MINISTRY OF NEW AND RENEWABLE ENERGY (R&D COORDINATION DIVISION)

R&D PROGRAMME ON RENEWABLE ENERGY FOR CONTINUTATION BEYOND 2020-21

Consolidated Review Report of Renewable Energy Research and Technology Development (RETD) Programme

Renewable Energy Research and Technology Development (RETD) Programme

Introduction

The objective of the Renewable Energy Research and Technology Development (RETD) Programme of the Ministry of New and Renewable Energy (MNRE) is to support the R&D projects for technology development and demonstration in various areas of new and renewable energy such as solar thermal systems, solar photovoltaic systems, biogas systems, waste to energy systems, wind energy systems, hybrid systems, storage systems, hydrogen and fuels cells, geothermal, etc. with the ultimate aim of increasing share of renewables in the energy mix in the country. The R&D efforts are expected to make industry competitive and renewable energy generation supply self-sustainable/ profitable.

The RD&D projects are sanctioned to various R&D/academic institutions, industries etc. following the MNRE's policy and guidelines dated 21.02.2019. During period from 2017-18 to 2019-20 Period, 33 nos. of R&D projects in solar thermal, solar PV, biogas/biogas purification, bio-fuel, hydrogen and fuel cells were sanctioned with total budget of Rs.175.87 crore to various R&D/academic institutions, industries, etc.. A total expenditure of Rs. 93.41 crores was done on R&D in said Period. In addition, MNRE has supports its three institutes, namely, National Institute of Solar Energy (NISE), Gurgaon, National Institute of Wind Energy (NIWE), Chennai and National Institute of Bio-Energy (NIBE), Kapurthala for R&D, testing and evaluation in Solar, Wind and Bioenergy, respectively.

R&D Focus in during the period from 2017-18 to 2019-20

1. The RD&D efforts are continued with emphasis on cost reduction and efficiency improvement. The thrust areas for R&D include solar thermal, SPV, biogas, wind, wind-hybrid and hydrogen and fuel cells. In solar, the focus has been developing high efficiency solar cells, storage and power electronic systems. Projects in solar thermal power generation utilsing solar concentrating technologies have been taken up for technology demonstration and validation for scaling up deployment for power generation and industrial process heat applications including storage. In SPV, support to a major R&D project "National Centre for Photovoltaic Research and Education (NCPRE) Phase II, which was taken up in 12th Plan Period at IIT, Bombay was continued in March 2017 for further five years for improving efficiency of crystalline Silicon Solar Cell from 18% to 22% at Lab Scale, apart from R&D in other solar cell materials. Research and Development supported in hydrogen and fuel cells focused on technology development and demonstration for hydrogen production and storage for stationary and transport applications.

2. The Period from 2017-18 to 2019-20 continued support for R&D in areas solar thermal, SPV, biogas/biogas purification for Bio CNG, biofuel, wind, wind–hybrid, hydrogen and fuel cells with focus on improving efficiency and cost reduction. A total of Rs. 93.41 crores was spent on RD&D in Period of 2017-18 to 2019-20. Support for Centres for Excellences was continued. The support provided by MNRE has strengthened capacity and capability of R&D/academic institutions, industries for carrying out R&D for technology development and demonstration in new and renewable energy. The details are given below

Table. 2 Expenditure incurred on R&D during the Period 2017-18 to 2019-20

Ministry provides up to 100% financial support to Government/non-profit research organizations/NGOs and up to 50% to industry/civil society organizations. The R&D scheme is implementing since 2010 and continue for the period from 2017-18 to 2020-21.

The following funds are allocated/Expenditure during the Period 2017-18 to 2019-20

Amount in crores

Year	Budget Estimate (BE)	Revised Estimate (RE)	Expenditure
2017-18	144.00	81.00	52.98
2018-19	94.00	43.00	25.43
2019-20	60.00	15.00	15.00
2020-21	20.00	20.00	17.60 (till date)

Procedure for Appraisal of the Projects

Proposals are invited from R&D Organisations/Institutions, Universities and Industries. Evaluations of the proposal are done through identified subject area experts. Proposals which are recommended by experts are approved by R&D Project Appraisal Committee (RDPAC). The RDPAC is Chaired by Secretary, MNRE, co-chaired by an eminent scientist and comprise of experts from various new and renewable energy areas and other relevant S&T departments.

Thrust areas identified for R&D support

Support are provided for development, demonstration, testing, standardization, and validation of technologies/ systems/ components with emphasis on application oriented R&D, improving efficiency, reliability and cost effective for indigenous development and manufacture. Industry associations are encouraged. In Solar Thermal, the thrust areas include development of solar thermal technology for power generation and industrial process/heat, storage systems, hybridization, etc. In Solar Photo Voltaic (SPV), thrust is on improving Si PV efficiency, reducing the cost, developing new material solar cells, extracting Si material from silica sand, improving modules quality and reliability, development of standard designs for support structure for SPV systems, materials and fabrication technology for solar cells and modules, inverters, power conditioning units, grid integration, etc. In addition, focus is also on storage solutions.

The thrust areas in biogas include development of efficient and cost effective designs of biogas plants, standardization of multiple designs of biogas plants, standardization of biogas slurry based bio-fertilizer, bio-manure up-gradation, development of biogas purification systems, development of efficient biogas engine for power generation.

In wind, the thrust areas include wind turbine system design, integration, off-shore technology and wind solar hybrid system. In SHP, thrust areas include development of ultra-low head turbines (below 3m), generators, monitoring systems, pumped storage systems, etc.

R&D in hydrogen and fuel cells focus on hydrogen production from various feedstock, technology for storage and development of efficient and cost-effective fuel cells for stationary, transport applications. In case of energy storages, next generation energy storage devices for grid-scale storage at economic cost and standardization of controls and interfaces to allow flexible operation; and simulation and modelling 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.

Achievements:

Major programmes were supported in the area of Solar Photovoltaic, Solar Thermal, Hydrogen, fuel cells and Wind-Solar hybrid systems. In Solar, a high efficiency crystalline silicon solar cell of 19.4% efficiency was achieved in lab scale under a project at IIT, Bombay. Support for developing solar cells using other materials such as storage and power electronic system was provided to R&D/academic institutions. Indigenous Silicon ingot has been prepared at SSN College of Engineering in Tamil Nadu and cost effective reliable Solar-powered Clean Drinking Water Systems suitable for various locations are installed in the

different part of the country. Support for developing solar thermal system and component was provided for technology development and demonstration for utilizing solar energy for thermal and power generation applications. One such project, 1MWe Solar Thermal Power Plant with 16 hours thermal storage has set up at Mount Abu by World Renewable Spiritual Trust (WRST), Mumbai which is running successfully. IISc Bangalore has developed a supercritical CO2 Turbomachinery along with high efficiency receiver for solar thermal power plants which would be the next step for close loop CO2 cycle waterless solar thermal power plant. Research and Development supported in hydrogen and fuel cells focused on technology development and demonstration for hydrogen production and storage for stationary and transport applications.

Appraisal of RD&D Programme

The Period expired on 31st March. 2021. As per the directions of Ministry of Finance's OM No. 24(35)/PF-11/2012 dated 5.08.2016, the schemes implemented in the Period 2017-18 to 2019-20 has to be appraised for achievements for justification for continuation. Accordingly, the MNRE has decided appraisal of the R&D scheme through Experts Panel. The status of various R&D projects sanctioned/implemented in Renewable Energy is Annexed for appraisal and recommendation by "Experts Panel" scheduled to meet on December, 2020 in MNRE.

Brief description of methods and analytical strategy

Subject: Review of Renewable Energy Research and Technology Development (RETD) Programme of New & Renewable Energy for continuation beyond 2020-21 via video conference.

The Ministry is implementing an Renewable Energy Research and Technology Development Programme for the period from 2017-18 to 2019-20 and continue till 31st March, 2021 or till the recommendations of 15th Commission come to effect, whichever is earlier. Therefore, R&D Programme need to be evaluated for Continuation for 2021-22 to 2025-2026. As per Para F. (iv) Monitoring & Evaluation of AA "Panel of Experts from lead R&D/academic institutions will be constituted for independent evaluation at the end of the programme period.". The consent of the Chairman of Dr. Anil Kakodkar has already been taken; other external member will be from various IITs/Institutions in the field of renewable Energy.

2. IFd has already been concurred to evaluate the scheme and form a Committee of experts under the Chairmanship of Dr. Anil Kakodkar is in line with the instruction of DoE as also the guidelines of the scheme.

3. In this regard, the concerned divisions have provided the status of R&D projects in a format to R&D coordination division for consolidation and a Consolidated Report is prepared, which will be provided to the panel of experts in advance.

4. As per the R&D guidelines, sector wise external panel of experts is proposed to be constituted which are as follows:

S.No.	Expert
	Solar (SPV-14 nos and Solar Thermal-8 nos of projects): Panel: 1
1	Prof. Vikrarn Kumar, Emeritus Professor, IIT Delhi
2	Prof. J. Vasi, IIT Bombay
3	Prof. S. Srinivasa Murthy, IISc Bangalore
4	Dr. Sudip Bhattacharya, Former GM-head BHEL
	New Technology & Storages Tech. (11 nos of projects): Panel: 2
Already count in Sl. No. 3	Prof. S. Srinivasa Murthy, IISc Bangalore
5	Prof. S.N. Upadhyay, Emeritus Professor, IIT BHU
	Bioenergy (3 nos of projects): Panel: 3
6	Dr. Manju Sharma, Institute of Chemical Technology, Mumbai

7	Dr. Shailey Singhal, UPES, Dehradun
	Wind Energy (2 nos of projects): Panel: 4
8	Dr NS Prasad, TERI, New Delhi
9	Dr. Nilanjan Saha, IIT Madras

5. The R&D projects of respective divisions will be reviewed by external experts as per the following details:-

S. No	Divisions	Total number of projects considered during 2017-18 to 2019-20	Number of projects to be reviewed by experts Panel in details
1	Solar Energy	14 nos (Solar Photovoltaic)	At least 5 nos of projects
		8 nos (Solar Thermals)	At least 3 nos of projects
2	New Technology (Fuel Cell and Hydrogen and Storages tech.)	11 nos	At least 4 nos of projects
3	Bio Energy	3 nos	At least 2 nos of projects

6. After sector-wise recommendations, a final overall Policy and R&D projects review of Renewable Energy will be done under the Chairmanship of Dr. Anil Kakodkar in which the committee constituted of sector wise external panel of experts shall nominate one member from the respective committee to be represented as a member of the Overall R & D Committee via video conference. Following are the proposed members:-

1. Dr. Anil Kakodkar, Chairman
2. Shri K. K. Jain ED, CHT, MoPNG
3. Dr. Sanjay Bajpai, Adviser, DST
4. Nominated member of Solar Expert Panel No.1
5. Nominated member of New Technology & Storages Tech Expert Panel No.2
6. Nominated member of Bioenergy Expert Panel No.3
7. Nominated member of Wind Energy Expert Panel No.4

Terms of References for review by panel of experts are as follows;

i. The panel will review achievements of all R&D Projects given in the format by respective divisions.

ii. Out of total 38 projects, 16 no. of projects in the respective Division will be reviewed in detail as per table in para 5. The panel will give the report on the following aspects:

a) Appraisal on achievement as per sanction

b) Suggestions for further course of action

iii. The concerned Group/Divisional Head will also be present in review meetings to facilitate providing relevant files/reports to panel, if required by them.

iv. The panel will submit review report summarizing the overall achievements and specific appraisal on the selected projects with recommendation after the review is completed.

Review of R&D Projects sanctioned/completed during FY 2017-18 to 2019-20

Solar Photovoltaic

For review of 14 Solar PV R&D and 9 Solar Thermal projects, the following Panel of Expert was formed:-

Panel: 1

1. Prof. Vikrarn Kumar, Emeritus Professor, IIT Delhi
2. Prof. J. Vasi, IIT, IIT Bombay
3. Prof. S. Srinivasa Murthy, IISc., Bangalore
4. Dr. Sudip Bhattacharya, Former GM-head BHEL

The Panel of Experts reviewed the 14 nos. Solar PV R&D projects out of which 5 projects were reviewed in detailed manner and held a meeting on dated 13.01.2021, in which a detailed discussion was done on the projects. In case of Solar Thermal, 9 nos of solar thermal projects out of which 4 projects were reviewed in detailed manner.

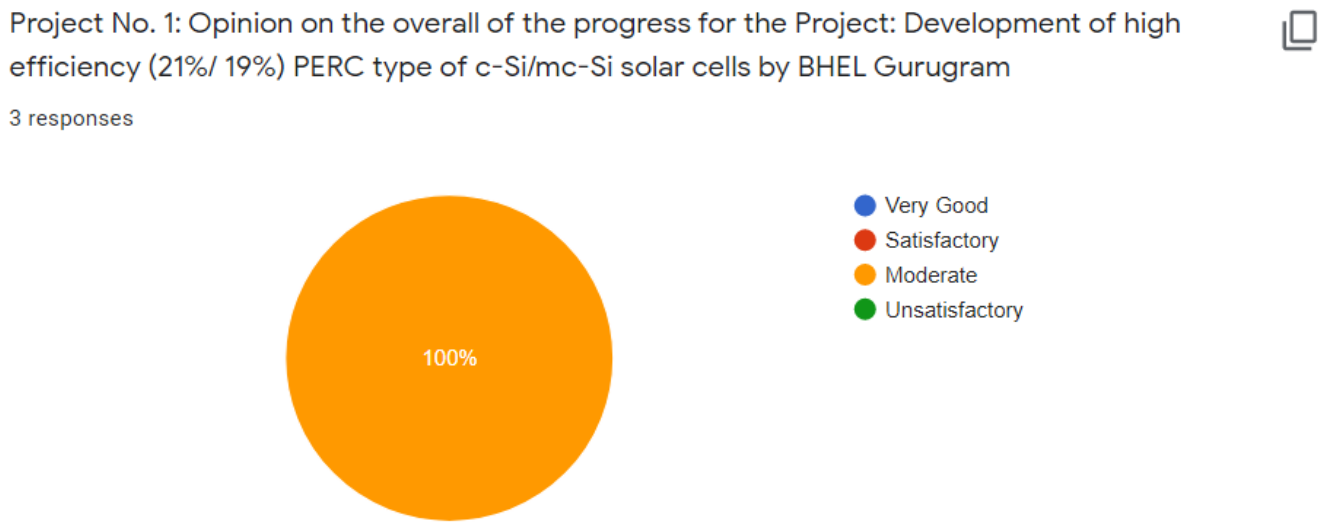
A online feedback form was filled by all the Experts of Panel 1 and given the opinion on the projects along with appraisal on achievements as per sanction of the projects and Recommendation with suggestion for further course of action.

Project No.-1: Development of high efficiency (21%/ 19%) PERC type of c-Si/mc-Si solar cells

Sl. No.	Items	Details
1.	Title of the project	Development of high efficiency (21%/ 19%) PERC type of c-Si/mc-Si solar cells
2.	Principle Investigator Co-principle Investigator	1. Dr. B. K. Pant, BHEL-ASSCP, Gwalpahari, Gurgaon 2. Dr. A.K. Tripathi Director General, NISE, Gwalpahari Gurgaon Co-Principal Investigators: 1. Ms. Shivangi, Manager, BHEL-ASSCP Gwalpahari, Gurgaon. 2. Dr. Chandan Banerjee, Dy. Director General, NISE, Gurgaon
3.	Name of the Implementing Institution/industries	BHEL and NISE Gurugram
4.	**Details of the project**	
	Date of the sanction	28/12/2017
	Cost of the project with details of the cost sharing with other institutions/industries	Total outlay: Rs. 5433 Lakh MNRE Share: Rs. 2628 Lakh
	Duration	3 years
	Date of completion	Dec 2020 (extended upto June 2021)
	Funds released and utilized (year-wise)	Rs. 13.00 crore (GIA) (28.12.2017) Rs. 2.00 crore (CCA) (28.12.2017) Rs. 1.18 crore (CCA) (28.02.2020) Rs. 1.18 crore (CCA) (17.06.2020) Rs. 6.50 crore (CCA) (27.10.2020)
	Status of UCs/Audited statement of accounts	Audited UC for FY 2017-18, FY 2018-19 submitted. UC for FY 2019-20 submitted.
	Unspent Balance with PIs	Rs.1,29,88,437/-
5.	Sanctioned objectives	➢ Development of unit processes for large area rear passivated, screen printed c-Si solar cells with benchmark parameters ➢ Integration of new processes to achieve targeted benchmark efficiencies ➢ Demonstration of the technology at pilot scale, enabling easy transfer to manufacturing and establishing yield and cost effectiveness.
6.	Expected output as per sanction	➢ A reliable and repeatable process for large area high efficiency silicon solar cells ➢ 5 modules with efficiency > 18% shall be fabricated with mono PERC cells ➢ Critical inputs for efficiency improvement and cost reduction to be provided to the production unit ➢ Capability development for manufacturing high efficiency solar cells in the country
7.	Status of the project/achievements including research publications in	All pieces of the capital equipment for process development have been commissioned at BHEL. Experimental trials are in progress.

	Journals/patents/prototype development	Approval obtained for a new process tool for BHEL (Single side polisher for silicon wafers); to be procured from the balance funds obtained from MNRE. The procurement is at enquiry stage. Similarly, approval obtained for procurement of a new test facility (minority carrier life time tester)at NISE; procurement process to be initiated soon and completed on a fast track. Unit process optimization trials for diffusion and laser contact opening in progress Optimization of rear and front dielectric layer using PECVD to start soon after all safety checks are completed post Covid-19 lockdown. A Class 100000, state-of-the art clean room has been established at NISE utilizing the capital funds of NISE (outside the project funds) to house the sophisticated test equipment under a single roof. Prototype:- Nil Patents generated:- Nil Paper published:- Nil

The online detailed review response of three experts on each project has been received which are as follows:-



Project No-1: Appraisal on achievements as per sanction of the projects

3 responses

The progress in the project is very much delayed, largely due to the pandemic and it has recently been granted extension by six months. The progress has so far been moderate with most of the process and test equipment put in place and the unit processes being developed. Since no solar cell has so far been made in the project and the time for development is very short, the project team must put in extra efforts to deliver the high efficiency PERC solar and modules as per the sanctioned objectives.

The sanctioned goals were very ambitious for a 3 year project, since the equipment had to be ordered, installed, and qualified before the PERC process could start being standardized. The current status

appears to be that most of the equipment has been received and been commissioned, and trials are under way.
The progress is slow for three years. All equipment have been commissioned and trial runs on. The process runs are yet to start. Project objectives are not likely to be met in the extended period.

Project No-1: Recommendation with suggestion for further course of action3 responses

The project envisages development of 21 % PERC solar cells on 6 inch Si wafers and 18 % modules which are considered very important from the Indian R&D as well as manufacturing perspectives. MNRE need to wait and watch carefully as well as monitor the progress periodically. Once the targeted results are achieved, efforts must be put for a smooth transfer of the technology to the industry.
This is an important project and should be continued. It should be extended upto at least December 2021 (if not June 2022, keeping in mind pandemic-related delays). Furthermore, frequent interaction between BHEL/NISE, NCPRE and IIEST should be mandated. A special monitoring committee should be set up which ensures good quarterly exchange of status and information between these three groups, considering that domestic PERC cell fabrication is becoming crucial with the proposed solar manufacturing initiative in India.
This is a prestigious project and needs close monitoring and coordination with BHEL HQ. Close association with an academic institute will be useful. Project should be given additional extension.

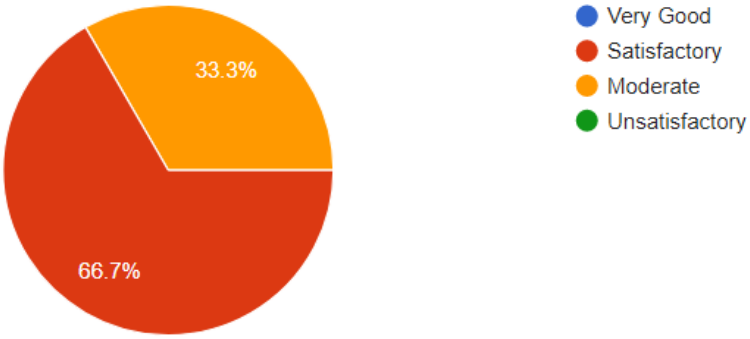
Project No.-2 : Flexible Perovskite Solar Cells and Intermediate Module

Sl. No.	Items	Details
1	Title of the project	Flexible Perovskite Solar Cells and Intermediate Module
2	Principle Investigator Co-principle Investigator	Prof. Shaibal K Sarkar
3	Name of the Implementing Institution/industries	Department of Energy Science and Engineering IIT Bombay, Powai 400 076 Mumbai
4	**Details of the project**	
	Date of the sanction	28.02.2019
	Cost of the project with details of the cost sharing with other institutions/industries	Rs. 830 Lakhs with 100% MNRE share
	Duration	4 years
	Date of completion	Feb 2023
	Funds released and utilized (year-wise)	Rs. 1.79 crore (CCA) (28.02.2019) Rs. 0.50 crore (GIA) (28.02.2019) Rs. 0.74 crore (GIA) (28.02.2020) Rs. 0.79 crore (CCA) (24.04.2020)
	Status of UCs/Audited statement of accounts	UC for FY 2019-20 submitted.
	Unspent Balance with PIs	As per UCs on dated 07.07.2020, Rs. 76,097/- is left in GIA and Rs. 83,67,201/- is left in CCA
5	Sanctioned objectives	➢ Scalable and high throughput (in comparison to the existing process) solution route deposition of individual p, i, and n layers that are device compatible. Such individual layers need to be synthesized specifically at low temperatures, suitable for plastic substrates and to be transformed onto the flexible devices. ➢ Small area devices (0.1cm2) utilizing above processed materials with champion efficiency of ca. 20% with T80>10,000 hrs. The stability of these devices will be achieved through ALD based robust encapsulates at low temperatures offering protection from the moisture and UV components. ➢ The above technology will be scaled up to 25cm^2 standard device using slot-die and blade coating – a step advance from the spin coating enabling repeatability and further scalability. We aim to achieve 18% efficiency in 25cm2 device with T80>10,000 hours at the end of the project. We aim to laminate the devices for practical usages. ➢ Roll-to-Roll perovskite device fabrication on polymer substrates. As of now we are aiming for an efficiency of ca. 15% with T80>5000 hrs. Final devices will be of 5cm in width and 100 cm in length. A demonstration of 10cm width and 100 cm length devices will also be delivered with the existing and availed instruments.
6	Expected output as per sanction	➢ Laminated R2R devices with >18% efficiency with T80>10000 hrs.

		➢ Rigid large area (25cm 2) devices (frit sealing) with >18% efficiency with T80>10000 † hrs. ➢ Oxide on perovskite (both n-i-p and p-i-n configuration) deposition optimization aiming for 18% in small area and 10% in large area (with T80>1000 hrs.).
7	Status of the project/achievements including research publications in Journals/patents/prototype development	IITB successfully developed low temperature p-type transparent conductors (NiO and Cu:NiO) to be applicable in flexible perovskite solar cells. PI have developed the deposition chemistry of electron transport layer. This process is also at room temperature and rapid processing. In the above two case, the device optimization is in process. PI have developed the chemistry for depositing multi-cation perovskite materials at room temperature and the device optimization is under process. This reduces the needed thermal budget and also the process time is greatly reduced which is suitable for R2R fabrications. PI have also successfully installed the large area device deposition tool involving slot-die and blade coating. Device making and optimization is yet to start. Prototype:- Patents generated:- Paper published:- 5 nos.

