

Research, Design, Development and Demonstration Activities in the Renewable Energy Sector

1. Introduction

Research, Design, Development and Demonstration (RDD&D) activities of MNRE were aimed at resource assessment, technology development, demonstration and facilitating the industry to become internationally competitive. Accordingly, the RDD&D projects pertaining to the above sectors were sponsored to the various Research and Development (R&D) organizations/institutions, industries, autonomous organizations, etc.

The RDD&D policy framework of MNRE provided guidelines for project identification, formulation, evaluation by experts, approval, financial support, monitoring and appraisal. It specified two types of committees for providing overall guidance to the RDD&D efforts in new and renewable energy sector i.e. RDD&D Sectoral Project Appraisal Committee and RDD&D Project Appraisal Committee.

A total of 190 RDD&D projects with budget of ₹ 545.90 crore had been funded to various R&D institutions/ organizations, Non Governmental Organisations (NGOs), Industries, etc during 2007-14. The position of RDD&D Projects taken up during 2007-14 is detailed in Table 50.

Table 50: Sector wise projects sanctioned, completed and funds sanctioned by MNRE

S.No.	Area of project	Projects sanctioned	Amount sanctioned (in ₹ crore)	Projects completed	Projects under progress
1	Solar Thermal	22	143.77	13	9
2	Solar Photovoltaic	27	148.22	17	10
3	Bio-energy	7	39.09	1	6
4	Biomass Cook stove	7	4.43	5	2
5	Biogas	32	36.87	19	13
6	Bio-Fuel	30	27.15	14	16
7	Waste to Energy	3	9.23	3	Nil
8	Hydrogen Energy	40	125.58	23	17
9	Fuel Cell	14	6.06	9	5
10	Wind Energy	8	5.50	8	Nil
	Total	190	545.90	112	78

Source: MNRE.

2. Audit Observations

Subject to scope limitation reported in Para 8 of Chapter I of this Report, Audit scrutinized 58 project records produced to it. Of these 58 projects, audit observations on 50 projects are given below:

2.1. Non development of high efficiency Heterojunction with intrinsic thin layer solar cells

National Institute of Solar Energy (NISE) sanctioned (July 2008) an R&D project titled 'Development of high efficiency Heterojunction with intrinsic thin layer (HIT)solar cells' to be implemented by NISE in collaboration with Indian Institute of Technology (IIT), Mumbai with four¹ deliverables proposed. The total project outlay was ₹ 98.58 lakh and was fully funded by MNRE. IIT Mumbai, contributed in terms of space, equipment and infrastructure. The project duration was initially for three years, but after extensions, the project was completed (July 2012), after incurring an expenditure of ₹ 71.80 lakh. The audit findings in this regard were:

- i. The project completion report indicated that a single side HIT cell with 12 *per cent* efficiency on a 4 cm² area was developed against the target of 10X10 cm² surface, double sided solar cell. Thus, the project parameters were not achieved. NISE in its reply accepted that only a single sided cell was developed due to technological constraints. It also stated that efforts were being made to fabricate a 36 cm² area cell.
- ii. The envisaged cells were to have a rated capacity of two watts, however the final completion report did not indicate the achieved output. NISE replied that power output would be calibrated only after development of the cell on 100 cm² area surface.
- iii. The final completion report was silent about development of a lab scale module as envisaged.
- iv. The developed cell was to be sent to NISE for performance evaluation and field observation. NISE replied that only after developing a 36 cm² area cell, module would be prepared and sent for field trial. It further stated that module could not be developed due to technological constraints.
- v. MNRE in its reply claimed that the process developed (Hot Wire Chemical Vapour Deposition) was novel and cost effective as compared to existing processes. However, it is observed in audit that the claim could not be verified as no effort was made to obtain the patent in this regard.

¹ Development of a 20 *per cent* efficiency HIT double sided solar cell on a 10 X 10 cm² surface with a power output of 2 watts, Demonstrate the lab scale module of PV cell, Performance evaluation of solar cells, their temperature dependence and field performance by NISE. After fabrication of HIT cell through Hot Wire Chemical Vapour Deposition (HWCVD), a unique process, patent to be obtained for fabrication of HIT cell.

- vi. As per RDD&D guidelines of MNRE, for all projects, a third party monitoring mechanism was to be introduced to ensure timely execution and achievement of deliverables and also to allow mid course correction, if required. In this project, it was observed that the task of monitoring was assigned to NISE and IIT Mumbai. This posed a conflict of interest as both were the stakeholders in the project.

