov.in).
 - b. Latest authenticated 'Statement of Expenditure' including Committed Expenditure, for the expenditure on the project including cost shared by any other organization since 1st April of that financial year till the previous month; and
 - c. Technical Progress Report, if not sent earlier.
11. The Comptroller & Auditor General of India, at his discretion, shall have the right of access to the books and accounts of the grantee organization maintained in respect of the grant received from the Government of India.
12. The grantee organization will maintain separate saving accounts for the project in a Bank. If it is found expedient to keep a part or whole of the grant in a bank account earning interest, the interest thus earned should be reported to the MNRE and should be reflected in the 'Statement of Expenditure'. The interest thus earned will be refunded to Ministry at the end of financial year.
13. The grantee organization will neither entrust the implementation of the work for which the grant is sanctioned to another institution nor will it divert the grant receipts to other institute as assistance. In case the grantee organization is not in a position to implement or complete the project, it should, forthwith, refund to this Ministry the entire grant or the balance received by it at the earliest.
14. All the personnel including Research personnel appointed under the project, for the full/ part duration of the project, are to be treated as project personnel on contract to the organization and will be governed by the Administrative rules/ service conditions (for leave, TA/DA etc.) of the implementing Institute. They are not to be treated as employees of the Government of India under any circumstances and the MNRE will have no liability, whatsoever, for the project personnel after completion of the project duration.
16. The Ministry reserves the right to terminate the project at any stage if it is convinced that the grant has not been properly utilized or sufficient progress has not been reported under the project or sufficient efforts have not been devoted.
17. The project becomes operative with immediate effect or within a maximum of one month from the date on which the ECS/ Draft/ Cheque is received by the implementing Institution. This date should be intimated by the grantee authorities/ Principal Investigator to this Ministry.
18. The grantee organization shall associate a co-PI with the project, if not already part of the project team. The co-PI shall function as PI in the absence of PI and should be

totally in knowledge of the activities of the project to avoid loss to the project in case PI leaves the project / organization.

19. If the PI to whom a grant for a project has been sanctioned wishes to leave the grantee organization where the project is sanctioned, the grantee organization/ PI will inform the same to the Ministry and in consultation with MNRE, evolve steps to ensure successful completion of the project through co-PI, before relieving the PI or appoint another Scientist as PI.
20. If the results of research are to be legally protected under IPR, the results should not be published without action being taken to secure legal protection for the research results.
21. Investigator(s) wishing to publish technical/ scientific papers based on the research work done under the project should acknowledge the assistance received from MNRE, indicating the project sanction no. under which grant has been given to the grantee organization. The PI will submit a copy of the paper to the Ministry as soon as it is published.
22. If the results of the work carried out under the grant require preparation of a technical booklet/ guides/ software/ CD etc. in such cases the grantee organization will publish/ prepare sufficient copies (number of copies to be decided in consultation with MNRE) and keep a portion for their use/ dissemination and submit the remaining copies to the Ministry for their use and distribution.
23. If the result is in the form of a survey report / product performance evaluation or other such activities which have commercial implications, the grantee organization will not publish the results without specific written approval of this Ministry.
24. The grantee institution/ PI should provide a copy of the 'Full Text Document' of the Patent/ PI within one month of its publication.
25. The grantee organization(s)/ Inventor(s) are required to seek protection of Intellectual Property Rights for the results/ output of the sanctioned R&D projects and shall share royalty/ proceeds of sale of IPR in accordance with the guidelines given below:
 - i. The Government shall have a royalty-free license/ marching right for the use of the Intellectual Property for the purposes of the Government of India and this Ministry reserves the right to require the institution and the industry to license others and that anyone exclusively licensed to market the innovation in India, must manufacture the product in India.
 - ii. In case MNRE files patents (when grantee organization is unable to file a patent) any earnings accruing from transfer and commercialization shall be shared equally by this Ministry with the Institution and the generator of the Intellectual Property. However, wherever the expected earnings are above Rs.10 lakh, the proportion of sharing can be 40% for the institution, 40% for this Ministry and 20% to the generator of Intellectual Property.
 - iii. The grantee organization(s) is permitted to retain the benefits arising out of the IPR. In case of more than one institution, IPR generated through joint research can be owned jointly by them as may be mutually agreed to by them through a written agreement.
 - iv. The institution and industry may transfer the technology to another industry for commercialization, on terms and conditions as may be mutually agreed upon, on

non-exclusive basis under intimation to MNRE. Any earnings accruing from such a transfer and commercialization shall be shared between the institution and the industry as may be mutually agreed to. The details of the agreement, amounts-received, annual sales turnover of the product shall be intimated periodically to this Ministry.

- v. In case of projects supported solely to industry, any earnings arising out of sale/transfer of IPR generated through the MNRE supported project shall be shared between the MNRE and the industry in the ratio of their individual shares of the project cost.
 - vi. Other terms and conditions regarding IPR issues shall be in accordance with the guidelines contained in the DST circular issued with the concurrence of Ministry of Finance, Department of Expenditure vide their O.M. No.33 (5)PF- II99, dated 22nd February, 2000 or subsequent circulars which may be issued by DST/ MOF on the subject ('R&D Formats' on home page of the Ministry (www.mnre.gov.in)).
26. In case of any dispute the decision of Secretary, Ministry of New and Renewable Energy shall be final.