Project No.2: Opinion on the overall of the progress for the Project: Flexible Perovskite Solar Cells and Intermediate Module by Prof. Shaibal K SarkarIIT Bombay

3 responses



Project No-2: Appraisal on achievements as per sanction of the projects.

3 responses

The progress in the project is somewhat delayed given the ambitious nature of the sanctioned objectives that comprise high efficiency on large cell areas, good stability, flexible substrates and roll-to-roll processing. Half way down the timeline, the PI could only report development of deposition techniques for certain individual layers and installation of tools necessary for large area depositions. The 20 % cell on small area was achieved in an earlier project supported by the Ministry. The project team needs to hasten the pace of development to meet the sanctioned objectives of the project.
Initial low-temperature processes have been developed and are under optimization. Actual devices have yet to be started. Although 2 years of the 4 year project are almost over, some leeway in this highly experimental project must be granted due to complete closure of labs for 8 months on account of the pandemic. 5 papers have been published, which is good progress.
Project is moving in the right direction. Only one year is over yet. This is a very hot topic. PI needs to push and MNRE should support the team fully.

Project No-2: Recommendation with suggestion for further course of action.

3 responses

Perovskite solar cells are considered very important and hold the promise of high efficiency coupled with low-cost processing of terrestrial solar cells. However, scalability and stability are the main issues with this technology. The project addresses both and envisages development of 18 % solar cells on 25 sq. cm glass substrates and 15 % cells on large flexible substrates with stability exceeding 10000 hours. MNRE must keep a close watch on the technology development milestones in this important project and resort to six-monthly on-site monitoring by a set of competent experts.
The project should be recommended for continuation, perhaps with new timelines. Status of R2R equipment should be ascertained.
A separate monitoring committee should be formed for this project.

Project No. 3 : Design and Development of 'High Efficiency Solar Water Pumping Systems'

S. N.	Items	Details
1.	Title of the project	Design and Development of 'High Efficiency Solar Water Pumping Systems'
2.	Principle Investigator Co-principle Investigator	Dr. Arun K. Tripathi, Director General, NISE Dr. Chandan Banerjee, Deputy Director General, NISE
3.	Name of the Implementing Institution/industries	National Institute of Solar Energy (NISE) (An Autonomous Institute of MNRE, Government of India)
4.	**Details of the project**	
	Date of the sanction	28th Feb, 2019.
	Cost of the project with details of the cost sharing with other institutions/industries	Total Cost: Rs. 6.85 Crores NISE share: Rs. 2 Crores MNRE share (sanctioned): Rs. 4.85 Crores
	Duration	3 Years
	Date of completion	28th February, 2022.
	Funds released (First Installment during 2019 -2020) and utilized (year-wise)	Funds released (First Installment during 2019 -2020 : Rs. 212 Lakhs (For Creation of Capital Assets) : Rs. 19 Lakhs (Grant in aids)
	Status of UCs/Audited statement of accounts	UCs and SoE is submitted
	Unspent Balance with PIs	Amount spent/ Committed: Rs. 2,08,52,658/- Amount Unspent :Rs- 22,47,342/-
5.	Sanctioned objectives	➢ Design and Development of Low Cost High Efficiency 'Controllers' ➢ Design and Development of "Variable Frequency Drive" (VFD) to work optimally under summer and winter profiles ➢ To increase the 'Overall Wire to Water Efficiency' of the 'Solar Water Pumping Systems (SWPS)' up-to 45% (from the existing level of around 38%-40%) ➢ Standardise the Specifications of various components and Sub-Systems (for end to end System Configuration) of 'Solar Water Pumping Systems ➢ Development of a 'State of The Art Testing and R&D Facility' for Solar Water Pumping Systems. ➢ To prepare and publish 'Best Practices Guidelines Document' for SWPS
6.	Expected output as per sanction	I. Low Cost High Efficiency 'Controllers' II. Variable Frequency Drive (VFD) to work optimally under summer and winter profiles. III. The Overall Wire to Water Efficiency of the 'Solar Water Pumping Systems (SWPS)' achieved up-to 45% through improved combination of developed controller and VFD. IV. 'Daily Water Discharge' of SWPS improved by at least 10 %. V. A new improved controller for GRID Connected Solar Pumping Systems, to ensure the operation of Solar Water Pumping Systems, even during Non-availability of power. VI. Standardized Specifications of various components and Sub-

		Systems (for end to end System Configuration) of SWPS, to ensure compatibility and interchangeability of components of different makes. VII. State of The Art Testing Facility for Solar Water Pumping Systems. VIII. Best Practices Guidelines Document' for SWPS. IX. Low cost and reliable 'Remote Monitoring System' including 'Diagnostic Analysis' of Functioning of Solar Pumps. X. Solar pumping Systems with 'Saline Water Tolerance'. XI. Low Cost and High Efficiency, Portable & Rugged 'Micro Irrigation Systems' with small motor pump sets. XII. Fully documented 'Standards and Specifications' of various components and Sub-Systems (for end to end System Configuration) to ensure Compatibility and Interchangeability of components of different makes. XIII. The 'Best Practices' guidelines 'Document' including: • Guidelines for users (specifically for farmers) to properly specify the requirement and selection of suitable System (e.g. whether a DC or AC System, combination with 'Micro irrigation equipment etc.) • Guidelines for System Integrators for identifying the suitable equipment and components. • Selection of proper 'Model' of 'Solar Water Pumping Systems' • Installation guidelines. • To achieve better performance and get additional advantages from 'Solar Water Pumping Systems'
7.	Status of the project/achievements including research publications in Journals/patents/prototype development	Work order for creation of high efficiency solar water pump Test Facility' has been issued to M/s Factual tech solution ,Delhi and work is under progress. Man Power has been hired for the Project. Through a transparent process, reputed manufacturers of Motor- Pump sets and controllers have been short listed and MOUs have been signed with them. The development work is under progress. NISE has prepared a 'Test Procedure' (in co-ordination with 'BIS') for Testing and Comparison of life cycle of Solar PV Pumps for reliability, Durability and Performance Evaluation 'with 'CI & SS' material.

Project No. 3: Opinion on the overall of the progress for the Project: Design and Development of 'High Efficiency Solar Water Pumping Systems by Dr. Arun K. Tripathi, Director General, NISE

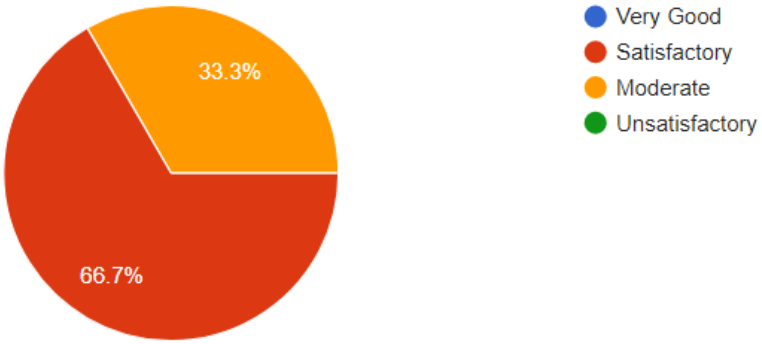
3 responses

Project No. 4: Process development for fabrication of CZTS based solar cells on flexible (polyimide) substrate

Sl. No.	Items	Details
1	Title of the project	Process development for fabrication of CZTS based solar cells on flexible (polyimide) substrate
2	Principle Investigator Co-principle Investigator	Dr. Udai P Singh
3	Name of the Implementing Institution/industries	School of Electronics Engineering, Kalinga Institute of Industrial Technology (Deemed University), Bhubaneswar-751024.
4	**Details of the project**	
	Date of the sanction	30.11.2016
	Cost of the project with details of the cost sharing with other institutions/industries	Total cost: Rs. 106.84 lakh MNRE share: Rs. 106.84 lakh
	Duration	3 years
	Date of completion	29.11.2019
	Funds released and utilized (year-wise)	Rs. 50.00 Lakhs (CCA) (30.11.2016) Rs. 10.00 Lakhs (GIA) (30.11.2016) Rs. 25.00 Lakhs (GIA) (24.03.2018)
	Status of UCs/Audited statement of accounts	UC/SoE had submitted.
	Unspent Balance with PIs	Recurring (₹ -31797)/ Non-Recurring (₹ 1108)
5	Sanctioned objectives	Fabrication of CZTS/CdS thin film solar cells on 6 cm x 6 cm flexible substrate using co-evaporation technique
6	Expected output as per sanction	6 cm x 6 cm CZTS/CdS thin film solar cells with efficiency in the range of 8 %
7	Status of the project/achievements including research publications in Journals/patents/prototype development	The project has achieved 5.41 % efficiency on small area. Prototype:- Nil Patents generated:-Nil Paper published:- 9 nos.

Project No. 4: Opinion on the overall of the progress for the Project: Process development for fabrication of CZTS based solar cells on flexible (polyimide) substrate by Dr. Udai P Singh Kalinga Institute of Industrial Technology (Deemed University), Bhubaneswar

3 responses



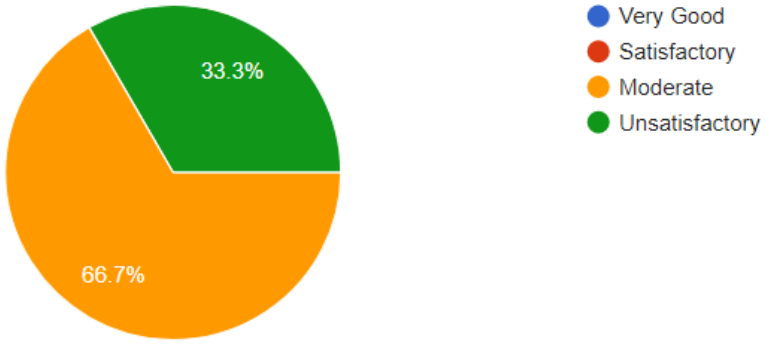
Project No. 05 : Porphyrin @Graphene Quantum Dots sensitized solar cells(PGSSCs) using Polypirrole-Graphene composites as Counter electrodes - a step towards 4G solar cells. (SP)

S.No.	Item	Details
1	Title of the project	Porphyrin @ Graphene Quantum Dots sensitized solar cells (PGSSCs) using Polypirrole-Graphene composites as Counter electrodes - a step towards 4G solar cells.
2	Name of the Principal Investigator	Dr. A. K. Narula
3	Name of the implementing Institution/ University/ Industry	Guru Gobind Singh lndraprastha University, Dwarka, New Delhi
4	**Details of the project**	
	Date of the sanction	28-12-2017
	Cost of the project with details of the cost sharing with other institutions/industries	Project cost = Rs 64.67 lakh MNRE Share = 100%
	Duration	3 years
	Date of completion	28-12-2020
	Funds released and utilized (year-wise)	Rs. 31.00 Lakhs (CCA) (28.12.2017)
	Status of UCs/Audited statement of accounts	UC/SoE had submitted.
	Unspent Balance with PIs	Rs. 1,00,000/-

6	Sanctioned objectives	**Synthesis and characterization of** polypyrrole (pPy) electrochemically, Graphene Oxide (GO) by modified Hummer's method, Graphene Quantum Dots (GQDs) Electrochemically and Hydrothermally, Reduced Graphene Oxide doped Polypyrrole (pPy/RGO) electrochemically. Porphyrin@Graphene Quantum Dots (Por/GQDs). II. **Preparation of layer-by-layer solar cell assembly** for fabricating Porphyrin@Graphene Quantum Dots sensitized solar cells (PGSSCs). III. **Characterization of the above synthesized materials** by UV-Vis spectrophotometry, PL, Cyclic voltammetry, EIS, FT-IR, SEM, TEM, TGA, NMR, XRD, I-V measurements. IV. **Testing of the prepared Porphyrin@Graphene Quantum Dots sensitized solar cells (PGSSCs)** for its efficiency and to re-evaluate the efficiency for its consistency, reproducibility and stability.
7	Expected output as per sanction	Final product in the form of a solar cell, papers/ Posters for national/international conferences, patent applications etc.
8	Status of the project as per the latest progress report from the PI.	The PI achieved 3.9 % efficiency on 1 cm2 and it is propsoed to close the project and submit the project completion report within project duration. Paper published:-1

Project No. 5: Opinion on the overall of the progress for the Project: Porphyrin @ Graphene Quantum Dots sensitized solar cells (PGSSCs) using Polypirrole-Graphene composites as Counter electrodes - a step towards 4G solar cells by Dr. A. K. Narula Guru Gobind Singh Indraprastha University,Dwarka, New Delhi

3 responses

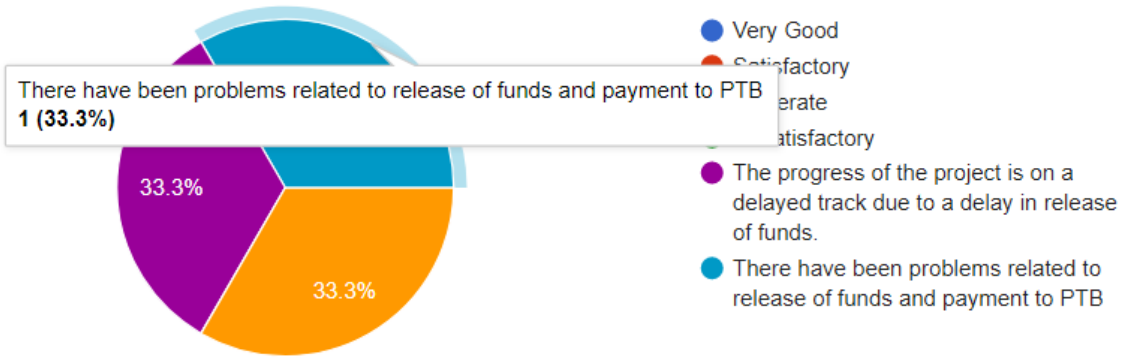


Project No- 6. National Primary Standard Facility for Solar Cell Calibration

Sl. No.	Items	**Details**
1.	Title of the project	**National Primary Standard Facility for Solar Cell Calibration**
2.	Principle Investigator Co-principle Investigator	Principal Investigator: Dr. Vandana, CSIR-NPL Co-Principle Investigator: 1. Dr. Prathap Pathi, CSIR-NPL, 2. Mr. CMS Rauthan, CSIR-NPL 3. Dr S. K. Srivastava, CSIR-NPL, 4. Dr. A. Tripathi, NISE
3.	Name of the Implementing Institutions/Industries	CSIR-National Physical Laboratory, New Delhi-110060
4.	Details of the project	
	Date of sanction	29th June 2017
	Cost of the project with details of the cost sharing with other institutions/industries	Rs. 17.885 Crores, 100% CSIR-NPL share.
	Duration	Three Years
	Date of completion	29th June 2020. (Extended upto December 2021)
	Funds released and utilized (year-wise)	Rs. 9.00 Crore (CCA) (29.06.2017)
	Status of UCs/Audited statement of accounts	UC's and SoE up to FY 2018-19 & 2019-20 are submitted.
	Unspent Balance with Pls	Rs. 1,13,92,328/-
5.	Sanctioned objectives	Establishment of national standard for calibration of photovoltaic's (PV) devices to provide traceability of device parameters through Apex level calibration and to participate in international inter-comparison with world PV Standard Labs to establish a degree of equivalence.
6.	Expected output as per sanction	➢ Building of primary reference solar cell calibration facility at PTM. ➢ Performance evaluation of the system to establish associated uncertainty setting up of the primary reference solar cell calibration facility at NPL. ➢ Setting up Primary Reference Solar Cell Facility at NPL. ➢ Identification and procurement of reference solar cells. ➢ Inter-comparison of measurement capability with PTB through round-robin mechanism. ➢ Secondary Reference Solar Cell Calibration, I-V & SR measurements.
7.	Status of the project/achievements including research publication in Journals/patents/prototype development	The project work was proposed in collaboration with PTB, Germany and an agreement for this purpose was signed with PTB, Germany in Sept. 2018. The first project grant of Rs. 9 Crores was released to CSIR-NPL in financial Year 2017-18. Project activities were started with available project money at CSIR-NPL. However system development related activities are stopped due to delay in payment to PTB Germany and now issues has been resolved and project has been extended upto December, 2021 Prototype:- Nil Patents:- Nil Paper published:- Nil

Project No. 6: Opinion on the overall of the progress for the Project: National Primary Standard Facility for Solar Cell Calibration by Dr. Vandana, CSIR-NPL

3 responses



Project No-6: Appraisal on achievements as per sanction of the projects.

1 response

Project is on-going

Project No-6: Recommendation with suggestion for further course of action.

3 responses

This is an important project that would bring parity in performance evaluation of industrial solar cells at international level. Though the project has now been extended till December 2021, it would be a tall order on part of PTB to build a system with the minimum level of uncertainty and transfer it to NPL. MNRE must review the progress periodically to ensure the project deliverables as per the sanction. Also, there should be a policy decision making it mandatory for the Indian PV community to utilize the primary reference cell facility directly or indirectly. The NPL manpower has to train itself sufficiently to take care of the future system maintenance needs as well.

This is an extremely important project which will become even more important with increasing manufacturing of solar cells in India. The reasons for delays in getting this critical project completed on time are not clear. This project should be put on fast track, and MNRE may also put in funding to ensure the project reaches a satisfactory conclusion soon.

Funds should be released by MNRE so that PTB can complete its part. This is an important project. Project duration should be extended to make up for loss of time due to non-release of funds.

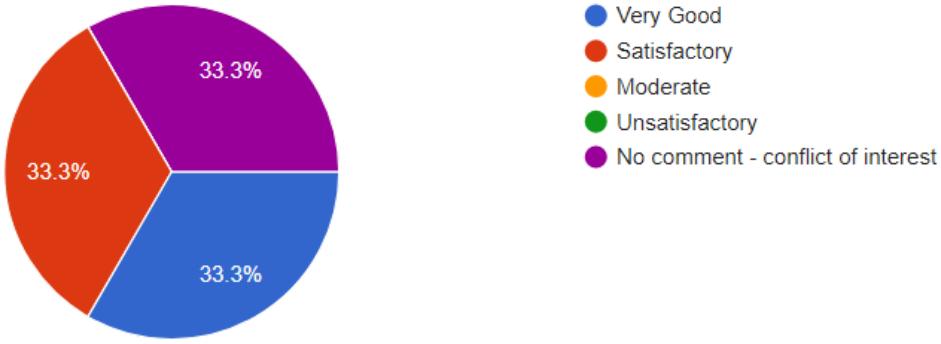
Project No. 7- National Centre for Photovoltaic Research and Education (NCPRE) Phase-II

Sl. No.	Item	Details
1	Title of the project and file no.	National Centre for Photovoltaic Research and Education (NCRE) Phase-II
2	Name of the Principal Investigator	Prof. B. G. Fernandes and Prof. C. S. Solanki
3	Name of the implementing Institution/ University/ Industry	Indian Institute of Technology, Bombay, Powai, Mumbai
4	Details of the project	
	Date of sanction	15-06-2016
	Cost of the project with details of the cost sharing with other institutions/industries	Total Cost: Rs. 6235 Lakh MNRE share: Rs. 6235 Lakh
	Duration	5 years
	Date of completion	15.06.2021
	Funds released	Rs. 4.00 Crore (GIA) (15.06.2016) Rs. 6.00 Crore (CCA) (15.06.2016) Rs. 7.00 Crore (GIA) (27.03.2017) Rs. 5.00 Crore (CCA) (27.03.2017) Rs. 6.77 Crore (GIA) (30.12.2017) Rs. 8.00 Crore (CCA) (30.12.2017) Rs. 7.17 Crore (GIA) (30.03.2019) Rs. 2.20 Crore (CCA) (14.01.2020) Rs. 3.70 Crore (GIA) (28.10.2020)
	Status of UCs/Audited statement of accounts	Submitted
	Unspent Balance with Pls	Rs. 4,50,25,546/-
5	Sanctioned objectives	The Centre's activities will be divided in two major themes, namely Education and Training and Research and Device Development
6	Expected output as per sanction	**Education and Training** **Crystalline Si Solar Cells**- High efficiency (18-22%) silicon solar cells using 6 inch X 6 inch, mono and multi crystalline wafers. **Thin Film Materials and Devices** – High efficiency (>15%) efficient tandem junction solar cells with perovskite on top and silicon/ CZTS at the bottom. Demonstration of high stability (1000 hrs) in perovskite solar cells. **Energy Storage –** Development of 2.5 Ah Li-ion pouch cells and batteries, iron flow batteries, modeling for large scale storage etc. **Power Electronics –** Test bench for power electronic inter faces of a solar PV system, multi objective control for synchronization of micro grids. DC side protection mythology for grid inter faced inverter system develop industry standard product for a number of PV and power electronic systems. **Module Reliability -** Field assessment of reliability of PV modules of various technologies, new models for accelerated testing, quality assessment for module materials etc.
7	Status of the project/achievements including research publication in	**Education and Training:** Various courses, workshops and training sessions have been organized to extend the knowledge gathered at NCPRE to people from academia and industry. Four familiarization workshops and two Hands-on training sessions were organized to familiarize other academia and promote their interaction

	Journals/patents/prototype development	with NCPRE investigators through the PUMP initiative which also saw submission of 67 new project proposals on PV. **Crystalline Si Solar Cells**- LIP set up established for 6 in x 6 in solar cells. Ni plating to be used as a barrier for Cu diffusion into Si. With all processes carried out at NCPRE, the champion cell on mono-Si wafers had an efficiency of 19.4% (V_{OC} = 634 mV, I_{SC} = 37.11 mA/cm^2, FF = 81.2%). through metal assisted chemical etching and additive-less alkaline texturing. PERC cell development saw further optimisation of sprayed Ai2O3 and joint development with industry a laser ablation process for dielectric films. For IBC solar cells, co-diffusion of B and P into silicon was studied with screen-printed diffusion source. For carrier selective contacts, an improved MoO_3/n-Si solar cell with efficiency of 13.6% (active area efficiency of 15.24%) was demonstrated. **Thin Film Materials and Devices**: Multi-cation perovskite solar cells in n-i-p and p-i-n configurations have been fabricated with efficiencies 14.3% and ~17% respectively. Screen printed carbon based perovskite solar cells in order to reduce the cost and easiness in scaling up have been fabricated by two step drop cast method with efficiencies ~13.36% on 0.09cm2 and 5.9% over 4cm2 device area. A mini module of 10cm2 with ~4V open circuit voltage has been fabricated by interconnecting 2cm2 solar cells in series. **Energy Storage:** 20 Li-ion cells of 2.5 Ah capacity with LCO-graphite chemistry, having cycle life of more than 100 cycles has been successfully demonstrated. Along with this, a new chemistry C-LTO/LFP have been under investigation for long cycle life (10K). Also, a Prototype- Battery fabrication facility for demonstration of 7 Ah, 10 Ah stacked pouch cells, 2.5 Ah jelly rolled pouch cell and cylindrical cells has been established. The team has been also able to demonstrate an ultrahigh specific Na-ion full cell with a doped ammonium vanadium oxide (NVO) cathode against hydrogenated sodium titanium oxide (NTO) The cell is capable of retaining 94% capacity after 400 cycles, having a high energy density of 467 Wh/kg at a very high rate of 0.2 A/g. **Power Electronics:** The power supply part of the high power inverter test setup has been completed. Five prototype, standalone 500 VA inverters for rural off-grid application have been fabricated and testing is carried out upto 125W power level. A 1 kVA inverter which can be operated in the presence or absence of grid is implemented and the detailed report along with BOM submitted to MNRE. A 2 HP BLDC motor which is driven from solar PV, and is used for surface mounted pumping application has been designed in-house. A 5 kVA solar PV based inverter with integrated 2.5 kW battery storage has been fabricated that can be operated in grid connected as well as in standalone mode. **Module Reliability:** All India Survey of PV Reliability 2018 has been completed and the report is ready. Potential Induced Degradation (PID) was found to be the key failure mechanism responsible for high degradation rates observed in < 5-year-old PV plants. Accelerated tests pertinent to Indian climates and module quality assessment have been developed. Prototype:- Nil Patents generated:-9 nos. Paper published:- 120 nos.