MNRE stated (May 2015) that additional large amount of funds for purchase of equipment were needed along with manpower and extension of project duration to achieve all objectives. Reply itself indicates deficiency in planning for the project. The project had, however, positively contributed in terms of award of PhD degree to two students.

Thus, though the research was aimed at developing high efficiency cells with an alternate and cost effective technology, the objectives of the project were overambitious and lacked necessary forecast for infrastructure. Lack of independent monitoring and follow up, evident through non filing of patent, exhibited a lackadaisical approach towards the research project.

2.2. Non-design and development of poly silicon deposition reactors

MNRE sanctioned (June 2009) a research project titled 'Development of solar grade poly silicon material' to be implemented by M/s Maharishi Solar Technology Pvt. Ltd (MSTPL), New Delhi at a total cost of ₹ 23.20 crore. Under the project it was proposed to design and develop process reactor and optimize the deposition process to make poly silicon for use in solar cell. The reactors for silicon production were to be indigenously designed and manufactured. MNRE's financial support was for ₹ 5.28 crore and was to be applied towards design and development of reactor and related equipments. MNRE released ₹ 1.76 crore in June 2009 as first installment to MSTPL. An expenditure of ₹ 1.74 crore was reported as incurred by MSTPL as on October 2010.

Audit scrutiny of the implementation of the project revealed the following:

- i. From the utilization certificate submitted in October 2010 by MSTPL, it could be seen that expenditure on civil works, which was to be borne by MSTPL, was also booked against MNRE contribution, which was irregular.
- ii. It was observed from the fourth quarterly report of MSTPL that till October 2010 the progress of project was slow. Works like civil work, infrastructure development, design of poly silicon reactor, arrangement of electrical power supply, plant and machinery and raw material storage facilities had not been completed by the MSTPL.
- iii. Research and Development Project Approval Committee in its meeting (May 2009) recommended that in line with 50 *per cent* support to industry concept, the company must match the MNRE funding. However, it was noticed that no record of any expenditure by MSTPL from its own budget as against an expenditure of ₹ 1.74 crore contributed by MNRE was available.
- iv. The monitoring of the project was lax as was evident from the fact that neither the report of the committee constituted by MNRE in July 2010 to visit the project site

was available in the records nor MSTPL submitted quarterly reports after October 2010.

- v. Project completion report was not submitted.

Audit observed that MNRE did not object to the slow progress of the project, application of MNRE funds to ineligible works and MSTPL not contributing to the project in terms of its financial commitment.

MNRE stated (May 2015) that the solar grade polysilicon material was developed; however, it required detailed characterization to establish quality. In absence of any characterization, no further instalments were released. Reply itself was indicative of the fact that the objective of the project was not achieved.

2.3. Development of a Megawatt-scale National Solar Thermal Power Testing, Simulation and Research Facility

MNRE sanctioned (September 2009) an RDD&D project 'Development of a Megawatt-scale National Solar Thermal Power Testing, Simulation and Research Facility' to be implemented by Indian Institute of Technology (IIT) Mumbai in collaboration with NISE with specific objectives². The total project outlay was ₹ 41.17 crore and was fully funded by MNRE. Cost of the project was revised from ₹ 41.17 crore to ₹ 48.12 crore. IIT Mumbai was to contribute in terms of space, equipment and infrastructure. The project duration was for five years and an expenditure to the tune of ₹ 43.51 crore had been incurred (July 2015).

Audit observed that:

- i. Initially the site in Aurangabad was selected due to good amount of solar radiation and convenience for the project team of IIT Mumbai to frequently visit the site. However, the site was shifted to NISE campus. This resulted in increase in the estimated cost by ₹ 7.27 crore on equipment alone. This was required due to revision in technical specification³ because of change in location.
- ii. The site at NISE had a number of riverines and the quality of soil was very loose. In order to protect the civil foundations of various structures and collector fields from soil erosion, additional expenses towards soil pitching, drainage, check dams and associated land development work had to be undertaken.

² Establishment of a National Research Facility on Solar Thermal Power (one MW grid-interactive), Establishment of test facility for component and system characterization, Development of simulation facility for future scale-up of plant capacity, Facilitate R&D for cost reduction of concentrated solar power.

³ The original project proposal was prepared for Aurangabad where the solar insolation was higher (800 Watt/m²) than the solar insolation at NISE (600-650 Watt/m²). Consequently, the aperture area of solar concentrators had to be increased to about 1.3 times to achieve the designed capacity of one MW. No specific reasons justifying the shift were found on record.