Project No. 7: Opinion on the overall of the progress for the Project: National Centre for Photovoltaic Research and Education (NCRE) Phase-II by Prof. B. G. Fernandes Indian Institute of Technology, Bombay, Powai, Mumbai

3 responses



Project No-7: Appraisal on achievements as per sanction of the projects. 3 responses

This flagship project of the Ministry is carrying out development on various types of solar cells based on silicon and perovskite, on storage devices such as Li-ion cells, on power electronic systems and reliability studies and failure mechanisms in PV modules. The cell efficiencies achieved have been encouraging (19.4 % on Al:BSF silicon solar cells, 17 % on perovskite solar cells etc.) with scope for further improvement. For energy storage, 2.5 AH Li-ion cells have been developed with LCO-graphite chemistry. Commendable work has been done on power electronics, reliability studies and education and training.

No comment

There have been several important achievements in this project. Closer interaction with industry partners should be useful.

Project No-7: Recommendation with suggestion for further course of action. 3 responses

During the remaining duration of the project, emphasis needs to be put on enhancing Al:BSF cell efficiency, realizing PERC and IBC type solar cells with high efficiencies, combining silicon and perovskite solar cells to provide a boost to the PCE. Looking at the good work being done at the centre, the Ministry may even consider funding the next phase of the project that should bring closer ties with manufacturing on all aspects of photovoltaics.

No comment

The PERC technology development may be coordinated with BHEL and other centres. Regular interaction meetings among the concerned teams should be held. Other technologies such as power instrumentation should be as per requirement of industry. Li battery technology should also be coordinated with users. Project should be given extension for completing its tasks.

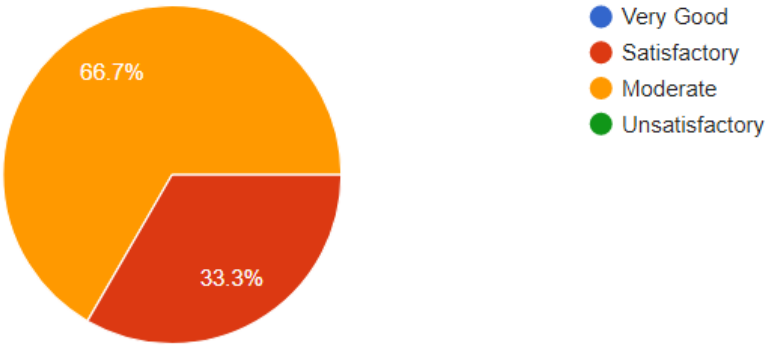
Project No. 8 - Development of Electrode Materials for High Energy Density Lithium ion Batteries and Computational Studies of Solar Absorber layers.

Sl. No.	Items	**Details**
1.	Title of the project	**Development of Electrode Materials for High Energy Density Lithium ion Batteries and Computational Studies of Solar Absorber layers.**
2.	Principle Investigator Co-principle Investigator	Prof. M. Sasidharan
3.	Name of the Implementing Institutions/Industries	SRM Research Institute, SRM University, Kattankulathur, Chennai
4.	Details of the project	
	Date of sanction	15-05-2016
	Cost of the project with details of the cost sharing with other institutions/industries	Project cost: Rs. 1117 Lakh MNRE Share: Rs. 505.56 Lakh
	Duration	Three Years
	Date of completion	29th June 17-05-2019
	Funds released and utilized (year-wise)	Rs. 2.50 Crore (GIA) (05.05.2016) Rs. 1.96 Crore (CCA) (30.03.2017) Rs. 40.00Lakhs (CCA) (04.02.2020)
	Status of UCs/Audited statement of accounts	UC's and SoE up to FY 2018-19 & 2019-20 are submitted.
	Unspent Balance with Pls	Nil
5.	Sanctioned objectives	The project is divided into two broad themes ➢ Development of various kinds of thin film solar cells including CZTS, Graphene oxide based and perovskite solar cells. ➢ Development of anode and cathode materials for high-energy density lithium-ion batteries. ➢ Computational Studies of solar cell's absorber layer materials.
6.	Expected output as per sanction	➢ 13% CZTS solar cells, 8% transparent grapheme oxide based solar cells, 10% perovskite solar cells. ➢ Anode materials with a specific capacity of > 1000 mAh/g in standard coin-type Li-ion cell, identification of new, high capacity cathode materials (200 mAh/g), development and testing of coin type CR 2032 battery with energy density of 1 Wh/g. ➢ Development of a property package using computer simulation for theoretical screening of solar absorber layers for potential use in solar cells, study of Kesterite based and Perovskite based solar absorbers, use of solar cell simulation programme for in-depth, quantitative study.
7.	Status of the project/achievements including research publication in Journals/patents/prototype development	The coin-type full cells fabricated using the cathode material which gave discharge capacities 215 mAh.g–1 with an average discharge voltage of around 3.5 V with an energy density of 0.75 Wh/g against a committed energy density of 1 Wh/g. Multilayer pouch type cells were also assembled and tested at Nanyang Technological University with rated capacities between 450 and 570 mAh. A complete database for sixty-two PV materials has been formed. New material CuZn2Al(S/Se)4 (CZASe) have a stannite structure with space group I-42m (121) and the lattice parameters are a=b=5.7694, c=11.495 respectively The pure CZASe has two major peaks at about 2.1 eV and about 3.9 eV. Enhancement to that of the pure CZASe through doping

		produces a higher photocurrent and improves the solar cell efficiency. The best CZTSSe device that could be achieved with solution based material was with an efficiency of 2.7% on 0.45 sq.cm. area. The highest efficiency of solar cells made with Sb2S3 absorber layer on imported Mo coated glass is 4.34 %. Prototype:- Patents generated:- 2 nos. (filed) Paper published:- 18 nos.

Project No. 8: Opinion on the overall of the progress for the Project: Development of Electrode Materials for High Energy Density Lithium ion Batteries and Computational Studies of Solar Absorber layers by Prof. M. Sasidharan SRM Research Institute, SRM University, Kattankulathur, Chennai

3 responses



Project No-8: Appraisal on achievements as per sanction of the projects. 3 responses

The achievements on development of Li-ion coin type cells can be termed as satisfactory in that the cathode material developed yielded a discharge capacity of 215 mAh/g against the budgeted figure of 200 mAh/g. However, no claim is made in respect of the development of anode material. Also, the energy density reached (0.75 W/g) falls short of the targeted figure of 1 W/g. The theoretical studies made on prediction of properties of compound semiconductors did not have much practical utility as the knowledge obtained could not be made use of in the low efficiency, thin film solar cells fabricated.
The achievements for both the CZTS and battery are lower than projected. However, for CZTS, it is not surprising since it was shown internationally in 2017 that efficiencies greater than 13% would be impossible. Efficiency for perovskite cells is not given – 10% should have been easy to achieve. The simulation of the solar absorber materials is difficult to judge without comparing detailed simulation data with experimental results. 2 patents and 18 papers is a good output.
Good effort and good results from a small college and a small budget project.

Project No-8: Recommendation with suggestion for further course of action . 3 responses

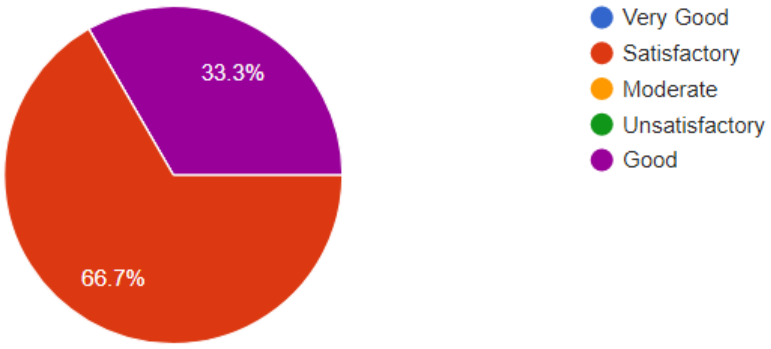
There need not be any further follow up of the work done as the project has since been closed successfully. The project may be closed. They should focus on battery technology.

Project No. 9 - Development of High Efficiency selective emitter, large area, N-Type crystalline silicon solar cell.

Sl. No.	Items	Details
1.	Title of the project	**Development of high efficiency (20-22%), selective emitter,Al2O3 passivated, large area, n type crystalline silicon solar cell**
2.	Principle Investigator Co-principle Investigator	Principal Investigator: Prof.(Dr.) Utpal Gangopadhyay Co-Principle Investigator: 1. Dr. Debasish De Meghnad Saha Institute of Technology 2. Prof. Hiranmoy Saha CEGESS, IIEST, Sibpur, Howrah (*A collaborative institute)
3.	Name of the Implementing Institutions/Industries	Meghnad Saha Institute of Technology
4.	Details of the project	
	Date of sanction	31st December, 2015,
	Cost of the project with details of the cost sharing with other institutions/industries	Rs.2, 98, 40,880/-.
	Duration	Three Years
	Date of completion	01/01/2019
	Funds released and utilized (year-wise)	Rs. 2,25,00,000/- (GIA) (31.12.2015) Rs. 48,00,000/- (GIA) (23.03.2017)
	Status of UCs/Audited statement of accounts	UC's and SoE up to FY 2018-19 & 2019-20 are submitted.
	Unspent Balance with Pls	Rs. (-) 11,84,660/-
5.	Sanctioned objectives	1. Optimization of simultaneous formation selective emitter (p++) & back surface field (n++) layers on texturised large area n-type c-Si wafer. 2. Optimization of Al_2O_3 passivation in conjunction with SiN_x ARC layer on n-type selective emitter doped c-Si wafer.
6.	Expected output as per sanction	
7.	Status of the project/achievements including research publication in Journals/patents/prototype development	**Status** – Completed (Considering as completed, as we have no money left, not yet received any further grant although project already sanctioned for extension up to Dec. 2020, letter dated 27th Jan.2020) **Achievements :** Base line n-type solar cell efficiency 17% (156mmx156mm) SILVACO Simulation for selective Emitter & PERT structure adopting improved fabrication process Selective Emitter n-type Solar Cell efficiency 19% (156mmx156mm). Easy fabrication process. All steps used in the fabrication process is batch compatibility. Prototype:- Patents generated:-Nil Paper published:-Nil

Project No. 9: Opinion on the overall of the progress for the Project: Development of high efficiency (20-22%), selective emitter,Al2O3 passivated, large area, n type crystalline silicon solar cell by Prof.(Dr.) Utpal Gangopadhyay, Meghnad Saha Institute of Technology, Kolkata

3 responses



Project No-9: Appraisal on achievements as per sanction of the projects. 3 responses

For the first time in the country, large area solar cells on n-type silicon wafers have been made in this project. Unit processes, that are different from those for p-type solar cells, have been successfully developed and integrated to yield 17 % solar cells with BSF and 19 % solar cells with selective emitter, both on 156 mm x 156 mm size wafers. The targeted efficiency was 20 – 22 % for selective emitter solar cells.
Efficiencies realized are reasonable, though not as high as proposed. However, more details would be desirable, for example on run-to-run repeatability, uniformity, etc. The point about not receiving further grant is not clear. It is also surprising that no publications came out of this activity.
Good work has been carried out and the results (19% efficiency) are close to the promised goals. More time should be given to make up for the pandemic lockdown.

Project No-9: Recommendation with suggestion for further course of action . 3 responses

Since n-type silicon wafers have higher efficiency potential compared to p-type silicon wafers, it would be good to support such projects in future.
The project may be declared completed. However, this is an important area of research, and may be extended to achieve the required efficiencies.
Perhaps a second phase project will be necessary. Closer interaction with an industry will be useful.

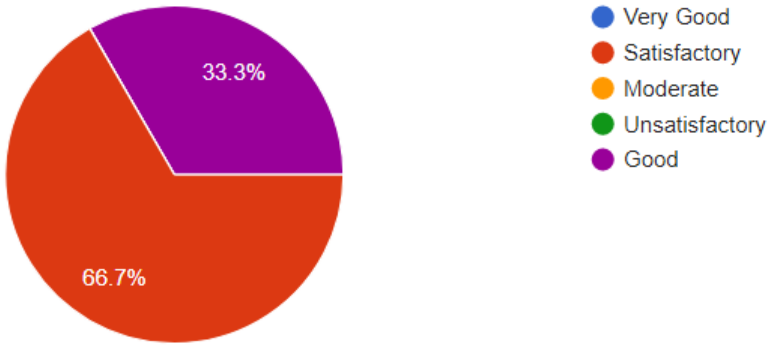
Project No.10- Development and Field Testing of Solar Powered Clean Drinking Water System for communities without piped water line and electricity

Sl. No.	Items	**Details**
1.	Title of the project	**Development and Field Testing of Solar Powered Clean Drinking Water System for communities without piped water line and electricity** **F. No:- 31/05/2013-14/PVSE**
2.	Principle Investigator Co-principle Investigator	Principal Investigator: Dr. Chandan Banerjee/ National Institute of Solar Energy Co-Principle Investigator: Dr. (Mrs.) Vibha Tripathi
3.	Name of the Implementing Institutions/Industries	National Institute of Solar Energy M/s Surya EnerTech, Gurgaon.
4.	Details of the project	
	Date of sanction	19-04-2016
	Cost of the project with details of the cost sharing with other institutions/industries	Rs. 320.14 Lakh MNRE Share = Rs 214.22 Lakh
	Duration	Three Years
	Date of completion	19-04-2019
	Funds released and utilized (year-wise)	Rs. 1,00,00,000/- (CCA) (06.05.2016) Rs. 53,10,000/- (GIA) (22.12.2017)
	Status of UCs/Audited statement of accounts	UC's and SoE up to FY 2018-19 & 2019-20 are submitted.
	Unspent Balance with Pls	Rs. 14,49,597/-
5.	Sanctioned objectives	To provide a simple solution for WHO standard portable water using appropriate purification system. The specific objectives are as follows: Setting up of about 5 prototype centres. R&D for improved machinery and plug & play equipment using solar PV. Testing of improved prototype centres. Continuous data collection and data analysis for identifying possible glitches. Implementation of data towards improved model. Development of software for content management system using cloud based applications. Networking and managing micro-finance options through banks. Promotion and awareness of clean water. Expanding the model further.
6.	Expected output as per sanction	Five well designed and energy independent running centers for potable water producing upto 3000 to 5000 liters per day of clean water, all software and hardware tested and in place, 7 to 8 trained man power to look after operation and maintenance of the systems.
7.	Status of the project/achievements including research publication in Journals/patents/prototype development	Five machines have been designed and fabricated. The controller and remote monitoring system have been developed and fabricated in-house. First Solar Powered drinking water station was designed and fabricated. System of 500 LPH capacity has been powered by multi-crystalline solar panels installed at the roof. It was installed at the NISE campus in April 2017. New 100 LPH has been installed in the Aditya Bhavan of NISE. This machine is highly energy efficient and consumes about 600 W power only for a capacity of 100 LPH. It is a completely DC system and does

		not involve an inverter. Third water purification machine of 500LPH capacity is installed in a village: Khurampur, Distt Gurgaon Fourth water purification machine of 200LPH capacity is installed at Safdarjung Hospital Delhi Fifth machine of capacity 200LPH is installed at Civil Hospital, Gurgaon. Developed the software for content management using cloud based application for operation and maintenance of the machines. Prototype:- Patents generated:-Nil Paper published:-Nil

Project No. 10: Opinion on the overall of the progress for Development and Field Testing of Solar Powered Clean Drinking Water System for communities without piped water line and electricity by Dr. Chandan Banerjee/ National Institute of Solar Energy

3 responses



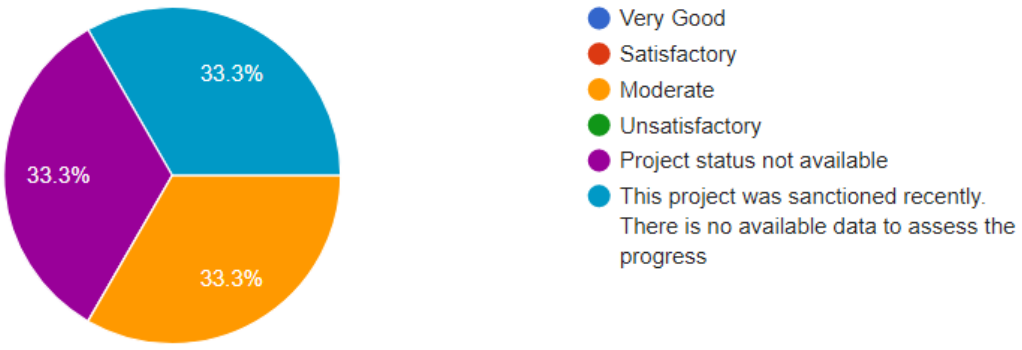
Project No.-11: Design and Development of high performance supercapatteries for solar applications (Solar Lantern, Solar Home Light)

Sl. No.	Items	Details
1.	Title of the project	Design and Development of high performance supercapatteries for solar applications (Solar Lantern, Solar Home Light)
2.	Principle Investigator Co-principle Investigator	1. Dr. S. P. Gairola, Professor & Head Research & Development Cell, Uttaranchal University, Dehradun, Uttrakhand Co-Principal Investigators: 1. Dr. Yogesh Kumar Sharma, Professor, Department of Physics, Indian Institute of Technology, (IIT-Roorkee), Roorkee
3.	Name of the Implementing Institution/industries	Uttaranchal University, Dehradun, Uttrakhand
4.	**Details of the project**	
	Date of the sanction	13/03/2020
	Cost of the project with details of the cost sharing with other institutions/industries	Total outlay: Rs. 99 Lakh MNRE Share: Rs. 66 Lakh

	Duration	3 years
	Date of completion	13/03/2021
	Funds released and utilized (year-wise)	Rs. 10.00 Lakh (GIA) (13.03.2020) Rs. 30.00 Lakh (CCA) (29.04.2020)
	Status of UCs/Audited statement of accounts	UC for FY 2020-21 not submitted yet.
	Unspent Balance with PIs	
5.	Sanctioned objectives	1) Synthesis and characterization of Graphenated-Metal Oxides nanocomposites using hummer's modified and hydrothermal methods. 2) The supercappatery and electrochemical energy storage characteristics of electrode materials will be evaluated using CV, GCD and EIS techniques in a beaker type of three electrode and two electrode cells with a reference electrode, a counter electrode and a working electrode. 3) A device unit cell, asymmetric as well as symmetric cell for the supercappatery will be fabricated with nanocomposite and activated carbon materials using different separators. The performance of symmetric and asymmetric type of unit cell will be evaluated in aqueous and solid state electrolyte solution using autolab electrochemical work station.
6.	Expected output as per sanction	i. Metal Oxides/graphnee nano-composite performance in three electrode configuration: Capacitance, 300 Fg-1, Cycle life: 10,000 cycles, Energy density: 50 WhKg-1 power density: 1.5 kWKg-1 ii. Symmetic /Assymetric ultracapacitor (supercapatteries) Single cell: Capacitance : 50 Fg-1, cyclability: 5000 cycles, Energy density : 50 WhKg-1 and Power density 1.5 kWkg-1.
7.	Status of the project/achievements including research publications in Journals/patents/prototype development	Prototype:- Nil Patents generated:- Nil Paper published:- Nil

Project No. 11: Opinion on the overall of the progress for the project: Design and Development of high performance supercapatteries for solar applications (Solar Lantern, Solar Home Light) by Dr. S. P. Gairola, Uttaranchal University, Dehradun, Uttrakhand

3 responses



Project No.-12: To study the technical feasibility of Lithium Titanium Oxide (LTO) Battery for energy storage in PV Power Plants to be deployed in the environmental conditions prevailing at Siachin Glacier.

Sl. No.	Items	Details
1.	Title of the project	To study the technical feasibility of Lithium Titanium Oxide (LTO) Battery for energy storage in PV Power Plants to be deployed in the environmental conditions prevailing at Siachin Glacier
2.	Principle Investigator Co-principle Investigator	1. Shri R. K. Jain, AGM, Solar Energy Corporation of India Limited, New Delhi
3.	Name of the Implementing Institution/industries	Solar Energy Corporation of India Limited, New Delhi
4.	**Details of the project**	
	Date of the sanction	28.2.2019
	Cost of the project with details of the cost sharing with other institutions/industries	Total outlay: Rs. 1.01 crore MNRE Share: 100% MNRE
	Duration	1 year
	Date of completion	28/02/2020 (Extension given upto Dec, 2021)
	Funds released and utilized (year-wise)	Rs. 81.00 Lakh (CCA) (28.02.2019)
	Status of UCs/Audited statement of accounts	UC for FY 2019-20 submitted and refunded the unspent balance
	Unspent Balance with PIs	Rs. 86,81,280/- SECI refunded the unspent balance 26-Aug-2020 15:05:51 26-Aug-2020 NEFT OW:SBIN-PAY AND ACCOUNTS-P20082617470268390 Rs. 86,81,280.00
5.	Sanctioned objectives	1) Design and develop an innovative system for charging Lithium Titanium Oxide (LTO) Battery deploying solar energy for proving energy at Siachen Glacier in view of high altitude, remote location and extremely low temperature of the region. 2) Being an innovative project, it is proposed that the project to be considered under research development and demonstration programme of MNRE.
6.	Expected output as per sanction	1) Identification and study of appropriate technology PV module for its use in Siachin Glaciers 2) Development of suitable technology for mounting of PV modules in Glaciers 3) Identification and selection of Super Capacitors / Lithium Titanium Battery for energy storage suitable for Siachin Glaciers 4) To Design, Develop, install and commission a PV power plant of capacity 15 kWp comprising of super capacitor of capacity 50 kWh as energy storage.

		5) To develop the Remote Monitoring system for continuous monitoring of the plant.
7.	Status of the project/achievements including research publications in Journals/patents/prototype development	Prototype:- Nil Patents generated:- Nil Paper published:- Nil

Project No. 12: Opinion on the overall of the progress for the project: To study the technical feasibility of Lithium Titanium Oxide (LTO) Battery for energy storage in PV Power Plants to be deployed in the environmental conditions prevailing at Siachin Glacier by Shri R. K. Jain, AGM, Solar Energy Corporation of India Limited, New Delhi

3 responses

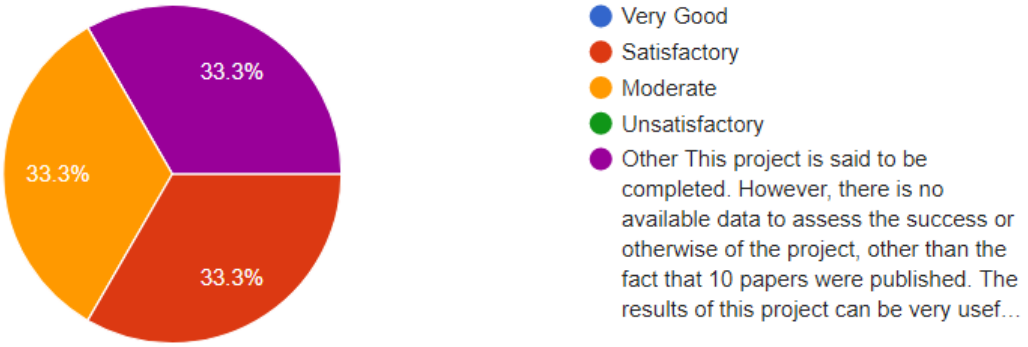
Project No.-13: Determination of Wind Forces on solar photovoltaic panels mounted on different types of Roof and on/above ground in India using computational fluid dynamics techniques.

Sl. No.	Items	Details
1.	Title of the project	Determination of Wind Forces on solar photovoltaic panels mounted on different types of Roof and on/above ground in India using computational fluid dynamics techniques.
2.	Principle Investigator Co-principle Investigator	1. Dr. Hassan Irtaza, Professor Department of Civil Engineering A.M.U., Aligarh 202002 India 1. Prof. Mohd. Jameel, Department of Mechanical Engineering, Aligarh Muslim University, Aligarh.
3.	Name of the Implementing Institution/industries	Aligarh Muslim University
4.	**Details of the project**	
	Date of the sanction	28-09-2016
	Cost of the project with details of the cost sharing with other institutions/industries	Total outlay: Rs. 38.59 Lakh MNRE Share: 100% MNRE
	Duration	2 years
	Date of completion	Scheduled completion date: 24.12.2018 Actual completion date: 28.02.2019
	Funds released and utilized (year-wise)	Rs. 32.08 lakh

	Status of UCs/Audited statement of accounts	UC for FY 201-17, 2017-18 submitted.
	Unspent Balance with PIs	Nil
5.	Sanctioned objectives	• To show that CFD techniques are effective and reliable approach for evaluation of wind effects on PV panels and to develop a mathematical model of PV panels subjected to wind loads. • To incorporate the mathematical model (meshing the model in GAMBIT) in Computational Fluid Dynamics Programs such as FLUENT. • To calculate the pressure/force coefficients on the PV panels mounted on different type of roofs and on/above ground at different angles of wind incidence. • To study the pressure/force coefficients on the PV panels for different terrain conditions. • To study the pressure/force coefficients on the PV panels both in isolation and in interfering conditions of arrays. • To obtain revised wind load pressures on the PV panels for inclusion in new/revised design codes. • For the structural safety of PV panels during cyclone,, design parameters of PV panel module and foundation design specifications to be studied. • To recommend the factor of safety for the design of PV panel module and foundation for the cyclone prone areas.
6.	Expected output as per sanction	1)Lab Scale model development: Scaled models of the actual PV panels will be developed to be used for various combinations of studies. 2)Technology Demonstration/Field Evaluation: Wind pressure coefficients will be used for the future design of Photovoltaic panels 3)Research Papers/Technical Documents/Reports (likely): To be published in different Indian & international journals.
7.	Status of the project/achievements including research publications in Journals/patents/prototype development	The project has been successfully completed Prototype:- Nil Patents generated:- Nil Paper published:- 10

Project No. 13: Opinion on the overall of the progress for the project: Determination of Wind Forces on solar photovoltaic panels mounted on different types of Roof and on/above ground in India using computational fluid dynamics techniques by Dr. Hassan Irtaza, Professor Department of Civil Engineering A.M.U., Aligarh

3 responses

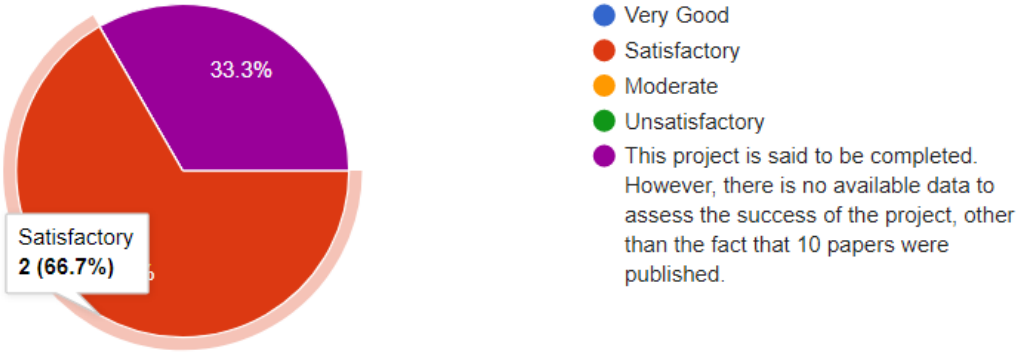


Project No.-14: From Cell towards Module using low cost Organo-Metal Halide Perovskite Materials, From cell towards Module.

Sl. No.	Items	Details
1.	Title of the project	From Cell towards Module using low cost Organo-Metal Halide Perovskite Materials, From cell towards Module
2.	Principle Investigator Co-principle Investigator	1. Dr. Shaibal K. Sarkar, Indian Institute of Technology, Mumbai
3.	Name of the Implementing Institution/industries	Indian Institute of Technology, Mumbai
4.	**Details of the project**	
	Date of the sanction	31.03.2016
	Cost of the project with details of the cost sharing with other institutions/industries	Total outlay: Rs. 1.01 crore MNRE Share: 100% MNRE
	Duration	3 year
	Date of completion	31.03.2019
	Funds released and utilized (year-wise)	Rs. 74.00Lakh (GIA) 31.03.2016 Rs. 74.00 Lakh (CCA)11.05.2016.
	Status of UCs/Audited statement of accounts	UC for FY 201-17, 2017-18, and 2019-20 submitted.
	Unspent Balance with PIs	Nil
5.	Sanctioned objectives	1. Develop!standard protocol to make solution processed high efficiency (ca. 15%) solar cellsusing AIBIICJ3 (A=alkali or organic cation, B=Pb or Sn, C=halide) 2. Achieve high efficiency·using inorganic electron and hole conductor and electron/hole blocking interface materials. 3. Define and access stability in terms of overall device performance under accelerated test condition with and without encapsulation. . 4. Optimization of process parameters towards large area cells with 6-8% efficiency. 5. Aim to study the stability of the cells (ca. 1000 hrs.). Understanding the modes of degradationunder accelerated test condition with and without bias. Defining parameter space of perovskite and material combination stabilities and implement ways to assure such stability.
6.	Expected output as per sanction	To develop a large area (1 cm2) solar cells with 8-10% efficiency with 1000 hrs life
7.	Status of the project/achievements including research publications in Journals/patents/prototype development	Prototype:- Nil Patents generated:- Nil Paper published:- 10

Project No. 14: Opinion on the overall of the progress for the project: From Cell towards Module using low cost Organo-Metal Halide Perovskite Materials, From cell towards Module by Dr. Shaibal K. Sarkar, Indian Institute of Technology, Mumbai

3 responses



Project No-14 : Appraisal on achievements as per sanction of the projects.

3 responses

The achievements in the project (20 % efficient perovskite solar cells) exceeded the target though the developments remained confined to small area solar cells. Translation to larger cell areas was mandated as per the sanction. The stability aspects and encapsulation of the active device with aluminum oxide thin films were also explored in the project.
This project is said to be completed. However, there is no available data to assess the success of the project, other than the fact that 10 papers were published.
There is no status report.

Project No-14: Recommendation with suggestion for further course of action.

3 responses

The achievements in the project have paved the way for a larger and more ambitious project on roll-to-roll perovskite solar cells supported by the Ministry (ref. Project at sl.no. 2 in this review).
A subsequent project has been granted to the PI in March 2019, which looks like an advanced The version of this project, with better specifications and on a flexible substrate.
Project is completed.

Suggestions and Recommendations on R&D Policy

3 responses

The R&D policy formulated by the Ministry is adequate but for the point of participation by the industry and start-ups in the RE area so that the aspect of product and/or process development is also addressed. The R&D policy may, therefore, be modified to encourage industries and start-up groups to have more participation in the RE projects with an eye to speedy developments. Introduction of well established industrial practices such as design of experiments and statistical process/ quality control in R&D activities may lead to quicker development of processes and products - Sudip Bhattacharya, Former head, BHEL-ASSCP

• With the proposed 300 GW target by 2030, a concentrated focus on R&D also becomes necessary.

• The R&D Committee, together with policy experts from MNRE, should decide specific areas of R&D which will be particularly relevant for India in the coming decade.

• A call for proposal in the above areas should be put out. Some expert R&D institutions should be specifically invited to participate.

• Funded projects at different institutions should be well co-ordinated to ensure national level goals are being pursued.

• Collaboration with industry is highly desirable in areas of applied research. MNRE may fund industry as well as academic institutions together in such cases.

• Some ‘blue skies’ research should also be funded, but not more that 10-15% of the overall solar R&D budget.

No further action is required as the project is completed.

Solar Thermal

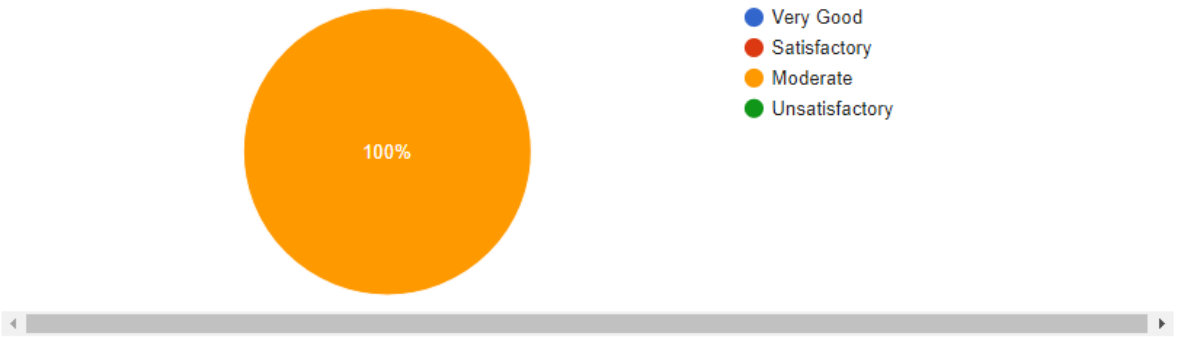
Project No. 1 - System Design, Erection, Testing & Commissioning of 40 kWth and 10 kWe pilot plant aiming at the Feasibility Study of MWe Scale Concentrated Solar Thermal Plant integrated with 24 x 7 Thermal Energy Storage (ST)

Sl. No.	Items	
1	Title of the project	System Design, Erection, Testing & Commissioning of 40 kWth and 10 kWe pilot plant aiming at the Feasibility Study of MWe Scale Concentrated Solar Thermal Plant integrated with 24 x 7 Thermal Energy Storage.
2	Principle Investigator Co-principle Investigator	PI: Dr. Vinod Krishna Sethi, DG (research) RKDF University CO-PI: Dr. Partha S Dutta, Professor (Electrical, Computer & Systems Engg.) & Dy. Director , RPI University, NY, USA
3	Name of the Implementing Institution/industries	Ram Krishna Dharmarth Foundation University, Gandhi Nagar, RGPV Campus, Bhopal 462033
4	Details of the project	
	Date of the sanction	March 29,2019 vide letter no. 15/01/2018-19/ST
	Cost of the project with details of the cost sharing with other institutions/industries	-RKDF share - Rs.22.50 Lakhs - RPI (USA) share - Rs. 20.00 Lakhs -MNRE share - Rs.39.00 Lakhs (Equipment-Rs.31 Lakhs+ manpower-Rs. 6 Lakhs + consumables-Rs. 1Lakh + local travel -Rs. 1 Lakhs); Total cost - Rs.81.50 Lakhs
	Duration	18 Months starting from April 2019
	Date of completion	September 30, 2020 extended upto March 2021
	Funds released and utilized (year-wise)	29 March 2019 … Rs. 10.00 Lakhs (29.03.2019) 27 Feb 2020 … Rs. 10.00 Lakhs (27.02.2020) Rs. 15.00 Lakhs (10.11.2020)
	Status of UCs/Audited statement of accounts	Utilization Certificates (Audited Statement) & SOE submitted
	Unspent Balance with PIs	NIL
5	Sanctioned objectives	➢ To conduct a comprehensive economic feasibility analysis of a MWe (electrical) scale concentrated solar thermal power (CSP) plant integrated with 24x7 thermal energy storage ➢ Engineering design, installation and testing of a pilot plant with 40 kWth (thermal) capacity / 10 kWe (electrical) integrated with 24x7 Thermal Energy Storage (TES)
6	Expected output as per sanction	1:Design and Economic Feasibility Analysis of a MWe capacity solar thermal energy storage system with volumetric energy density exceeding 300 kWh/m3, capable of operating at high temperatures up to 1 000 degree C. 2:Commissioning and field data on energy storage capacity, energy losses, steam generation and electrical power generation (using steam turbine) of a pilot plant with 40kWe Capacity 3:Joint IPR from the research and Research papers
7	Status of the project/achievements including research publications in Journals/patents/prototype	The Objective wise Project status/achievement 1 Feasibility study of a Dispatchable 1.5 MW_e Solar Power System with TES of 60 MW_{th} has completed 2: Engineering design, installation and testing of a pilot plant with 40

	development	kW_{th} (thermal) capacity completed. Steam blowing and trial run of 100 hrs. completed , Prototype:- Patents generated:- Paper published:- 06 nos.

Project No. 1: Opinion on the overall of the progress for the Project: System Design, Erection, Testing & Commissioning of 40 kWth and 10 kWe pilot plant aiming at the Feasibility Study of MWe Scale Concentrated Solar Thermal Plant integrated with 24 x 7 Thermal Energy Storage by Dr. Vinod Krishna Sethi, DG (Research) RKDF University, Bhopal

2 responses



Project No 1 : Appraisal on achievement as per sanction of the Project.

2 responses

Slightly delayed; but a new project and hence can pick-up.
The progress reported is very vague to assess whether the project is progressing well or not. 6 papers have been published.

Project No 1: Recommendation with suggestion for further course of action.

2 responses

PI may be requested to expedite the progress.
The project should be continued, and assessed after the proposed completion date in March 2021.

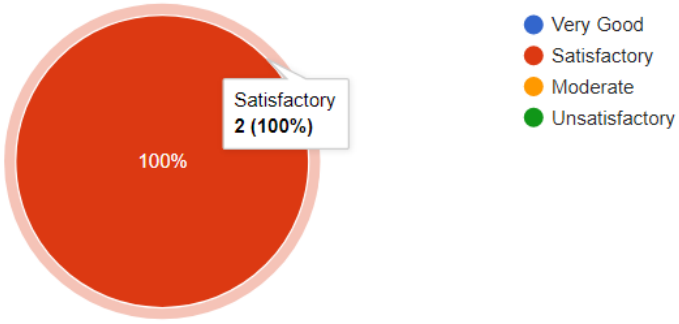
Project no 02.- Design, development and demonstration of Solar dryer suitable for drying natural rubber sheets in North-East India (ST)

<table>
<tr><td>1.</td><td>Title of the Project</td><td colspan="7">Design, development and demonstration of Solar dryer suitable for drying natural rubber sheets in North-East India</td></tr>
<tr><td>2.</td><td>Principal Investigator
Joint –Principal Investigator</td><td colspan="7">DR.(Mrs.) Subarna Maiti, Principal Scientist, CSIR-CSMCRI
Dr. Paritosh Bhattacharya, Associate Prof., NIT-Agartala</td></tr>
<tr><td>3.</td><td>Name of the Implementing Institution/Industries</td><td colspan="7">CSIR-Central Salt & Marine Chemicals Research Institute, Bhavnagar, Gujrat & NIT, Agartala, Tripura</td></tr>
<tr><td>4.</td><td colspan="8">Details of the Project</td></tr>
<tr><td></td><td>Date of the sanction</td><td colspan="7">Sanction No. 15/27/2016-17/ST dated 30-06-2017</td></tr>
<tr><td></td><td>Coast of the project with details of the cost sharing with other Institutions/industries</td><td rowspan="2">Sanction Head</td><td colspan="6">Sanctioned Amount by MNRE (in lakhs)</td></tr>
<tr><td></td><td></td><td colspan="3">CSIR-CSMCRI</td><td colspan="3">NIT-A</td><td rowspan="2">Grand Total</td></tr>
<tr><td></td><td></td><td>1</td><td>2</td><td>3</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td></td><td></td><td>Equipment</td><td>0.4</td><td>2.0</td><td>-</td><td>4.0</td><td>3.6</td><td>-</td><td>10.0</td></tr>
<tr><td></td><td></td><td>Manpower</td><td>3.6</td><td>3.6</td><td>4.2</td><td>-</td><td>-</td><td>-</td><td>11.4</td></tr>
<tr><td></td><td></td><td>Total Cost</td><td>4.0</td><td>5.6</td><td>4.2</td><td>4.0</td><td>3.6</td><td>-</td><td>21.4</td></tr>
<tr><td></td><td>Duration</td><td colspan="7">3 years</td></tr>
<tr><td></td><td>Date of Completion</td><td colspan="7">30-06-2020</td></tr>
<tr><td></td><td>Funds released and utilized (year-wise)</td><td>FY</td><td colspan="3">Funds released (Rs.)</td><td colspan="3">Utilization (Rs.)</td></tr>
<tr><td></td><td></td><td>2017-2018</td><td colspan="3">8,00,000.00</td><td colspan="3">5,30,961.00</td></tr>
<tr><td></td><td></td><td>2018-2019</td><td colspan="3">-</td><td colspan="3">2,34,239.00</td></tr>
<tr><td></td><td></td><td>2019-2020</td><td colspan="3">9,20,000.00</td><td colspan="3">7,42,800.00</td></tr>
<tr><td></td><td></td><td>2020-21</td><td colspan="3">-</td><td colspan="3">1,99,374.00</td></tr>
<tr><td></td><td>Status of UCS/Audited Statement of accounts</td><td colspan="7">Audited UC/SOE submitted for
2017-18 on 06.05.2018
2018-19 on 10.05-2019
2019-19 (April, May 2019) on 14.06.19
2019-20 (June 2019 to March 2020) on 22.06.2020
2020-20 (April, May, June 2020) on 22.06.2020</td></tr>
<tr><td></td><td>Unspent Balance With PI</td><td colspan="7">Rs. 12,626.00</td></tr>
<tr><td>5.</td><td>Sanctioned objectives</td><td colspan="7">Development of a mathematical drying model for drying of rubber sheet based on preliminary literature based data
Design and development of a 1 kg/day scale convective solar dryer suitable for drying of naturally produced sheet rubber based on the mathematical model
Installation of the fabricated small scale dryer in the premises of NIT, Agartala
Testing & performance evaluation in the ambient conditions of Tripura, North –East India
Designing a scaled up solar dryer of 5 kg/day capacity based on performing of the smaller dryer
Fabrication of the 5 kg/day dryer and installation in local community of Tripura where the rubber sheets are dried.
Comparison of drying rates, quality etc. for solar dryer dried and conventionally dried rubber sheets.
Techno-economic evaluation based on performance
Handing over the solar dryer to local co-operative and industry attraction</td></tr>
</table>

6	Expected output as per sanction	1Kg solar dryer 5 Kg soalr dryer
7.	Status of the project/Achievements including research publications in Journals/patents/prototype development	1. Majority of the objectives have been achieved (No. 1-7 completed, 8&9 Partially completed). 2. Publications – 02 3. HR – 01 M. Tech student dissertation completed and 01 project JRF pursuing PhD 4. (A) 1 Kg solar dryer developed and installed at CSIR-CSMCRI (B) 5 Kg solar dryer installed at NIT Agartala for drying of natural rubber sheets Prototype:- Patents generated: 1 nos -applied for

Project No. 2: Opinion on the overall of the progress for the Project: Design, development and demonstration of Solar dryer suitable for drying natural rubber sheets in North-East India by DR.(Mrs.) Subarna Maiti, Principal Scientist, CSIR-CSMCRI, NIT, Agartala, Tripura

2 responses



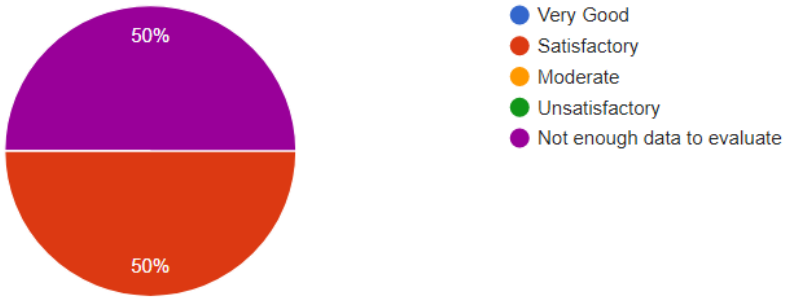
Project no. 3- "**Development of High Efficiency Receiver for Supercritical CO2 Integrated with Static Focus Parabolic Dish" (ST)**

Sl. No.	**Items**	Details	
1	Title of the project	"Development of High Efficiency Receiver for Supercritical CO2 Integrated with Static Focus Parabolic Dish"	
2.	Principal Investigator Co-principal Investigator	Prof. Pradip Dutta, IISc Bangalore 080-22933521,9845010520; pradip@iisc.ac.in Dr. B.K. Jayasimha, WRST, 941631798, bkjsimha@yahoo.co.uk	
3.	Name of the Implementing Institution/Industries	Implementing Institution Indian Institute of Science (IISc), Bangalore- 560012 Collaborating Institution World Renewal Spiritual Trust (WRST), Abu Road- 307510	
4.	Details of the Project		
	Date of the Sanction	08th Sep, 2016 (Receipt of 1st installment at IISc)	
	Cost of the project with details of the cost sharing with other institutions/industries	Indian Institute of Science I Year : Rs. 106.83 lakhs II Year: Rs. 78.83 lakhs III Year: Rs. 37.83 Total: Rs. 223.49 lakhs	WRST Mt. Abu I Year: Rs. 89.00 lakhs II Year: Rs. 15.00 lakhs III Year: Rs. 15.00 lakhs Total: Rs. 119.00 lakhs
	Duration	3 Years	

	Date of completion	Scheduled completion: 07th Sep, 2019	
	Funds released and utilized (Year-Wise)	Funds received	1st Installment Rs. 130 lakhs (IISc)+96 lakh (WRST)
		Funds Utilized	Rs. 2,31,33,350 lakhs (till 7 September 2019)
		Refunded to MNRE	Rs. 9,02,877 (March 2019)
	Status of UCs/Audited statement of accounts	Submitted to MNRE as of 31.03.2019 (New UC as of 31/3/2020 under preparation)	
	Unspent Balance with Pls	(-) 5,33,350 (7.9.2019)	
	Balance funds to be received as per sanction	For IISc: Rs. 93.49 lakhs + For WRST: Rs. 23 lakhs	
5.	Sanctioned objectives	To design and develop a hybrid volumetric receiver which uses the high absorption efficiency of volumetric receiver with porous honeycomb and has tubular passages embedded in the heated honeycomb for air and pressurized CO2 Flow. Prototyping a medium scale volumetric s-CO2 receiver and establishing design methodology for scale-up to industrial scale. For performance testing of the receiver, Pls aim to develop two optical systems.	
6.	Expected output as per Sanction	Prototype hybrid volumetric receiver and tubular cavity receiver Laboratory test facility for receiver with solar simulator and integrated with compressed air loop and s-CO2 test loop, Small-scale high flux solar simulator with concentrator systems.	
7.	Status of the project/achievements including research publications/	Prototype:- Patents generated:- Paper published:- 5 nos.	