- iii. As per Standing Finance Committee (SFC) memorandum, the participation of Indian industry⁴, to the tune of ₹ 3.57 crore was proposed by MNRE. However, nothing on record showed that industry partners were involved. MNRE stated (May 2015) that a number of industry partners left due to change in site location and contributions received from industry were 'in kind'.
- iv. As per RDD&D guidelines of MNRE the project was to be monitored regularly by an expert committee. To facilitate this, a provision of one *per cent* of the project cost was kept aside for monitoring charges. Such monitoring was to also review the industry participation and revenue generation by the project. However, nothing was on record to show that the project was monitored by any expert committee.
- v. As per the MNRE's sanction, the extensive testing and data collection was scheduled to start from the third year of implementation. However, it was noticed in audit that work of extensive testing and data collection was not done even after lapse of third year of implementation.

MNRE stated (May 2015) that the plant was feeding power to the grid since May 2014. However it further stated that Power Purchase Agreement (PPA) with Distribution Company was yet to be signed. In the absence of PPA, there remains ambiguity regarding the status of grid connectivity.

2.4. Establishment of 3.5 MW Solar Thermal Power plant with 16 hours thermal storage for continuous operation

MNRE sanctioned a RDD&D project 'Establishment of 3.5 MW Solar Thermal Power plant with 16 hours thermal storage for continuous operation' to World Renewal Spiritual Trust (WRST) at Mount Abu in October 2010 at a total cost of ₹ 63 crore. The project cost was to be shared amongst MNRE (₹ 12.60 crore), WRST (₹ 26.40 crore), BMU Germany (₹ 10 crore) and M/s Unnathi projects (industrial partner - ₹ 14 crore).

During the period October 2010 to November 2012, MNRE released ₹ six crore (50 *per cent* of its commitment) to WRST. Further, as per audited Statement of Expenditure (SoE) and Utilisation Certificates (UCs) submitted by WRST, WRST and M/s Unnathi projects together had released a sum of ₹ 8.10 crore for the project. In November 2012, WRST intimated that M/s Unnathi Projects had withdrawn from the project without contributing anything. It also proposed that the project cost should be revised to ₹ 81 crore and contributions enhanced. Accordingly MNRE enhanced (February 2014) its contribution to ₹ 21.20 crore, BMU's to ₹ 32.80 crore and WRST's to ₹ 27 crore. MNRE had released a total sum of ₹ 18.50 crore till date (July 2015).

Audit observed that the project was approved by RDD&D Project Appraisal Committee subject to involvement of an industrial partner, in addition to BMU Germany, for sharing the cost of the project. Accordingly M/s Unnathi Projects Ltd entered into a Memorandum of Understanding (MoU) (November 2009) with WRST with a contribution of ₹ 14 crore.

⁴ L&T, KIE Thermosystems, Clique Development Pvt Ltd, Tata Power, Heavy Water Board and TCE consulting engineers.

Withdrawal of M/s Unnathi Projects at a later stage was in violation of this condition. Further, at the stage of revision in the project cost and contribution shares, MNRE did not raise the discrepancy in audited SoE regarding the fact that contribution of M/s Unnathi Projects and WRST was being shown together to give an impression that the industry partner was meeting its financial commitment. Thus, the failure of MNRE in monitoring SoEs and fund flows to the project resulted in a situation where MNRE was been saddled with extra financial burden due to withdrawal of industrial partner.

MNRE stated (May 2015) that it tried its best to convince and bring in another industry partner, but in vain. However, the fact remains that timely monitoring and securing M/s Unnathi Projects' contribution at early stages could have tied the partner to the project as envisaged. MNRE reply was silent on current status of the project.

2.5. Preparation of standards and guidelines and certification of Wind Power Systems

NIWE was established to render well organised support on a continuous basis to manufacturing industry, investors, developers and utilities in the Wind Energy Sector, including developing Indian standard and guidelines for design criteria, loads and safety in association with Bureau of Indian Standards (BIS).

Audit, however, observed that so far NIWE had not finalised standards and guidelines with respect to Indian conditions⁵. NIWE at present provided certificates to the wind turbines based on a provisional scheme titled 'Type Approval Provisional Scheme 2000 (TAPS 2000)'. Further, Audit also observed that certificates issued by the Centre had no universal acceptance.

During the last six years NIWE could undertake only 26 proposals for certification. Audit analysis revealed that after 2008-09, the number of certifications undertaken registered a declining trend. While in the year 2008-09 it was eight, it was only four in subsequent two years. In the year 2011-12, it was further reduced to three before it marginally rose once again to four. The amount of revenue earned also came down significantly. While it was ₹ 117.10 lakh in the year 2008-09, it was only ₹ 19.40 lakh in the year 2012-13.