Project No. 3: Opinion on the overall of the progress for the Project: "Development of High Efficiency Receiver for Supercritical CO2 Integrated with Static Focus Parabolic Dish" by Prof. Pradip Dutta, IISc Bangalore

2 responses



Project No 3 : Appraisal on achievement as per sanction of the Project.

2 responses

Objectives are reasonably well achieved.

No data presented (except 2 papers published) to compare actual output to sanctioned.

Project No 3: Recommendation with suggestion for further course of action.

2 responses

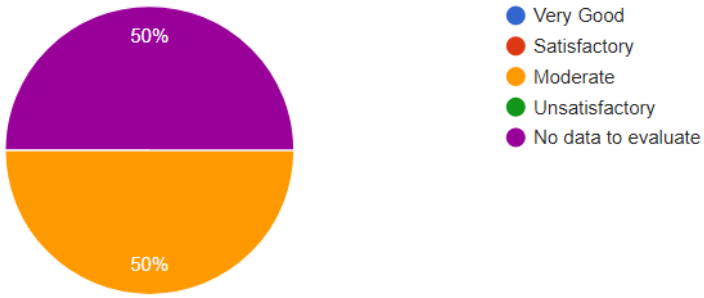
Balance funds may be released and extension till December 2021 may be given. The PIs may be requested to expedite the completion of the project.
This is an important activity, and has a good academic researcher teaming up with a serious player in the solar thermal field. It should be continued and taken to its logical conclusion.

Project No-4. Development of Supercritical CO2 Turbomachinery for Solar Thermal Power Plants" (ST)

Sl. No.	Item	Details
1	Title of the project and file no.	""Development of Supercritical CO2 Turbomachinery for Solar Thermal Power Plants"
2	Name of the Principal Investigator	Dr.-Ing Punit Singh, Assistant Professor, CST and ICER, IISc Bangalore
3	Name of the implementing Institution/ University/ Industry	Implementing Institution: Indian Institute of Science (IISc), Bangalore – 560012 Collaborating Institution: Triveni Turbines Limited (TTL), 12-A Peenya Industrial Area, Bangalore 560058, Karnataka
4	Date of Sanction and Completion	30.03.2017 30.03.2020 extended up to March, 2021
5	Outlay and MNRE share (Rs. In lakhs)	a. March 29,2019 vide letter no. 15/01/2018- 19/ST b. - RKDF share - Rs.22.50 Lakhs – RPI (USA) share - Rs. 20.00 Lakhs – MNRE share - Rs.39.00 Lakhs Total cost - Rs.81.50 Lakhs
6	Funds released	Rs. 20.00 lakh
7	Sanctioned objectives	1. To conceive turbomachinery of different design configurations suitable for testing and analysis on the existing test loop at IISc. The first configuration would be a decoupled pump (turbine driven) and power generator involving designing two turbines and one pump, while the second configuration will be an integrate turbine, generator and pump. 2. To select, size and develop mechanical system comprising of critical components like shaft seals and bearings of small sizes and for high speed operation. The seal in particular will to have deal with fluid pressures exceeding over 140 bar and temperatures above 500 deg C. 3. To use the laboratory investigations and develop a completely new design of the turbomachinery power block for a scaled up capacity of 500 kW to 1 MW first to be retrofitted into existing CSP steam power plants having temperatures below 5000c and second to target higher turbine inlet temperatures of 7000c
8	Expected output as per sanction	- High speed turbo-compressor drive for open air cycle - Motor driven compressor testing from 80 to 110 bar - Turbine driving the generator and compressor with net electricity of 10 to 15 kWe
9	Status of the project/achievements including research publications/	Prototype:- Patents generated:- Paper published:-

Project No. 4: Opinion on the overall of the progress for the Project: “Development of Supercritical CO2 Turbomachinery for Solar Thermal Power Plants” by Dr.-Ing Punit Singh, Assistant Professor, CST and ICER, IISc Bangalore

2 responses



Project No 4: Appraisal on achievement as per sanction of the Project.

2 responses

Somewhat delayed progress.

No data presented to compare actual output to sanction.

Project No 4: Recommendation with suggestion for further course of action.

2 responses

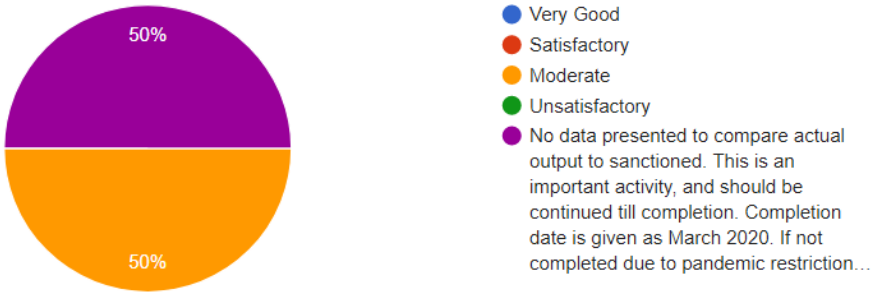
Balance funds may be released and PI may be advised to expedite the completion of the project.
This is an important activity, and should be continued till completion.

Project No.-5. Setting up facility for Calibration of Solar radiation measuring sensors and its analysis/modeling based on the ground surface measurement.

Sl. No.	Items	Details
1.	Title of the project	Setting up facility for Calibration of Solar radiation measuring sensors and its analysis/modeling based on the ground surface measurement.
2.	Principle Investigator Co-principle Investigator	Dr. Arun K. Tripathi Director General National Institute of Solar Energy Dr. Chandan Banerjee Deputy Director General National Institute of Solar Energy
3.	Name of the Implementing Institution	National Institute of Solar Energy
4.	**Details of the project**	
	Date of the sanction	Sanction order No. 15/22/2012-13/ST dated 7th June 2018
	Cost of the project with details of the cost sharing with other institutions	Rs. 1,20,76,818 with 100% MNRE support
	Duration	2 years (31St March 2018 to 31st March 2020)
	Date of Completion	31st March 2020
	Funds released and utilized (year-wise)	Total Amount released for FY 2018-19 : ₹ 25 L(Grant in aid) : ₹ 15 L(Grant for Capital Total Amount released for FY 2019-20 : ₹ 40L(Grant in aid) Amount Utilized in FY 2018-19 : ₹ 24,62,608 (Grant in aid) Amount Utilized in FY 2019-20 : ₹ 39,64,610 (Grant in aid)
	Status of UCs/Audited statement of accounts	UC & SOE for FY 2019-19 submitted.
	Unspent Balance with Pls	Grant in Aid : ₹ 35,390 Grant for Capital : ₹ 15 L
5.	Sanction objectives	Periodic Calibration of solar radiation measuring sensors of SRRA stations in Northern region. Development of Calibration protocol for improving the quality and reliability of measured solar radiation data. Estimating TMY for four distinct solar power projects sites.
6.	Expected output as per sanction	The calibration for sensors from SRRA stations would ensure the generation of the accurate, reliable investor grade solar radiation data under SRRA program. Such quality solar radiation data is useful for design of solar power projects and development of models for solar radiation forecasting studies. The calibration results of sensors of the SRRA network would enable to study the performance of the soalr radiometer under prolonged exposure conditions and drafting guidelines for calibration intervals based on the calibration results.
7.	Status of the project	Prototype:-Nil Patents generated:-Nil Paper published:-Nil

Project No. 5: Opinion on the overall of the progress for the Project: "Setting up facility for Calibration of Solar radiation measuring sensors and its analysis/modeling based on the ground surface measurement" by Dr. Arun K. Tripathi Director General National Institute of Solar Energy

2 responses



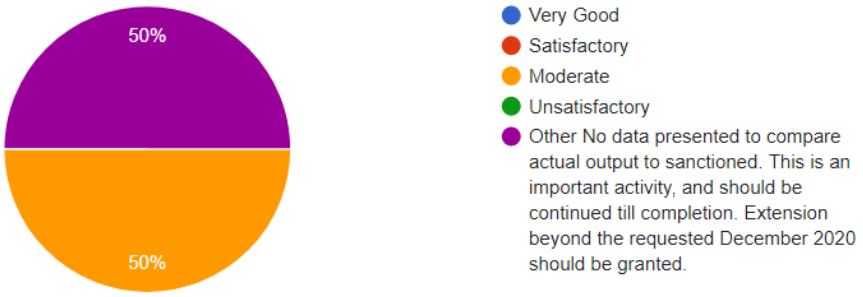
Project No. 6:- Studies on utilization of Solar Energy in Tasar Post Cocoon Technology Operations

Sl. No.	Items	Details
1.	Title of the project	Studies on utilization of Solar Energy in Tasar Post Cocoon Technology Operations
2.	Principle Investigator Co-principle Investigator	Sri Z.M.S Khan, Scientist- D,
3.	Name of the Implementing Institution	Post Cocoon Technology Section, Central Tasar Research & Training Institute, Central Silk Board, Ministry of Textiles, Government of India, Government of India, Nagri, Ranchi, Jharkhand, Pin- 835303
4.	**Details of the project**	
	Date of the sanction	October, 2016
	Cost of the project with details of the cost sharing with other institutions	Total cost: Rs. 50.73 Lakhs MNRE share: Rs. 38.73 Lakhs
	Duration	3years
	Date of Completion	September, 2019 Extension of this project was approved by MNRE vide Correspondence No. 15/28/2016- 17/ST dated 4th February, 2020 up to March, 2020. Due to present pandemic situation, another correspondence has communicated to Secretary and Director- Solar R & D, MNRE, Government of India, New Delhi vide No. CTR&TI/PMEC/Tech- 60/2020- 21/2030 dated 11th August, 2020 for further extension up to December, 2020).
	Funds released and utilized (year-wise)	Rs. 10,00,000/- (CCA) 30.09.2016 Rs. 6,23,199/- (GIA) 30.09.2016 Rs. 14,36,000/-(GIA) 30.03.2019
	Status of UCs/Audited statement of accounts	UC & SOE for FY 2019-19 submitted.

	Unspent Balance with Pls	Nil
5.	Sanction objectives	Economizing the energy consumption in Tasar post cocoon technology operations. 2. Reducing dependence on electricity supply and consumption in rural areas silk clusters. 3. Following Cleaner Production Technology processing in Tasarpostcocoon-technology operations. 4. Replacement of thigh reeling by introducing solar energy driven machines in reeling clusters of the country. 5. Drudgery reduction in machine operations. 6. Providing support to poor and marginal reelers and enhancing their profit margin.
6.	Expected output as per sanction	Modifications of the existing Reeling and Spinning Machines so that energy consumption can be reduced and thereby the same can be operated using electricity generated from solar Energy. 2. Design and fabrication of one Cooking Device and one Hot air Dryer/Stifling Chamber which can be operated using electricity generated from solar Energy. 3. Modifications of the existing Weaving Machine/Loom in order to reduce the energy consumption to be operated using electricity generated from solar Energy.
7.	Status of the project	Prototype:-Nil Patents generated:-Nil Paper published:-Nil

Project No. 6: Opinion on the overall of the progress for the Project: "Studies on utilization of Solar Energy in Tasar Post Cocoon Technology Operations" by DSri Z.M.S Khan, Scientist-D,Central Tasar Research & Training Institute, Central Silk Board, Jharkhand

2 responses



Project No. 7- R&D project entitled 1 MW electricity (3. MW) Solar Thermal Power Plant with 16 hours thermal storage for continuation operation at Mount Abu by WRST, Bombay

Sl. No.	**Items**	Details
1.	Title of the project	**R&D project entitled 1 MW electricity (3. MW) Solar Thermal Power Plant with 16 hours thermal storage for continuation operation at Mount Abu by WRST, Bombay**
2.	Principle Investigator Co-principle Investigator	Mr. GoloPilz , Advisor, Mr Jayasimha
3.	Name of the Implementing Institution	WRST, Mumbai & Mount Abu

<table>
<tr><td>4.</td><td colspan="2">Details of the project</td></tr>
<tr><td></td><td>Date of the sanction</td><td>07/10/2010</td></tr>
<tr><td></td><td>Cost of the project with details of the cost sharing with other institutions</td><td>Revised cost Rs. 81 crores
(previous total cost: Rs. 63 crores)</td></tr>
<tr><td></td><td>Duration</td><td>3years</td></tr>
<tr><td></td><td>Date of Completion</td><td>06/10/2013 and extension has been given upto March 2017 for completion and one year for performance monitoring.</td></tr>
<tr><td></td><td>Funds released and utilized (year-wise)</td><td>
<table>
<tr><td>Name of Institution</td><td>Expenditure as on today
(in crores)</td><td>Revised cost sharing (in crores)</td></tr>
<tr><td>MNRE</td><td>10.50</td><td>21.20</td></tr>
<tr><td>GIZ</td><td>14.83</td><td>31.76</td></tr>
<tr><td>WRST</td><td>20.44</td><td>28.01</td></tr>
<tr><td>Industry</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>44.77</td><td>81</td></tr>
</table>
Fund released so far: Rs. 20.50 crores by MNRE</td></tr>
<tr><td></td><td>Status of UCs/Audited statement of accounts</td><td>UC & SOE for FY 2019-19 submitted.</td></tr>
<tr><td></td><td>Unspent Balance with Pls</td><td>Nil</td></tr>
<tr><td>5.</td><td>Sanction objectives</td><td>Setting up 1 MW el. (3.5 MW) solar thermal power plant with 16 hours thermal storage for continuous operation based on parabolic dish solar concentrators designed and fabricated indigenously at an estimated solar to electric efficiency of about 12 %.
The configuration of power plant will include 750 solar dishes having a provision of thermal storage and each having 60 square meter aperture area. The estimated output of the power plant will be i) electrical power of 1 MW el. Z 8 hrs, ii) electrical power of 800 kW x 16 hrs, iii) cogeneration of 1 million liters of hot water, and iv) 8 tones of steam for 24 hrs.
Detailed report on a) technical specifications and performance of solar dish concentrator, b) solar collector field lay out and rationale behind the lay out, c) performance data for one year after installation and commissioning containing comparison of the design.</td></tr>
<tr><td>6.</td><td>Expected output as per sanction</td><td></td></tr>
<tr><td>7.</td><td>Status of the project</td><td>The Plant has been commissioned successfully.
The project is first of its kind to provide thermal storage of 16 hours and based on fully indigenously developed solar dish technology. The project has been commissioned and showed some good initial results. Trial runs are in progress and power is generating in day and night depending upon sun light (upto 07.00 AM).
This project provides enormous opportunity in terms of product development and energy storage.
60 sqm-770 no’s of reflector are erected
Turbine and generator were installed and aligned by an engineer from Siemens.
Information dissemination centre for the visitor was established and is operational on the site.
Papers published in national Journals: 2 nos,
Patents filed : 2 nos</td></tr>
</table>

		Patents generated:-Nil Prototype:-Nil

Project No. 7: Opinion on the overall of the progress for the Project: "R&D project entitled 1 MW electricity (3. MW) Solar Thermal Power Plant with 16 hours thermal storage for continuation operation at Mount Abu by WRST.

2 responses

Project No 7 : Appraisal on achievement as per sanction of the Project.

2 responses

- One of the major successes of solar thermal power generation coupled with steam generation for cooking purposes. The Sheffler collector development is a major achievement.
- Although originally sanctioned in 2010 (not sure why a 3 year project went on for 10 years), this project can be deemed to be successful, as it has accomplished a difficult objective. Besides actual commissioning of the plant, 2 papers and 2 patents have also resulted from this project.

Project No 7: Recommendation with suggestion for further course of action.

2 responses

- The Sheffler Dishes developed indigenously are of excellent design. Should be employed in other locations in the country; especially for steam generation.
- This project is deemed to be continuing, since trial runs are in progress. The final outcome should be closely tracked, as this will be one of the working solar CSP plants with storage, and should be replicated elsewhere.

Project No. 8- R&D project entitled " Unified Solar Radiations Resources Assessment Project (SRRA) by the National Institute of Wind Energy (NIWE), Chennai.

Sl. No.	Items	
1.	Title of the project	Unified Solar Radiations Resources Assessment Project (SRRA) by the National Institute of Wind Energy (NIWE), Chennai.
2.	Principle Investigator Co-principle Investigator	K.BOOPATHI Director & Division Head Research & Development, Resource data Analytics & Forecasting And Solar Radiation Resource Assessment (R&D, RDAF & SRRA) National Institute Of Wind Energy (NIWE) (Formerly CWET) Chennai-600100, Tamil Nadu, India
3.	Name of the Implementing Institution/industries	National Institute of Wind Energy (NIWE), Chennai
4.	**Details of the project**	
	Date of the sanction	30/06/2016
	Cost of the project with details of the cost sharing with other institutions/industries	Total outlay: Rs. 12.14 crore
	Duration	4 years
	Date of completion	30.03.2020 extension up to October, 2020
	Funds released and utilized (year-wise)	Rs. 119.00 Lakhs GIA30.06.2016 Rs. 158.17 Lakhs GIA 04.09.2017 Rs. 259.00 Lakhs GIA 22.03.2018 Rs. 40.78 Lakhs GIA 22.03.2017 Rs212.07 Lakhs GIA 30.03.2019 Rs. 77.00 Lakhs GIA 27.03.2020
	Status of UCs/Audited statement of accounts	Audited UC for FY 2017-18, FY 2018-19 and FY 2019-20 submitted.
	Unspent Balance with PIs	Nil
5.	Sanctioned objectives	The availability of high-quality ground measured solar radiation data in the country till 2011 was sparse, except for the compiled & published data available from the India Meteorological Department (IMD) stations and satellite data. Hence, to provide high-quality ground measured solar radiation data for the benefit of all the stakeholders involved in the promotion of the Solar sector in the country, and to collect a database of bankable and investor grade data of both solar and meteorological parameters, the SRRA project was implemented. Ground measurements of the solar and meteorological parameters are useful and handy for analyzing the performance and financial viability of any solar power projects.

6.	Expected output as per sanction	All 111 SRRA stations and 4 AMS have been established well in time, and data collection from all the SRRA stations and 4 AMS is going on. • Automatic quality control mechanism developed with the technical assistance of GIZ for the online quality control of the SRRA data. • Based on the SRRA data collected in conjunction with high-resolution satellite data, Indian Solar Atlas was developed and launched in 2015. • An SRRA data policy was framed to enable all stakeholders to access the SRRA data collected. Revenue has been generated by providing bankable and investor grade SRRA data on a commercial basis. • An international standard calibration laboratory for calibrating solar sensors have been established at three locations for in house use as well for stakeholders use. All the SRRA field solar sensors are calibrated as per the standards for maintaining the data quality and reliability. The calibration of solar sensors is being carried out periodically. • A Mobile App has been developed on the android and iOS platforms, for the benefit of the stakeholders to find out solar resources at any location in the country and information required to establish a solar power plant at the click of a button. • Conducted multiple training programs to sensitize the staff of the institution where the SRRA stations are installed for the up keeping of the station, to the solar industry for updating information, for HR development program, and also online training program under PPP mode. Conducted multiple workshops on solar radiation resource assessment for stakeholders with NREL officials and even with German Experts on data analysis, making of the solar atlas, etc. • The four AMS have been included in the elite and prestigious BSRN network of WMO. • The development of a solar power forecasting model is initiated based on the SRRA data collected in conjunction with data from solar power plants. Solar power forecasting has been mandatory as per CEA regulation for more exceptional grid management.
7.	Status of the project/achievements including research publications in Journals/patents/prototype development	All 111 SRRA stations and 4 AMS have been established well in time, and data collection from all the SRRA stations and 4 AMS is going on. • Automatic quality control mechanism developed with the technical assistance of GIZ for the online quality control of the SRRA data. • Based on the SRRA data collected in conjunction with high-resolution satellite data, Indian Solar Atlas was developed and launched in 2015. • An SRRA data policy was framed to enable all stakeholders to access the SRRA data collected. Revenue has been generated by providing bankable and investor grade SRRA data on a commercial basis. • An international standard calibration laboratory for calibrating solar sensors have been established at three locations for in house use as well for stakeholders use. All the SRRA field solar sensors are calibrated as per the standards for maintaining the data quality and reliability. The calibration of solar sensors is being carried out periodically. • A Mobile App has been developed on the android and iOS platforms, for the benefit of the stakeholders to find out solar resources at any location in the country and information required to establish a solar power plant at the click of a button. • Conducted multiple training programs to sensitize the staff of the institution where the SRRA stations are installed for the up keeping of the station, to the solar industry for updating information, for HR development program, and also online training program under PPP mode. Conducted multiple workshops on solar radiation resource assessment for stakeholders

		with NREL officials and even with German Experts on data analysis, making of the solar atlas, etc. • The four AMS have been included in the elite and prestigious BSRN network of WMO. • The development of a solar power forecasting model is initiated based on the SRRA data collected in conjunction with data from solar power plants. Solar power forecasting has been mandatory as per CEA regulation for more exceptional grid management.Prototype:- Nil Patents generated:- Paper published:- 7

Project No. 8: Opinion on the overall of the progress for the Project: "Unified Solar Radiations Resources Assessment Project (SRRA) by K.BOOPATHI Director & Division Head, the National Institute of Wind Energy (NIWE), Chennai

2 responses

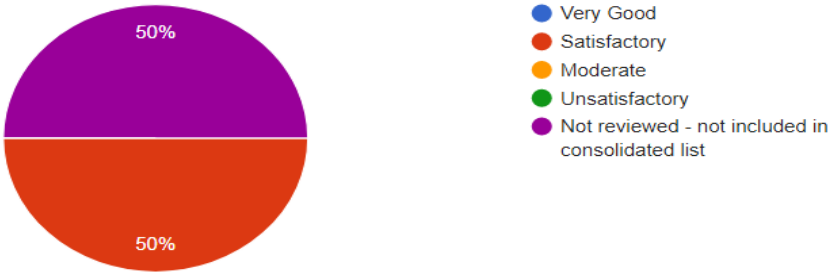
Project No. 9- R&D project "Development of a Modular Central Receiver Concentrated Solar Power Plant for Decentralized Power Generation

Sl. No.	Items	Details
1.	Title of the project	**"Development of a Modular Central Receiver Concentrated Solar Power Plant for Decentralized Power Generation**
2.	Principle Investigator	Director General, National Institute of Solar Energy, Gurugram
3.	Name of the Implementing Institution	National Institute of Solar Energy, Gurugram
4.	**Details of the project**	
	Date of the sanction	28.03.2018
	Cost of the project with details of the cost sharing with other institutions	Total cost Rs. 397.24 Lakhs
	Duration	18 months
	Date of Completion	only 55% of the work has been completed by M/s Sunborn and the remaining part of the project was taken over by NISE for completion of the project
	Funds released and utilized (year-wise)	Rs.298 Lakhs
	Status of UCs/Audited statement of accounts	UC & SOE for FY 2019-19 submitted.
	Unspent Balance with Pls	Unspent money is return
5.	Sanction objectives	The remaining objective to be achieved by taken over by NISE is as follows; Installation of 03 Heliostats is remaining in the Solar Field • Flux characterization of the heliostats and testing & optimization of their control system

		• Reliability test for Solar field commercialization • Design finalization of 1 MWth receiver •Designing and construction of a storage element, including vessel manufacturing, fill material filling, site preparation and assembling. • 1 MWth Pilot plant testing and performance evaluation: The testing of the receiver & storage subsystems, including the development of a testing plan, testing for sufficient duration at different solar conditions and performance evaluation. • Overall testing & performance evaluation of Heliostat, receiver and Thermal Storage including control strategy during startup, shutdown and transient period. • Design Simulation of commercial plant: The above test results will be used to provide a conceptual engineering design of a scaled-up power tower with an electrical of 5MWe. It will include design parameters and performance basis detailed cost estimation of both solar and power blocks.
6.	Expected output as per sanction	Same as objectives
7.	Status of the project	The PMC found that the specialized manpower required for implementation of the project was not available and could not be hired by NISE in spite of the efforts made by NISE. The site of project including control room was got cleaned and maintained by NISE. The already installed heliostats were put in operational mode manually. The PMC observed that there was no progress made by NISE in respect of the achievements of the deliverables of the project. The original implementing agency of the project i.e. Ms. SunBorn could not complete the project in time and also enhanced the project cost , the project was taken over by NISE with a target to complete the project within the sanctioned budget. In view of this the PMC recommended that claim of 1.2 crores made by Sunborn need not be considered. Since there was no significant progress made by NISE under the project till date and also due to non availability of the specialized manpower, it does not seem feasible for NISE to make the progress for achieving the target further. In view of this the committee recommended that the project should be closed and NISE may return the balance funds to MNRE. NISE should maintain installed facility and the same may be utilized for training and demonstration purpose by NISE Papers published in national

Project No. 9: Opinion on the overall of the progress for the Project: ""Development Modular Central Receiver Concentrated SolarPower Plant for Decentralized Power Generation" by Dr. Arun K. Tripathi Director GeneralNational Institute of Solar Energy

2 responses



Suggestions and Recommendations on R&D Policy

2 responses

Expert 1

Solar thermal is an important area but under-funded. It should be noted that nearly 70 percent of our energy consumption comes under thermal (heating, cooling, drying, desalination, etc.). Hybridizing and retrofitting of existing and future fossil fired thermal power plants with solar thermal should be encouraged. High efficiency- high concentration thermal storage systems need to be developed. Power blocks based on supercritical CO2, integrated with high temperature solar collection systems should be developed, may be for distributed power systems.

Expert 2

• With the proposed 300 GW target by 2030, a concentrated focus on R&D also becomes necessary.
• The R&D Committee, together with policy experts from MNRE, should decide specific areas of R&D which will be particularly relevant for India in the coming decade.
• A call for proposal in the above areas should be put out. Some expert R&D institutions should be specifically invited to participate.
• Funded projects at different institutions should be well co-ordinated to ensure national level goals are being pursued.
• Collaboration with industry is highly desirable in areas of applied research. MNRE may fund industry as well as academic institutions together in such cases.
• Some ‘blue skies’ research should also be funded, but not more that 10-15% of the overall solar R&D budget.

Wind Energy

For review of 2 nos of wind energy R&D projects, the following Panel of Expert was formed:-

Panel: 4

Wind Energy (2 nos of projects): Panel: 4

1. Dr. Nilanjan Saha, IIT Madras
2. Dr NS Prasad, TERI, New Delhi

The Panel of Experts reviewed the 2 nos. wind energy projects in detailed manner and an online feedback form was filled by all the Experts of Panel 4 and given the opinion on the projects along with appraisal on achievements as per sanction of the projects and Recommendation with suggestion for further course of action.

Project no.-1 Met-Ocean Measurements (Wind, Wave, Tide, Current, Water Level, etc.,) at Gulf of Khambhat and Gulf of Mannar for fostering the growth of offshore wind in the country

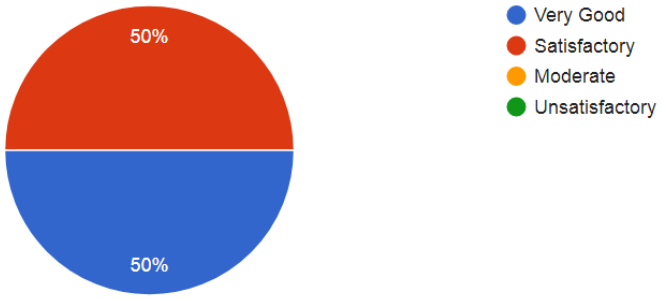
<table>
<tr><td>1</td><td>Title of the project
(with File No.)</td><td>Met-Ocean Measurements (Wind, Wave, Tide, Current, Water Level, etc.,) at Gulf of Khambhat and Gulf of Mannar for fostering the growth of offshore wind in the country.
(WRA/CF/MOM/2018)</td></tr>
<tr><td>2</td><td>Principle Investigator
Co-Principle Investigator</td><td>Principle investigator:
Dr. Rajesh Katyal, DDG & Division Head, WSOM
Co-Principle Investigator
Mr. B. Krishnan, Assistant Director (Technical), WSOM
Mr. J. Bastin, Deputy Director (Technical), WSOM</td></tr>
<tr><td>3</td><td>Name of the Implementing Institution/ Industry</td><td>National Institute of Wind Energy, Chennai</td></tr>
<tr><td>4</td><td>Details of the project
Date of sanction
Cost of the project with details of cost sharing with other institutions/industries
Duration
Date of completion
Funds released and utilized(year-wise)
Status of UCs/ Audited statement of accounts.</td><td>MNRE Sanction Order No: 226 / 1 2018 – Wind dated 29.03.2018.
INR 44.64 Crores (No sharing with other institutions/industries)
3 Years (April 2018 – March 2021).
31st March 2021 (Extension sought from PMC)
Fund released and utilized (year -wise)
<table>
<tr><th>Financial year</th><th>Capital INR</th><th>Revenue INR</th></tr>
<tr><td colspan="3">Fund Released</td></tr>
<tr><td>FY 2018-19</td><td>4 cr.</td><td>6 Cr.</td></tr>
<tr><td>FY2019-20</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">Funds Utilized</td></tr>
<tr><td>FY 2018-19</td><td>-</td><td>-</td></tr>
<tr><td>FY2019-20</td><td>2.18 Cr.</td><td>4.09 Cr.</td></tr>
<tr><td colspan="3">Carry Forward</td></tr>
<tr><td>FY 2020-21</td><td>1.82 Cr.</td><td>1.91 Cr.</td></tr>
</table>
Utilization certificates up to 2019-20 have been submitted and the same has been uploaded in MNRE service web portal .</td></tr>
<tr><td>5</td><td>Sanctioned objectives</td><td>To carry out the Met ocean measurements at Gulf of Khambhat and Gulf of Mannar for fostering the growth of offshore wind in the country along with oceanographic measurement.
To demarcate offshore wind energy blocks for International competitive bidding</td></tr>
<tr><td>6</td><td>Expected output as per sanction.</td><td>LiDAR and Oceanographic measurement for sufficient period towards quantifying the wind potential and understanding the sea state conditions of the site will result in efficient demarcation of the offshore wind energy blocks for International Competitive Bidding.</td></tr>
<tr><td>7</td><td>Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.</td><td>Selection of Sites has been identified for both (Gujarat & Tamil Nadu) proposed LIDAR locations
The procurement of 4nos of Remote sensing device (LiDAR) has been completed, validation underway
Geo-technical investigation successfully completed at two new LiDAR locations at Zone A1 and B2 in Gulf of Khambhat off Gujarat coast.
Monopile design/ design basis report for Offshore structure was successfully completed based on geotechnical results and third party vetting of design report is also completed
E-Tender floated for the Supply &Fabrication and installation of monopile structure at Zone A1 and B2.
E-tender for Geo-technical investigation has been floated for two LIDAR locations off the Tamil Nadu coast and two bidders have submitted their bids and technical evaluation is underway.
E-Tender floated for the “Procurement of 6nos of Oceanographic sensors packages (Water level, Wave, Current etc.,)
The clearance protocols for both (Gujarat & Tamil Nadu) proposed LIDAR locations were obtained from different central and state level ministries and awaiting clearances from the Ministry of external affairs(MEA) and necessary follow up action has been taken to expedite.</td></tr>
</table>

		Prototype:- Patents generated:- Paper published:-

The online detailed review response on each project has been received which are as follows:-

Opinion on the overall of the progress of the Project No. 1: Met-Ocean Measurements (Wind, Wave, Tide, Current, Water Level, etc.,) at Gulf of Khambhat and Gulf of Mannar for fostering the growth of offshore wind in the country by Dr. Rajesh Katyal, DDG & Division Head, NIWE, Chennai

2 responses



Project No. 1: Appraisal on achievement as per sanction

2 responses

- The project, with good ovedrall objective and aim, has been undertaken well. The milestoes of the project have been completed. However, due to COVID19 the progress for the past 8-9 months is deterred.
- The PIs have again taken up an important project of mapping offshore wind potential for the Gujarat and Tamil Nadu region. These regions have different climate effects and therefore the wind potentials are different. Geotechnical information is important for these locations, which the PIs are performing. These will be useful for offshore wind farm projects and for this project for LIDAR installation. The PIs have identified suitable locations in the offshore area where the LIDAR instruments can be installed. The wind measurements are completed in Gujarat offshore where the homogenous pattern of wind is obtained. Since the number of LIDARs are limited, the PIs are performing Geotechnical investigations are taken at suitable locations in Tamil Nadu in various zones. Then they will install LIDARs at the two locations.

Project No. 1: Recommendations with suggestion for further course of action

2 responses

- The further activities of the project need to be continued as planned, to get good technical data to support the off-shore development.

- Without doubt, this is an important landmark project for the country for developing offshore wind farms. Offshore wind is the future for the country due to enormous potential and also our prior knowledge in oil and gas field. The PIs are applauded for the task of collecting geotechnical investigation at specific locations as well as wind-data collection. Therefore, the monitoring committee should persuade the PIs to continue offshore LIDAR measurement along with providing appropriate manpower, and funding to clear the hurdles faced. All countries have started collecting 10 year data and PIs should be requested to keep on continuing the measurements at other locations so as to make India energy free.

Project no.-2 Integrated Wind and Solar Resource Assessment through Mapping and Measurements

<table>
<tr><td>1</td><td>Title of the project

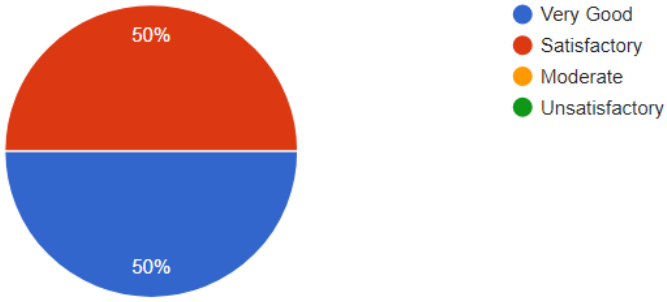
(with File No.)</td><td>Integrated Wind and Solar Resource Assessment through Mapping and Measurements</td></tr>
<tr><td>2</td><td>Principle Investigator</td><td>Dr. Rajesh Katyal, DDG & Division Head, WSOM</td></tr>
<tr><td></td><td>Co-Principle Investigator</td><td>A. Hari Bhaskaran, Deputy Director, WSOM
J. Bastin, Deputy Director, WSOM
Former Co-PIs:
Dr. G. Giridhar, DDG & Group Head, SRRA (Retd)*
J. Bastin, Assistant Director, WSOM
Prasun Kumar Das, Assistant Director, SRRA *
*Due to the superannuation of Dr. G. Giridhar and resignation of Shri. Prasun Kumar Das, the Co-PIs have been changed</td></tr>
<tr><td>3</td><td>Name of the Implementing Institution/ Industry</td><td>National Institute of Wind Energy (NIWE), Chennai</td></tr>
<tr><td>4</td><td>Details of the project</td><td></td></tr>
<tr><td></td><td>Date of sanction</td><td>226/1/2018-Wind, dated 29/03/2018
226/1/2018-Wind, dated 07/05/2018</td></tr>
<tr><td></td><td>Cost of the project with details of cost sharing with other institutions/industries</td><td>Rs. 17.99 Crores (No sharing with other institutions/industries)

Capital: Rs. 16.00 Crores
Revenue: Rs. 1.99 Crores</td></tr>
<tr><td></td><td>Duration</td><td>3 Years</td></tr>
<tr><td></td><td>Date of completion</td><td>31.03.2021 (Time Extension sought from the PMC)</td></tr>
<tr><td></td><td>Funds released and utilized (year-wise)</td><td>
<table>
<tr><td>Year</td><td>Capital (Rs.)</td><td>Revenue (Rs.)</td></tr>
<tr><td colspan="3">Funds Released</td></tr>
<tr><td>2018-19</td><td>2,86,00,000</td><td>70,00,000</td></tr>
<tr><td>2019-20</td><td>-</td><td>-</td></tr>
<tr><td>2020-21</td><td>-</td><td>-</td></tr>
<tr><td>Total</td><td>2,86,00,000</td><td>70,00,000</td></tr>
<tr><td colspan="3">Funds Utilized</td></tr>
<tr><td>2018-19</td><td>-</td><td>1,06,079</td></tr>
<tr><td>2019-20</td><td>87,57,248</td><td>41,13,632</td></tr>
<tr><td>Total</td><td>87,57,248</td><td>42,63,206</td></tr>
</table>
</td></tr>
<tr><td></td><td>Status of UCs/ Audited statement of accounts.</td><td>Utilization certificates up to 2019-20 have been submitted. The same has also been uploaded in MNRE service portal .</td></tr>
</table>

5	Sanctioned objectives	Preparation of indicative Renewable Energy (Wind & Solar) potential maps through advanced numerical meso-scale modelling techniques Validation of potential maps with integrated wind and solar and remote sensing in-situ ground measurements by using Model Output Statistics (MOS) bias correction techniques to enhance the accountability of the maps
6	Expected output as per sanction.	Wind potential map at 120m agl Papers related to long term wind correction Publications on meso map bias correction Data Bank for Hybrid (Wind & Solar) Farms development Papers related to Vertical Extrapolation by using Remote Sensing Devices Wind – Solar Hybrid Map Wind Potential Map at 150m agl Publications on topographical influences on SoDAR measurement Publications on meso-map correction in varying terrain conditions
7	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	The 120m Wind Potential map has been successfully prepared Hybrid (Wind + Solar) map at 120m agl has been successfully prepared Integrated wind solar measurements at 25 locations in the first phase of the project are under execution. Prototype:- Patents generated:- Paper published:-

Opinion on the overall of the progress of the Project No. 2: Integrated Wind and Solar Resource Assessment through Mapping and Measurements by Dr. Rajesh Katyal, DDG & Division Head, WSOM, NIWE Chennai

2 responses



Project No. 2: Appraisal on achievement as per sanction 2 responses

- The project, with good overall objective and aim, has been undertaken well. The milestoes of the project have been completed. However, due to COVID19 the progress for the past 8-9 months is deterred.
- India has good potential for onshore wind alongwith solar energy. This project provides the wind and solar maps throughout the country. These maps are necessary for Indian government for leasing out the various land areas in India. The PIs have procured the LIDARs and SODARs for measurement, however, due to ongoing pandemic these sensitive instruments could not be procured, or installed. Once proocured, the PIs will be able to start recordings and generate maps for the wind and

solar potential across the country. Not only that, the measurements initially carried out using 100m masts are now being extended for 150m for wind-solar maps. These data will be a good gold mine for future development (verification and validations of wind-shear for tall masts) of renewable energy map of India. It will also attract potential industrialists to invest in these sector along with banking sectors. Therefore, I strongly urge the PIs to continue use these masts for long term collection of data.

Project No. 2: Recommendations with suggestion for further course of action

2 responses

- The further activities of the project need to be continued as planned. May be the Ministry can offer scope to estimate more no. of sites.
- The project should be continued and the PIs should be encouraged to continue collection of data for longer periods. Collection of these large scale data and filtering unwanted ones is a huge job and I applaud the enthusiasm shown by PIs in this laborious task of monitoring the data. If required, an appropriate extension should be given for even long term collection of data for better understanding of the variation of intensity (wind/solar). The committee should fund extra amount in the project for setting up additional masts rather than shifting the masts from one place to another.

Suggestions and Recommendations on Wind Energy Thrust area and R&D Policy

2 responses

Expert 1

Support for off-shore development is much needed. Keeping Atmanirbharbharat aims in view encouraging indigenous development and capabilities may be of great need. Solar - Wind hybrid projects will provide the much needed impetus to achieve the major share of RE in the mix of supply options.

Expert 2

Extremely good and important projects for development of onshore and offshore Wind Energy In India. As onshore wind potential is less, it is coupled with solar projects. The MNRE R&D policy should be made must for offshore wind policy as most future vehicles, ships, etc will be electric and only offshore wind will suffice the same. Already European countries have started producing green vehicles and therefore R&D offshore wind policy should be aligned accordingly if necessary by funding to CFTIs as DST.

Bio-Gas

For review of 3 nos of Biogas R&D projects, the following Panel of Expert 3 was formed:-

Panel 3

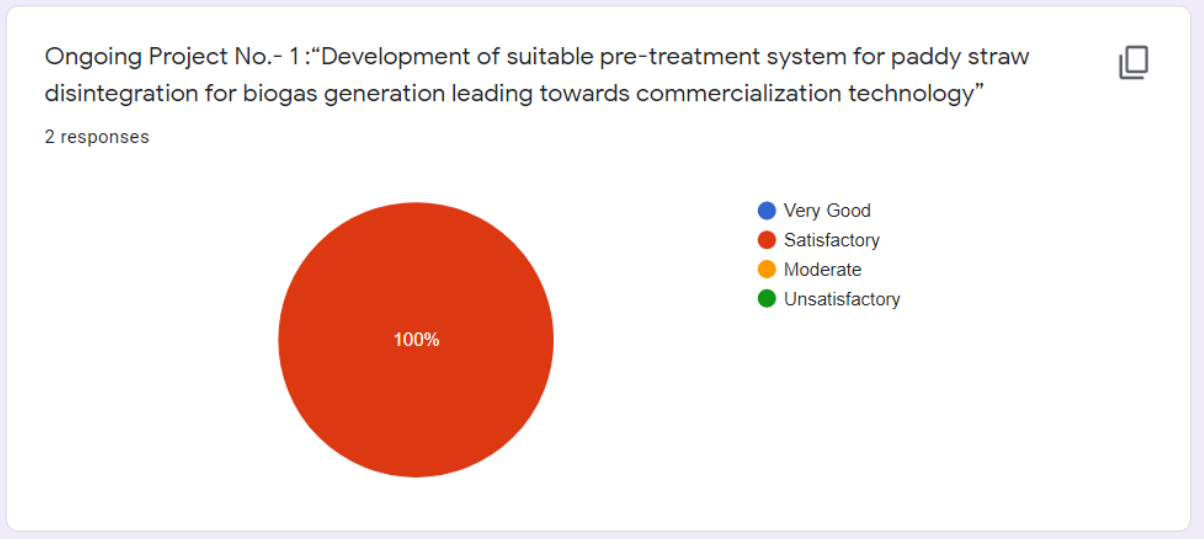
1. Dr. Manju Sharma, Institute of Chemical Technology, Mumbai
2. Dr. Shailey Singhal University of Petroleum & Energy Studies, Dehradun.

The Panel of Experts reviewed the 3 nos. Biogass R&D projects were reviewed in detailed manner and held a meeting on dated 10.01.2021, in which a detailed discussion was done on the projects.

A online feedback form was filled by all the Experts of Panel 3 and given the opinion on the projects along with appraisal on achievements as per sanction of the projects and Recommendation with suggestion for further course of action.

Project no.- 1 "*Development of suitable pre-treatment system for paddy straw disintegration for biogas generation leading towards commercialization technology"*

1	Title of the project (with File No.)	Development of suitable pre-treatment system for paddy straw disintegration for biogas generation leading towards commercialization technology. (File No.19-13/2014-15 (Biogas R&D) dated 29.03.2017
2	Principle Investigator Co-Principle Investigator	PI: Prof. (Dr.) Virendra Kumar Vijay, CRDT, IIT Delhi Co-PI: Dr. P.M.V. Subbarao Professor, IIT Delhi, Dr. Ram Chandra, Scientist, IIT Delhi
3	Name of the Implementing Institution/ Industry	Centre for Rural Development & Technology, Indian Institute of Technology, Delhi
4	Details of the project Date of sanction Cost of the project with details of cost sharing with other institutions/industries Duration Date of completion Funds released and utilized(year-wise) Status of UCs/ Audited statement of accounts.	 Date of sanction: 29.03.2017 Cost of the project: ₹49,77,440/-, No Sharing with other Institutions Duration: 2 years. Further extended up to 31.01.2021. Date of completion: 31.01.2021 Funds released: ₹37,00,000 /-. Funds utilized: ₹34,38,042 /- Status of UCs: UC and SoE received for an amount ₹34,38,042 /-.
5	Sanctioned objectives	To conduct studies on assessment of biomethane potential of paddy straw and biomass characterization. Pretreatments of paddy straw, evaluation and comparison of biogas production potential at laboratory and field scale anaerobic reactors. Technical and economic feasibility evaluation of the pretreatment processes for its commercial application.
6	Expected output as per sanction.	An optimised process for pretreatment and biomethanation of paddy straw for field scale implementation for higher methane content and easy digestion. Technology developed will be promoted to paddy cultivators on promotional basis with funds from the ministry as an extension of this project. A patent of technology developed is expected at the end of the project along with 02 international publications. PhD will also be awarded to JRF against the successful completion of the project.
7	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	Project is ongoing. 2 objectives have been successfully completed and third objective is underway. PMC has reviewed the progress Dec, 2019 and recommended for extension up to 31.01.2021. Papers Published: 2 papers have been published in International Journals of Repute/Conference. Prototype:- Patents generated:-



Project 1: Appraisal report on achievements as per sanction of the project:

2 responses

- Work has been carried out as per objectives, and as per PCR, last objective is in progress. In the list of sanctioned objectives, 2nd objective speaks about 'pretreatments' of paddy starw, which indicates that various pre-treatment techniques will be explored for delignifying paddy straw and then the process will be optimized, but in PCR, direct hydrothermal route is utilized for this purpose.
- Thoroughly worked objectives in terms of detailed aspects needed for the work.

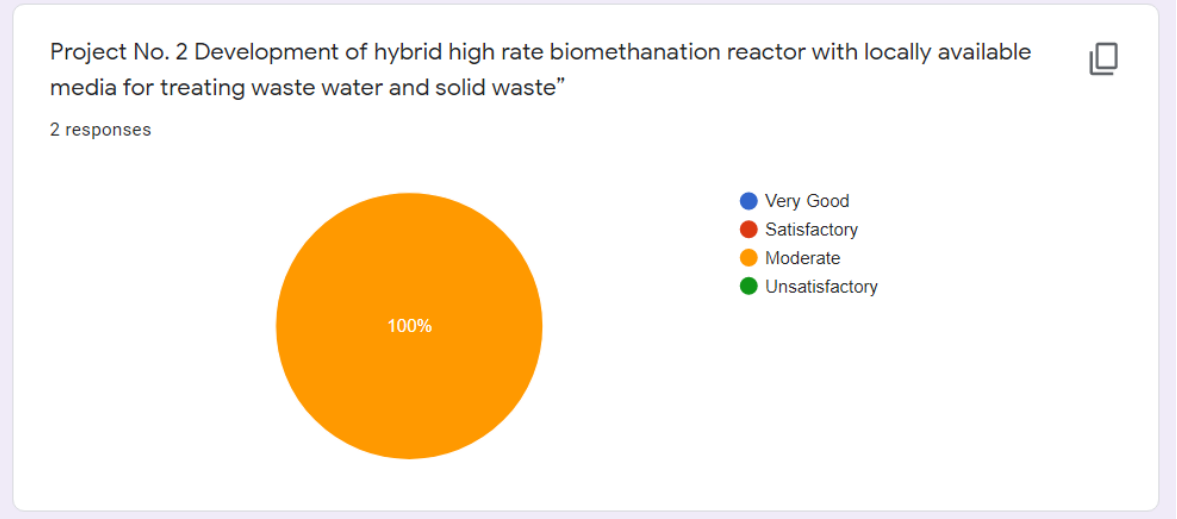
Project 1: Recommendations with suggestion for further course of action

2 responses

- Area is good and needs to be firmed up for bringing up at larger scale. Following are the suggestion towards completing the project: 1. Completion of last objective within stipulated duration. 2. Final PCR should reflect the efforts put on all the pre-treatment techniques attempted for paddy straw as a part of this project, as mentioned in sanctioned objetcives.
- HTT treatment does not seem economically feasible due to 50 % energy loss. The overall process needs to be evaluated for its commercial feasibility concerning the overall OPEX and CAPEX cost for pilot scale biogas plant including HTT and biogas digester modules. Besides, the focus should always be on the design and development of a decentralized model.