Thus, the capability of independent certification with internationally acceptable standards was not developed even after a lapse of fifteen years of establishment of the Centre. NIWE replied that international accreditation was not obtained due to lack of adequate trained manpower in multi disciplinary engineering. As regards low number of certifications undertaken, NIWE replied that numbers could be increased only with an increase of manpower. As regards non-incorporation of Indian standards, NIWE stated that the BIS committee had already approved three draft standards and the documents would be printed in due course.

⁵ To reflect special considerations for the country such as wind condition, grid conditions or temperature limits

2.6 Other audit findings

Apart from the significant audit findings reported in the preceding paragraphs, audit findings on the remaining 45 projects reviewed by Audit are given below. The project wise audit findings are given at **Annexure XVIII**.

2.6.1 Delays in completion of projects and deficiencies in monitoring

The audit findings relating to timely completion of projects, submission of UCs, monitoring of the projects, submission of Project Completion Reports (PCRs) and their evaluation with regards to these 45 projects, are summarized in Table 51.

Table 51: Summarised audit findings on 45 RDD&D projects

S.No.	Audit finding	Total (in Nos.)	Percentage
1.	Project not completed in time	32	71
2.	UCs not submitted in time	7	16
3.	Projects not monitored by independent Experts	16	36
4.	Project Completion Report not received	4	9
5.	Project Completion Report not evaluated by Experts	16	36

As can be seen from the table above 71 *per cent* of the projects could not be completed in time. In 36 *per cent* of the projects reviewed, neither the quarterly reports had been submitted nor were these reviewed by independent Experts. While in nine *per cent* of the reviewed projects the PCRs had not been submitted till July 2015, in 36 *per cent* of the cases where PCR had been received, it had not been evaluated by Experts.

2.6.2. Non achievement of objectives

Some project proposals approved by MNRE set out certain measurable outputs in terms of transfer of technology, patents to be filed and research papers to be published. Some projects also envisaged engagement of industry partners in the research project. Audit scrutiny in this regards revealed the following:

- i. Of the 45 projects, in nine projects participation of industry was envisaged. In none of these projects such a partnership could be secured.
- ii. In seven projects where it was anticipated that the research papers would be published, no such publications were made.
- iii. In six cases though the project proposal targeted transfer of technology, this could not be achieved.
- iv. In 16 cases, where filing of patents was committed to in the project proposal, no such patent was filed.

2.7 RDD&D activities in States

Audit observed that in the 24 selected States, only a few States had undertaken RDD&D activities. The audit observations on the projects undertaken by the States are given below.

Gujarat

For Wind Energy, GEDA had identified two focus areas for R&D without any feasibility study and had not implemented any project till 2013-14. For Biomass Energy GEDA had identified 10 focus areas for RDD&D without any feasibility study and had not implemented any project till 2013-14.

Kerala

No R&D activities were carried out by the State during the period 2007-2014 except for the development of two portable type biogas plants during the year 2012-13.

West Bengal

WBREDA signed (February 2013) MoU with Bengal Engineering and Science University for creating a Centre of Excellence for Green Energy and Sensor System to be funded through a Green Energy Fund. The Green Energy Fund was to be funded by an initial equity contribution from the State Government and then it was to generate sufficient revenues to be self-sustained. Audit observed that neither was the fund set up nor could the Centre of Excellence be established.

3. Conclusion

Under the Research, Design, Development and Demonstration programme, MNRE sanctioned 190 projects at a cost of ₹ 545.90 crore during the period 2007-08 to 2013-14 to various R&D organizations, of which 112 projects were completed and 78 projects were under progress.

Audit observed that although a large number of sanctioned projects were in alignment with focus areas identified under various Divisions of MNRE, realisation of deliverable outcome was not achieved in a majority of projects. This was partly due to the fact that industry participation could not be secured in the projects where it was envisaged, which limited the commercial exploitation of technologies developed. There were delays in implementation of projects and inability of the implementing agencies to either file patents or publish research papers as envisaged in the projects.

Monitoring of the projects by MNRE was lax, as in many cases, project progress reports were not submitted by the implementing agency and project completion reports were not evaluated by MNRE or by third parties.

MNRE sponsored research, design, development and demonstration activities did not yield significant results with regard to cost reduction or development of new technology and processes.

4. Recommendations

- *Project Completion Reports of research projects should invariably be vetted by field experts and peer groups before their acceptance, to validate the presented output.*
- *Emphasis should be laid on regular monitoring of ongoing projects to ensure that these are completed on time and if required, course correction introduced.*

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