REVIEW OF COMPLETED R&D PROJECTS SUPPORTED BY MINISTRY IN BIOGAS TECHNOLOGY

1	Title of the project (with File No.)	Development of hybrid high rate biomethanation reactor with locally available media for treating waste water and solid waste" (File No.19-1/2013-R&D/BE dated 27.03.2014)
2	Principle Investigator Co-Principle Investigator	PI: Dr. (Prof.) S. Pugalendhi, Co-PI: Dr. P. Doraisamy, Dr. J John Gunasekar
3	Name of the Implementing Institution/ Industry	Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Coimbatore
4	Details of the project Date of sanction Cost of the project with details of cost sharing with other institutions/industries Duration Date of completion Funds released and utilized(year-wise) Status of UCs/ Audited statement of accounts.	 Date of sanction: 28.03.2014 Cost of the project: ₹59,32,500/-, No Sharing with other Institutions Duration: 2 years. Further extended up to 31.03.2017 and 30.06.2018. Date of completion: 30.06.2018 Funds released: ₹44,00,000 /-. Funds utilized: ₹46,80,235 /- Status of UCs: UC and SoE received for an amount ₹46,80,235 /-.
5	Sanctioned objectives	To dispose and treat the waste and solid waste in an environmental friendly way. To identify suitable locally available media for enhanced activities of biomethanation To explore the possibility of using the treated effluent for irrigation. To develop cost effective simple and efficient waste water treatment system through hybrid big rate bio-methanation process To demonstrate and from the stake 110lders in the promotion of waste water and soild waste treatment system for wider adoption. To study the livelihood, socioeconomic, digester output and efficiency.
6	Expected output as per sanction.	Development of standard high rate bio-methanation reactor for treating waste water (maximum capacity of each reactor 1 lakh liter per day) and solid waste (with maximum capacity 50 kg. per day. Four reactors will be developed for the purpose. The gas generated from the plant comprising from reactor will be utilized to run generator for power generation
7	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	Project is completed and PCR has been received. The PCR was sent to 3 experts and comments from 2 experts have been received as satisfactory. Papers Published: 4 papers have been published in International Journals /Conference. The Project was monitored by RDSPAC and the completion report will be evaluated in the next meeting of RDSPAC. Prototype:- Patents generated:-



Project 2: Appraisal report on achievements as per sanction of the project:

2 responses

- Work done during the project is satisfactory, however is bit slightly dispersed in the PCR. Further, development of activated charcoal from various biomass could not present any improvement in adsorption efficiency, so development of cost-effective technique is not clear from the findings.
- Results achieved as per the sanctioned objectives. However, the UASB reactors developed in the process are still unable to high OLR. There already exists reports on wastewater treatment using UASB digesters and these UASBs have handled OLRs of upto 30 kg COD/m3. day.

Project 2: Recommendations with suggestion for further course of action

2 responses

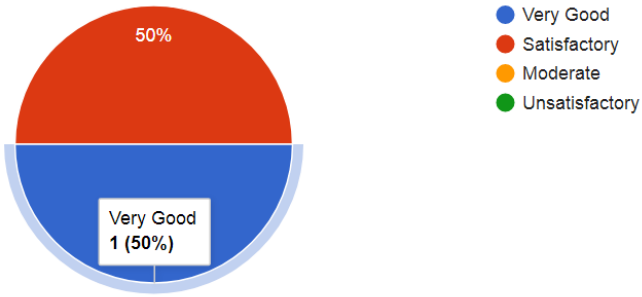
- Studies need to be validated and efforts need to be made to further strengthen the outcome. However, if found promising, can be scaled up for multiplying at larger level, which can address the problem of waste water and solid waste by co-digestion.
- The designed high rate UASB digesters should be evaluated further for higher OLRs. The focus should be on the development of decentralized models for waste treatment rather than community-based models as the need of the hours is to address the issues of the masses.

Project No. 03:- Development & performance evaluation of a 3 kWe Biogas based power generation system utilizing Lignocellular biomass"

1	Title of the project (with File No.)	Development & performance evaluation of a 3 kWe Biogas based power generation system utilizing Lignocellular biomass" (File No.19-11/2014-R&D/BE, dated 13.05.2015)
2	Principle Investigator Co-Principle Investigator	PI: Dr. (Prof.) Pinakeswar Mohanta Co-PI: Dr. Niranjan Sahoo
3	Name of the Implementing Institution/ Industry	Dept. of Mechanical Engineering, IIT Guwahati
4	Details of the project Date of sanction Cost of the project with details of cost sharing with other institutions/industries Duration Date of completion Funds released and utilized(year-wise) Status of UCs/ Audited statement of accounts.	Date of sanction: 13.05.2015 Cost of the project: ₹29,27,400 /-. No Sharing with other Institutions Duration: 2 years. Further extended up to 31.07.2018. Date of completion: 31.07.2018 Funds released: ₹22,29,000 /-. Funds utilized: ₹22,28,798 /- Status of UCs: UC and SoE received for an amount ₹22,28,798 /- and an amount of ₹31,705 /- has been refunded to MNRE.
5	Sanctioned objectives	Installation of an integrated biogas digester system to produce 15 m3 biogas per day, gas cleaning and storage unit followed by 100% gas engine generator system to produce 3kW electric power. Performance study of the system with lignocellular feed material mixed with cattle dung, optimization of feed rate, gas quality and kinetic parameters for efficient power production with gas engine. Laboratory experiments for optimization of a 5HP diesel engine parameters such as valve timing, fuel injection, compression ratio, fuel air mixing, etc. and conversion of the same based on existing VCR engine experiments for necessary modifications. Performance study with the modified engine and comparison with 100% gas engine. Simulation study for a single 15 m3/day biogas digester with ferro-cement as construction material.
6	Expected output as per sanction.	Optimized operating parameters of diesel engine (5 HP) to run with biogas. Modified diesel engine (5 HP) to run with biogas. Design and drawing of a 15 m^3 gas per day biogas digester made of ferrocement. Optimized data (feeding rate, gas quality, kinetic parameters) for utilization of lignocellulosic feedstock. On field performance data of the modified engine and 100%gas engine in terms of efficiency, emission, operating cost etc. Technical reports, research papers, articles, technology manuals and patents. Conducting regular training for NGO's and other users in the Aunitai plant to popularize use of biogas for power generation.
7	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	Project is completed and PCR has been received. The PCR was sent to 3 experts and comments from 1 experts have been received as satisfactory. Papers Published: 9 papers have been published in International Journals /Conference.

Project No. 03:- Development & performance evaluation of a 3 kWe Biogas based power generation system utilizing Lignocellular biomass"

2 responses



Project 3: Appraisal report on achievements as per sanction of the project:

2 responses

- PCR of the project has been prepared very nicely, putting all the details systematically. But, last objective seems to be missing in PCR against the sanctioned objectives; further impact of addition of inoculum on C/N ratio of various feedstocks has not been elaborated, which could be of significance as initially also, C/N ratio for 2 feedstocks, viz. switch grass and rice straw is already very high. Overall, work has been done very meticulously during the project.
- Objectives well worked with respect to all possible detailing required

Project 3: Recommendations with suggestion for further course of action

2 responses

- The project outcomes can be taken forward for engine design/ upgradation, which can run solely on biogas as fuel; and can be promoted to be implemented at various sites also.

- NA

Suggestions and Recommendations on Bio Gas Thrust area and R&D Policy

Expert-1

I, Dr. Shailey Singhal, thank the Ministry for providing me this opportunity to be the part of this significant program. After going through various documents on policy, thrust areas, etc. shared by the Ministry, with all due respect, I put forward my sincere suggestions here, and am open to further discussion as well:

Administrative suggestions:
• Multiplication of existing technology.
• Bio-toilets can be encouraged at community level.
• In every city/ township, community-based plants can be there, with properly routing the input and output distribution.

Policy:
Mandatory replacement of conventional fuel by fixed percentage of biogas through state-wise agency established for the same.

R&D and its thrust areas:

Various TRL levels can be fixed, with a maximum capping of financial support and duration for the project with following thrust areas (keeping few of existing ones also):
• Addressing lignocellulosic waste for biogas generation after pre-treatment
• Co-digestion of feedstock and sewage sludge
• Methods for capturing carbon dioxide generate in biogas
• Biogas plant design for multi-feed operation
• Cost-effective upgradation of biogas and bottling
• Simplified segregation and feeding of bio-digester
• Biogas enhancement in low temperature zones
• Improved designs of biogas stoves
• Suitable and simpler route to convert slurry to manure

Monitoring of on-going projects:
Regular physical monitoring of projects should be there, sometimes surprize visits also.

BDTCs:
• Proper database of all the types of feedstock and established biogas plants needs to be available in the state office for renewable energy.
• Regular monitoring of biogas plants needs to be there, ensuring their proper running.
• Centres can be established state-wise; however in case of very small states, they can be merged, but a maximum radius of operation always needs to be kept in mind.
• Categories and salaries of manpower need to be defined. Other suggestions:
• Mandatory requirement of publications should be minimized, and only those publications should be encouraged, which can actually contribute to science/ technology/ society.

• In the document of R&D policy, at page 17, Annexure A-I, no description is there for biogas, it should be included.

Expert 2:-

1. Biomass supply chain and logistics should be a part of biogas projects focussing on biogas production from any waste material
2. Projects should be categorized based on TRL levels and benchmarks should be laid for the achievement of quantifiable outputs
3. Core R & D proposals for the development of proof of concept should be under a different category of proposals and the validation and demonstration level projects should be categorized separately
3. Focus should be on the development of decentralized models
4. Review committee meeting for review of the sanctioned projects should be held every six months or at least once a year to keep a follow up of ongoing work.
5. On-site evaluation of sanctioned projects should be conducted once a year by the review experts

Fuel Cell, Hydrogen & Storage Tech.

For review of 8 nos of R&D projects, the following Panel of Expert was formed:-

Panel 4

Dr NS Prasad, TERI, New Delhi
Dr. Nilanjan Saha, IIT Madras

The Panel of Experts reviewed the 4 nos. Biogass R&D projects were reviewed in detailed manner .

A online feedback form was filled by all the Experts of Panel 4 and given the opinion on the projects along with appraisal on achievements as per sanction of the projects and Recommendation with suggestion for further course of action.

Fuel Cell, Hydrogen & Storage Tech.

ON-GOING PROJECT NO. 1 Studies on novel semiconductor towards increasing the efficiency of PEC water splitting for hydrogen generation

S. No.	Items	
1	**Title of the project**	Studies on novel semiconductor towards increasing the efficiency of PEC water splitting for hydrogen generation
	Reference File No.	103/241/2015-NT
2	**(i) Principal Investigator**	Prof. Sahab Dass
	(ii) Co-Principal Investigator	Prof. Vibha Rani Satsangi & Prof.Rohit Shrivastav
3	**Name of the implementing Institution/Industry**	Dayalbagh Educational Institute, Dayalbagh, Agra-282005
4	**Details of the Project**	
	a) Date of Project Sanction Order	29/06/2018
	b) Financial Summary	Original cost: ₹ 141.97 lakhs Revision 1 : ₹ 149.82 lakhs (revision of fellowship) Revision 2 : ₹ 349.82 lakhs (additional funds for FE-SEM) Funds released/sanctioned: ₹ 289 lakhs Expenditure(31 March 2020): ₹ 41 lakhs
	c) Duration	Three years
5	Sanctioned objectives	
6	Expected output as per sanction.	
7	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	Prototype:- Nil Patents generated:- Nil Paper published:- Nil

Project No. 1: Opinion on the overall of the progress for the Project: Studies on novel semiconductor towards increasing the efficiency of PEC water splitting for hydrogen generation by Prof. Sahab Dass, Dayalbagh Educational Institute, Dayalbagh, Agra

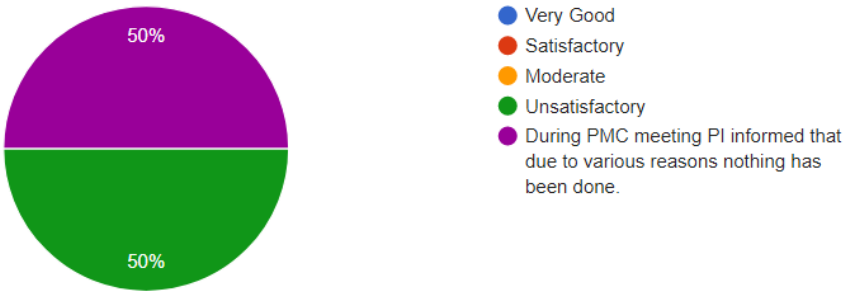
2 responses

ON-GOING PROJECT NO. 2 Setting Up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Haryana

1	**Title of the project**	Setting Up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Haryana
	Reference File No.	No. 350/2/2018-NT dated 28th February 2019
2	**(i) Principal Investigator**	Dr. A.K. Tripathi
	(ii) Co-Principal Investigator	Dr. Chandan Banerjee, Dr. M R Nouni
3	**Name of the Implementing Institution/Industry**	National Institute of Solar Energy, Gwalpahari, Gurugram – 122003 Haryana
4	**Details of the Project**	
	a) Date of Project Sanction Order	28/02/2019
	b) Financial Summary	Original Cost: ₹ 10.30 crore Funds released/sanctioned: ₹ 7.70 crore Expenditure(31 July 2020): ₹ 10 lakhs
	c) Duration	3 Years
	d) Date of completion	27/02/2022
5	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	The physical and financial progress under the project is significantly lagging behind the schedule even after considering the delays due to COVID-19. There is no progress under any of the project deliverables. NISE should, within 15 days from receipt of the PMC report, submit details of the strategy for completing the project deliverables. The paper should inter-alia include delivery linked plan for the resource utilization, and time schedule for attaining each of the deliverables. The PMC will review the paper and recommend approach for further activities to NISE. NISE's request for time extension will be considered in accordance with PMC's review and recommendation. ***It was informed that over Rs. 7.5 crore unspent balance is lying with NISE, there is no additional fund requirement at present, and NISE has remitted the interest earned on unspent balances to the Ministry. Proposal for further release will be considered in accordance to PMC's review and recommendation.*** Prototype:- Nil Patents generated:- Nil Paper published:- Nil

Project No. 2: Opinion on the overall of the progress for the Project: Setting Up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Haryana by Dr. A.K. Tripathi, National Institute of Solar Energy, Gwalpahari, Gurugram, Haryana

2 responses



Project No 2: Appraisal on achievement as per sanction of the Project.

2 responses

Very poor progress; both technically and financially.
Nothing has been done to achieve various objectives listed in the original proposal

Project No 2: Recommendation with suggestion for further course of action.

2 responses

NISE is an MNRE Institution. They should expedite the well defined proposal.
Since NISE is a unit created under MNRE and the project is a demonstration project , it is recommended that the PI be asked to re-look into various stated objectives, prioritize them and start work as soon as possible after taking care of the bottlenecks.

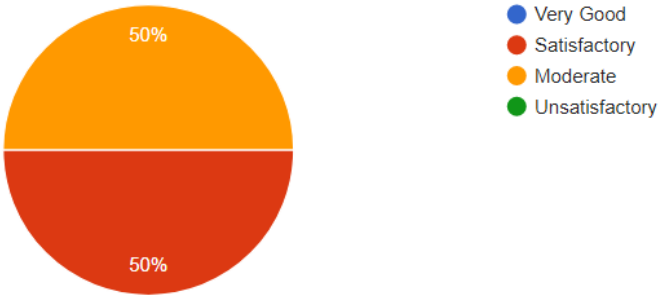
ON-GOING PROJECT NO. 3 - Hierarchical Composite Nanostructure Photocatalysts for Efficient Water Splitting under Solar light Irradiation

1	**Title of the project**	Hierarchical Composite Nanostructure Photocatalysts for Efficient Water Splitting under Solar light Irradiation
	Reference File No.	No.103/227/2014-NT dated 31-12-2015
2	**(i) Principal Investigator**	Dr. M.V.Shankar Professor & Principal Investigator Dept of Materials Science and Nanotechnology Yogi Vemana University Vemanapuram, Kadapa – 516 005
	(ii) Co-Principal Investigator	Dr.M.Sathish Scientist & Co-Principle InvestigatorCentral Electrochemical Research Institute, Karaikudi -630 003
3	**Name of the Implementing Institution/Industry**	Yogi Vemana University, Kadapa Central Electro-Chemical Research Institute (CSIR-CECRI), Karaikudi
4	**Details of the Project**	
	a) Date of Project Sanction Order	31-12-2015
	b) Financial Summary	Original Project Cost: ₹ 72.19 lakh YVU :₹39.10 lakh CECRI :₹33.08 lakh Funds Released: ₹ 56.73 lakh (including interest) Expenditure: ₹ 56.40 lakh
	c) Duration	Original: 3 Years
	d) Date of completion	Original: 30 December 2018 Recommended extension: 31 December 2019 (previous PMC)

5	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	Achievements against deliverables may be clearly defined in quantified terms. Identified promising catalyst material should be produced in larger quantity, say at a few grams scale. The project is running behind the schedule. PMC in its meeting held in March 2019 had recommended extension of the project up to 30 December 2019 with no additional. Considering progress, funds for the project may be released and 6 months extension to the project duration may be granted at no additional cost. Prototype:- Nil Patents generated:- Nil Paper published:- Nil

Project No. 3: Opinion on the overall of the progress for the Project: Hierarchical Composite Nanostructure Photocatalysts for Efficient Water Splitting underSolar light Irradiation by Dr. M.V.Shankar Professor & Principal Investigator Dept of Materials Science and Nanotechnology Yogi Vemana University Vemanapuram, Kadapa

2 responses



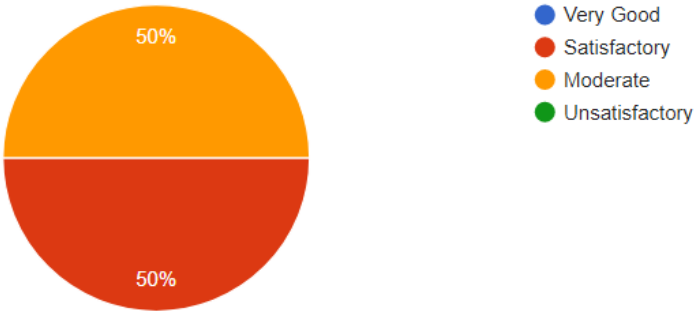
ON-GOING PROJECT NO. 4 - Hydrogen Generation using Biomass Gasification for Fuel Cell Application (HBGF)

1	**Title of the project and Reference File No.**	Hydrogen Generation using Biomass Gasification for Fuel Cell Application (HBGF) No.103/234/2014-NT
2	**Principal Investigator** **Co-Principal Investigator**	Prof. S Dasappa Prof. Ashok M Raichur
3	**Name of the Implementing Institution/Industry**	Indian Institute of Science
4	**Details of the Project**	
	a) Date of Project Sanction Order	31 March 2016
	b) Financial Summary	Original Cost: ₹ 478.81 lakhs with ₹ 25 Lakhs from Tata Motors Limited Funds Released: ₹ 294.0 lakhs Sanctioned funds under release process: ₹ 80.0 lakhs Expenditure(31 March 2020): ₹ 293.7 lakhs
	c) Date of completion	Original: 31 March 2020

		Revised: 31 March 2021
5	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	Under the project, it has been reported that the design for Pressure Swing Absorption(PSA) system for gas separation has been developed. It is suggested that the PSA may be integrated with the scaled up gasification system and the composition of the resultant purified gas be analyzed using GC-MS, followed by testing in the actual PEM Fuel Cell system. PI should initiate the process for patenting of the process and /or system developed under the project. PI has informed that Tata Motors has backed out of the support indicated at the initiation of the project. Considering that the main objective of the project is to produce fuel cell grade hydrogen from biomass, it is necessary to integrate the produced hydrogen gas with a fuel cell system and carry out performance evaluation. PI should accordingly explore means to test the hydrogen in a PEM Fuel Cell system available with other organizations The committee expressed serious concern on the quality of H2 as the main deliverable of project is production of H2 for fuel cells. The purification steps should be listed. The PI should clearly indicate the type of biomass and any preprocessing required. The next installment of funds for the project may be released at the earliest to ensure completion of activities within stipulated time. Prototype:- Nil Patents generated:- Nil Paper published:- Nil

Project No. 4: Opinion on the overall of the progress for the Project: Hydrogen Generation using Biomass Gasification for Fuel Cell Application (HBGF) by Prof. S Dasappa, Indian Institute of Science, Bangalore

2 responses



Project No 4: Appraisal on achievement as per sanction of the Project. 2 responses

Partially achieved objectives commensurate with the expenditure.

Achievement as per the original objectives is not satisfactory, the primary reason is unavailability of the proposed gas purification system (PSA) and lack of interest from Tata Motors.

Project No 4: Recommendation with suggestion for further course of action. 2 responses

Release of balance funds and Extension till December 2021.
The PI should look for procuring appropriate PSA system to get Fuel Cell Grade hydrogen. If this is not possible he should revise the objectives

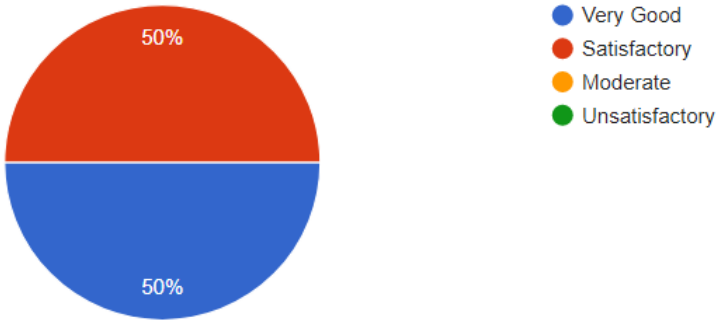
COMPLETED PROJECT NO. 5- Maximization of gaseous energy recovery from organic wastes through Biohythane process

1	**Title of the project**	Maximization of gaseous energy recovery from organic wastes through Biohythane process
	Reference File No.	103/243/2015-NT, 29-12-2015
2	**(i) Principal Investigator**	Prof. Debabrata Das Department of Biotechnology
	(ii) Co-Principal Investigator	Prof. Subhabrata Roy Department of Chemical Engineering
3	**Name of the Implementing Institution/Industry**	Indian Institute of Technology Kharagpur
4	**Details of the Project**	
	(a) Date of Project Sanction Order	29-12-2015
	(b) Financial Summary	Original Cost: ₹ 48.12 lakhs Funds Released: ₹ 33 lakhs Sanctioned funds under release : ₹10 lakhs Expenditure: Final expenditure to be communicated by IIT Kharagpur
	(c) Duration	3 years
	(d) Date of completion	28-12-2018

5	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	The sanctioned objectives of the project have been completed. PI may intimate the final expenditure incurred in the project so that the balance, if any, may be released/recovered. As per the recommendations of the PMC in its meeting held in March 2019, ex-post facto extension may be granted up to 31 December 2019. The project completion report may be accepted and the project may be closed. Prototype:- Nil Patents generated:- Nil Paper published:- Nil

Project No. 5: Opinion on the overall of the progress for the Project: Maximization of gaseous energy recovery from organic wastes through Biohythane process by Prof. Debabrata Das Department of Biotechnology, Indian Institute of Technology Kharagpur

2 responses



Project No 5: Appraisal on achievement as per sanction of the Project. 2 responses

Objectives achieved to a large extent.
The PI has achieved the stated objectives.

Project No 5: Recommendation with suggestion for further course of action. 2 responses

Project may be closed as completed satisfactorily.
The results are suitable for transferring the technology. It would be useful to transfer the technology to interested industries.

COMPLETED PROJECT NO. 6- Design and development of porous graphene modified metal oxide photo anode for photo electro chemical water splitting

1	**Title of the project**	Design and development of porous graphene modified metal oxide photo anode for photo electro chemical water splitting
	Reference File No.	File No: 103/233/2014-NT
2	**(i) Principal Investigator**	Prof. Kulamani Parida
	(ii) Co-Principal Investigator	Dr. Satyabadi Martha
3	**Name of the Implementing Institution/Industry**	Centre for Nano Science and Nano technology,Siksha O Anusandhan (Deemed to be University),Bhubaneswar
4	**Details of the Project**	
	a) Date of Project Sanction Order	31 December,2015
	b) Financial Summary	Original Cost: ₹ 64.81 lakhs Funds Released: ₹ 50.4 lakhs Expenditure: Final expenditure to be communicated by SOA University
	c) Duration	Original: 3 yrs
	d) Date of completion	Original: 30 December2018 Revised: 31 December 2019
5	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	The sanctioned objectives of the project have been completed. PI may intimate the final expenditure incurred in the project so that the balance if any, may be released/recovered. As per the recommendations of the PMC in its meeting held in March 2019,ex-post facto extension may be granted up to 31 December 2019. The project completion report may be accepted and the project may be closed. Prototype:- Nil Patents generated:- Nil Paper published:- Nil

Project No. 6: Opinion on the overall of the progress for the Project: Design and development of porous graphene modified metal oxide photo anode for photo electro chemical water splitting by Prof. Kulamani Parida Centre for Nano Science and Nano technology,Siksha O Anusandhan (Deemed to be University),Bhubaneswar

2 responses

COMPLETED PROJECT NO. 7- Design & development of solar light driven graphene based mixed oxide photocatalysts for efficient production of hydrogen (solar fuel)

1	**Title of the project**	Design & development of solar light driven graphene based mixed oxide photocatalysts for efficient production of hydrogen (solar fuel)
	Reference File No.	No. 103/239/2015-NT dated 31-12-2015
2	**(i) Principal Investigator**	Prof. B. Neppolian, Energy and Environmental Remediation Lab SRM Research Institute
	(ii) Co-Principal Investigator	
3	**Name of the Implementing Institution/Industry**	SRM Research Institute SRM Institute of Science and Technology Kattankulathur , Chennai
4	**Details of the Project**	
	a) Date of Project Sanction Order	31/12/2015
	b) Cost of the project with details of cost sharing with other institutions / industries.	Original Cost: 41.08 lakhs Funds Released: ₹ 36.0 lakhs Expenditure: Final expenditure to be communicated by SRM University
	c) Duration	Original: 3 Years
	d) Date of completion	Original: 31 December 2018 Revised: 31 December 2019
5	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	The sanctioned objectives of the project have been completed. PI may intimate the final expenditure incurred in the project so that the balance if any, may be released/recovered. As per the recommendations of the PMC in its meeting held in March 2019, ex-post facto extension may be granted up to 31 December 2019. ***The project completion report may be accepted and the project may be closed.*** Prototype:- Nil Patents generated:- Nil Paper published:- Nil

Project No. 7: Opinion on the overall of the progress for the Project: Design & development of solar light driven graphene based mixed oxide photocatalysts for efficient production of hydrogen (solar fuel) by Prof. B. NeppolianEnergy and Environmental Remediation Lab SRM Research Institute, Kattankulathur , Chennai

2 responses

ON-GOING PROJECT NO. 8- Design and development of 20kW Low Temperature Polymer Electrolyte Membrane (LT-PEM) fuel cell with high indigenous content.

1	**Title of the project**	Design and development of 20kW Low Temperature Polymer Electrolyte Membrane (LT-PEM) fuel cell with high indigenous content.
	Reference File No.	350/2/2018-NT & 28th Feb, 2019
2	**(i) Principal Investigator**	Dr. N. Rajalakshmi
	(ii) Co-Principal Investigator	Dr. K. Ramya, Dr. R. Balaji, Dr. V. Raman
3	**Name of the Implementing Institution/Industry**	International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI)
4	**Details of the Project**	
	(a) Date of Project Sanction Order	25-03-2019
	(b) Cost of the project with details of cost sharing with other institutions / industries.	Total Project Cost: Rs 21.39 crore MNRE Share: Rs 17.74 crore ARCI Share : Rs 3.4 crore Other Partner Organisation : Rs 0.35 crore
	(c) Duration	42 Months
	(d) Date of completion	September 2022
	(e) Funds released and utilized (year-wise):	

Capital Assets

FINANCIAL YEAR	SANCTION	UTILIZED	UNUTILIZED	INTEREST	UNSPENT BALANCE
2019-20	₹ 6,15,00,000	₹ 5,89,83,740	₹ 25,16,260	₹ 82,726	₹ 25,98,986

Grant-in Aid General

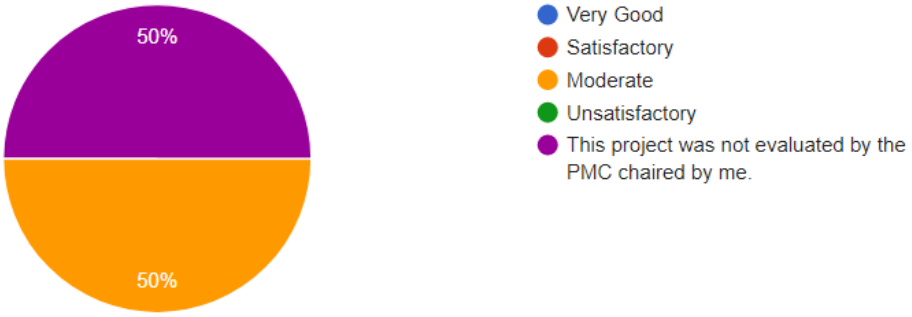
FINANCIAL YEAR	SANCTION	UTILIZED	UNUTILIZED	INTEREST	UNSPENT BALANCE
2019-20	₹ 1,74,00,000	₹ 98,34,121	₹ 75,65,879	₹ 2,55,351	₹ 78,21,230

5	**Status of Achievements against Sanctioned Objectives**	
	Sanctioned Objectives	**Status of achievements so far**
	Design, development and demonstration of 5 numbers of 20kW LT-PEM fuel cell with the said specifications like 5000 hours operating time, energy efficiency of greater than 45%, cost being Rs, 200000/kW , capability for easy start up down to -20C, and use of imported components by value	1kW module has been sent to IOCL for testing. Raw materials and Manpower recruirtment are being done. Identified a partner for setting up an assembly line for PEMFC Pick and place Robot has also been oidentified for automation Due to covid pandemic issues, no experimental work has

	5% , except electrolyte.	been taken up.
6	**Status of Achievements against Expected Output / Deliverables as per sanction**	
	Expected output / Deliverables as per sanction	**Status of the achievements so far**
	5 Numbers of 20 kW capacity	Materials Procurement in Progress
	Automation of stack assembly	Designing and Vendor Identification - Completed
	Mass manufacturing of Membrane electrode assemblies	Commencement of Assembly Line setup
	Mass manufacturing of bipolar Plates	**Yet to Begin**
	Standardisation of stack components	**Yet to Begin**
	Easy adoptability for industry to scale up/mass manufacture	
	Specific Power would be 100W/kg; power density is 110 w/l; and the geometric power density is 135 mW/cm^2	1 kW system sent to IOCL is 80W/Kg and 70W/l, 110mW/sqcm Work is in progress to achieve the other parameters.
	The cost would be reduced to Rs. 2 Lakhs/kW	Present material and processing cost is Rs. 3 lakhs/KW, will be reduced to Rs. 2 lakhs /KW by operation of pilot plant and processing cost
7	Status of the project including achievements (with details of the prototypes/patents generated/paper published etc.) and details of monitoring/ challenges and proposals by technology.	Prototype:- Nil Patents generated:- Nil Paper published:- Nil

Project No. 8: Opinion on the overall of the progress for the Project: Design and development of 20kW Low Temperature Polymer Electrolyte Membrane (LT-PEM) fuel cell with high indigenous content by Dr. N. Rajalakshmi, International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI)

2 responses



Project No 8: Appraisal on achievement as per sanction of the Project. 2 responses

Some progress has been made. Delay due to Covid?
Unable to comment

Project No 8: Recommendation with suggestion for further course of action. 2 responses

PI needs to be advised to expedite the project execution.
Not applicable

Suggestions and Recommendations on R&D Policy2 responses

H2 and FC projects are in general aimed at product & process development. This is the right direction. Monitoring the progress and follow up actions must be given high priority. Development of small capacity H2-FC Power packs need to be encouraged. Also, H2 storage and delivery in large capacities need to be taken up. We are still lagging in the development of lightweight, high pressure (700 bar) H2 cylinders.

The R&D Policy document is quite comprehensive and is well-prepared. It would be of national interest to lay more emphasis on projects capable of developing technology for large scale exploitation. By now sufficient basic data is available on various types of photo-catalytic/photo-electrocatalytic materials capable of producing hydrogen on lab-scale. The economically and technologically viable ones out of these need to be produced on large scale. Several aspects of electrolytic cells for producing hydrogen from water and fuels cells are quite similar.It would be appropriate to use a synergistic approach in deciding the goals for the projects focussing on these two areas. The technology for electrolytic route hydrogen production is quite mature.

सत्यमेव जयते

No. 223/90/2017-R and D COORD

भारत सरकार/ **Government of India**

नवीन और नवीकरणीय ऊर्जा मंत्रालय / **Ministry of New & Renewable Energy**

(अनुसंधान और विकास प्रभाग/ R&D Division)

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Subject: Review of Renewable Energy Research and Technology Development Programme for continuation beyond 2020- 21 under the Chairmanship of Hon'ble Dr. Anil Kakodkar.

The Ministry implemented an Renewable Energy Research and Technology Development Programme for the period from 2017-18 to 2019-20 and continued till 31st March, 2021. Therefore, in order to evaluate R&D Programme for Continuation for FY 2021-22 to FY 2025-2026, external panel of experts reviewed the R&D scheme/projects. The Review is done at two levels by panels of Experts. Firstly, panels of experts from various field like solar, wind, biogas, hydrogen etc have reviewed through online feedback of R&D projects in detailed manner. Secondly, to review overall R&D Policy, meeting of the following Expert Committee was held on 14th January, 2021 at 11:00 AM under the Chairmanship of Dr. Anil Kakodkar through video conferencing. Other members who attended the meeting were:

1. Dr. Anil Kakodkar, Chairman
2. Shri Dinesh D Jagdale-Joint Secretary-R&D, MNRE
3. Shri K. K. Jain ED, CHT, MoPNG
4. Prof. Vikram Kumar, IIT Delhi
5. Dr. Vineet Sani, Scientist/Director, DST
6. Prof. S. Srinivasa Murthy, IISc., Bangalore-ST & New Technology
7. Prof. J. Vasi, IIT, IIT Bombay-SPV
8. Dr. Manju Sharma, Institute of Chemical Technology, Mumbai -Bio Gas
9. Dr. Nilanjan Saha IIT Madras-Wind

Dr. Anil Kumar, Scientist 'D', MNRE also attended the meeting.

2. At the outset, the Chairman welcomed the members of the Committee. Members were requested to consider the agenda of the meeting for recommendations to the Ministry in view of the policy guidelines.

Introduction

3. The introductory remarks were made by Shri Dinesh D Jagdale-Joint Secretary-R&D, in which he outlined the agenda of the meeting. The following were the primary objectives of the meeting:-

a) Brief presentation on R&D scheme and review.
b) Review of technologies in renewable energy, i.e solar, wind, biomass, waste to energy, hydrogen, fuel cells and storage technologies by various domain experts.
c) Sector wise recommendations for the improvement of overall policy by the domain experts.

Dr. Anil Kumar presented brief of the R&D Scheme implementations, achievements and review by panel of experts of various field like solar, wind, biogas, hydrogen etc who have reviewed through online feedback of R&D projects. The Presentation is enclosed as ***Annexure.***

The Chairman: Dr. Anil Kakodkar

4. Chairman in his address stressed on the urgent need of the country to reduce imports of fossil fuels as well as reduce carbon footprint through the use of surplus agricultural residue as a resource for bio-energy. He also emphasized the need for focused R&D for cost reduction to ensure viability of commercial projects on bio fuels including those with related to hydrogen that Government is promoting. Utilisation of surplus agri residue as well as other significant biomass resources for energy production is an important thrust area in the country even in the context of thrust to rural/tribal economy.

In the context of solar energy , the Chairman was of the opinion that there should be major emphasis on realisation of MW scale commercial solar thermal projects with thermal storage, as he believes that the basic knowledge and capability for the entire value chain is available within the country. Such projects invariably would

require customised engineering and project management focused on domestic value addition. In absence of such an emphasis solar thermal projects have turned out to be more expensive preventing their spread. With growing solar integration in our grids there would be additional system and grid costs in the transmission and distribution domain which can be minimised with large capacity through solar thermal with thermal storage. He also mentioned the significant advantages of solar thermal with supercritical CO_2 Brayton cycle which can significantly reduce the viable plant capacity. He stressed on the potential of much higher efficiency (>45 – 50%) that can be realised with solar thermal. This should thus be the thrust area in solar R&D. With respect to photovoltaics, he emphasised development of commercially viable microgrids in urban and rural areas as a better means of reaching the unreached as well as creating a pull for distributed solar generation. He commended work done by Centers of excellence that have been established and highlighted the need to accelerate development of flexible photovoltaics manufactured in roll-on-roll mode to its logical end.

On the Hydrogen and Fuel Cells, Dr. Kakodkar emphasised on the potential cost competitiveness of fuel cell based electric transportation in comparison with diesel. He mentioned that the cost parity of bio-hydrogen fuel cell trucks with diesel trucks is expected to be demonstrated soon besides eliminating range anxiety. India thus has a significant opportunity to push ahead with hydrogen based commercial transportation and reduce carbon emission besides substituting fuel imports. Regarding the source of green hydrogen, agricultural waste can provide the required raw material besides other competitive technologies such as electrolysis using renewable and nuclear electricity.

Dr. Kakodkar suggested suitable co-ordination between MNRE and other funding agencies (science departments on one side and user ministries like MoPNG, MoP etc. on the other). While the focus of science departments could be on laboratory development leading to proof-of concept level development and that of user ministries on commercialisation / market entry of a developed technology, MNRE should focus on translating the technology from low TRL to high TRL ready for commercialisation.

Regarding changes that need to be made to R&D scheme, Dr. Kakodkar suggested that MNRE could consider remodeling the scheme broadly around the practice followed by Arpa-e* or DARPA** programs of US:

*Advanced Research Projects Agency – Energy" of US Department of Energy

** Defense Advanced Research Projects Agency (DARPA) of Defense Science Office, USA.

- We could invite competitive proposals from industry in collaboration with academia/research institutions that could deliver on a specified user need while pushing the technology envelope.
- Deliverables including the performance and qualification requirements could be should be clearly spelt out.
- There should be independent test houses to ascertain performance of products developed.
- There should be support for guaranteed purchase up to a specified quantum provided the products meets the specified qualification and the price.

The Ministry's R&D program should in principle be **leading, not lagging** behind the technology scene in the country.

He further invited comments from other members of the committee.

Speaker 2: Dr. Vineet Saini, **DST**

5. He commented that the new R&D scheme should have new element and emphasis on MW level power plants in the scheme with larger budgets for technology commercialization. There is lack of support in the field of bio energy. There should also need for inter departmental synergies for developing basic research to commercial level.

To this, Dr. Kakodkar had following to say:

- MNRE certainly needs to provide larger funding.
- Bio energy should be one of the key areas of the project and the need for some large commercial project is the need of an hour.

- Clean cooking fuel is an important thrust area and compressed biogas has huge potential for cooking applications.
- Sustainable and clean rural energy solutions should be developed as villages are now moving towards gas cooking which leads to increased import.

Speaker 3: Dr. S Srinivasa Murthy, IISc. Bangalore

6. He commented that large scale project on CSP - CO2 would be possible in the near future with appropriate funding support. Potential for integration of existing coal based power plants with CSP for pre-heating, hybridisation should be emphasized. Commercial scale PV CSP hybrid is a need of an hour as the storage cost of CSP is significantly lower as compared to existing PV with Li ion battery storage. PV CSP is the lowest renewable storage based project currently. Policy thrust should be given to at least a few demonstration projects.

There is huge scope in solar thermal cooling and industrial heat application and for domestic industry in CSP as almost all components can be locally manufactured. Subsidy scheme can also be designed by keeping viability gap funding into consideration. This will give significant boost to local manufacturing and also boost exports in the future.

In case of Fuel cell and Hydrogen tech, Significant emphasis to be given to hydrogen infrastructure that includes storage cylinders. Carbon composite cylinders are a mature technology and India could become an export hub due to low cost of labor. Combined Heat, Power and Cooling running on Fuel cells for distributed generation can be a very large market for fuel cells and should be a thrust area in the field of Hydrogen. Small Distributed Generation applications such as telecom towers is a huge market to be explored.

To this, Dr. Kakodkar had following comments:-

- Large scale CSP is certainly the need of an hour. However, due to dissatisfactory performance of some of the past projects, strong performance guarantee should be emphasized.

- Due to involvement of international consultants, the cost of project is significantly large. Local engineering firms with some experience in the field should be encouraged through a policy.
- R&D policy should focus on cost competitive PV CSP hybrid power plants on a large scale. Initially, few commercial projects should be given support with strict cost targets so as to make them cost competitive.
- We should develop a scheme for such projects.

Speaker 4: Dr. Manju Sharma, ICT Mumbai

7. She commented on urgent need to set up target deliverables based on cost effectiveness and feasibility of the developed process with respect to input and output energy. Economic feasibility and commercial sustainability should be emphasized in evaluation of projects. Involving industry at research and demonstration stages are very important and industrial validation of technology should be mandatory. Industry academia collaborative projects should be given priority. For Bio gas projects, logistic supply and managements should also be the part of R&D projects as most of the project fails due to improper supply of feedstocks. Focus should be laid on development of decentralized models and feedstock agnostic technologies.

R&D proposals should have well defined target deliverables and should indicate minimum and maximum achievable improvements with respect to biogas yield and productivity. Research areas such as improvement in process operations, microbiology of the digester, consortium design and dynamics should also be considered for R&D proposals.

PMC review meetings should be more frequent with major emphasis on monitoring the progress viz a viz sanctioned objectives and at least one on site visit for evaluations of the sanctioned project should be done during the project duration. Besides, intermittent progress review meetings can be conducted through video conferencing in a year.

Speaker 5: Shri K.K Jain CHT MoP&NG

8. The potential of bio energy is huge in India. With 175 million tons of biomass, India can produce 30-35 tons of gasoline. Significant potential in compressed biogas as it can be a source of high calorific value fuel. As translation from TRL 6 to TRL 9 is a major challenge for technology commercialization, MNRE and DST and CHT can jointly work to expedite the process. Projects from lab scale to pilot scale should be given priority and deliverables should be clearly outlined. There is need to maintain a centralized database/dashboard to avoid duplicity of projects funding and display of projects available at different TRL levels for taking to further TRL level or to commercialization.

Speaker 6: Dr. J Vasi, IIT Bombay

9. He commented that call for proposals should include quantified deliverables. Funding for R&D should be in tandem with the aggressive RE targets that GoI has set. Funding certainly is not sufficient for India to take a lead in RE technology. DST and MNRE should collaborate closely. MNRE needs to play a significant role in manufacturing in the solar sector by giving support to R&D of key solar technologies. Indigenous technology development in the field of Solar cells, inverters, Flexible solar cells, pervoskites, Agri RE tech and PV–CSP-wind-storage hybrid should be encouraged. Proposal review time should be shortened. R&D roadmap for 2021 - 2030 with clear targets should be made.

Speaker 7: Dr. Vikram Kumar, IIT Delhi

10. He commented that research is very important for renewable energy and MNRE should take it seriously with increasing budget and more projects should be taken up be in a time bound manner. There should not be a cap of 50% support for the industry. Like DST, private institutions and industry should be given upto 100% support for R&D if projects are found deserving. R&D in RE was in a nascent stage upto 2010 and lot of capacity building was required. Presently, the situation is better especially in technologies like Perovskite, Fuel cells, etc. Staff in MNRE should be increased for timely processing and review of R&D projects .

To this, Dr. Kakodkar had following comments

- Support for 100% grant for the industry is important and should be incorporated in the policy. A project can be evaluated and funded according to the gap in viability. For industry, funding should be in graded manner. 100% for first level research and 50% for prototype/product developmental research and viability gap funding for larger size demonstration projects.
- Involvement of the industry from the initial level of R&D should be high. This will expedite commercialization of technology.

Speaker 8: Dr. Nilanjan Saha, IIT Madras

11. He commented that offshore wind (especially fixed platforms) is quickly reaching a mature technology and policy needs to be adopted for research (e.g., floating multi-purpose platforms wind-solar hybrid along with desalination) and implementation projects in a cost effective manner. LiDARs are important for research and scaling up of projects. Hence, MNRE will require a policy that focuses on increased number of LiDAR installations and Horizontal/Vertical Axis turbine. In order to leverage the implementation of offshore wind, organizations as ONGC, IOL, etc. can be roped in to install offshore platforms in abandoned oil platforms as well as with Ports (Ministry of Shipping) for installations in open sea jetty/ports. Indian islands (Andaman and Nicobar as well as Lakshwadweep) can easily be taken as offshore wind installation as one wind turbine (5MW) would be suffice to power these islands as well as drinking water by desalination. Floating offshore platforms should be explored as India has a large coastline and will make India energy independent through the wind energy. There should be a Centre of excellence of Wind Energy Technology immediately to explore new research in wind energy.

12. **After the detailed discussion on various issues, the Committee came to conclusion that the proposal for the scheme continuation from period 2021-22 to 2025-2026 may be extended and file may be processed accordingly keeping in view of the suggestions/observations mentioned in para 4 to 11.**

The meeting ended with Thanks to the Chair.

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Ministry of New and Renewable Energy
(R&D Division)

Review of Renewable Energy Research and Technology Development Programme for continuation beyond 2020-21

1

Objectives and Financial support

Objectives:-

- Research, design, development, standardization and demonstration
- To lower the cost of renewable energy systems/devices
- To improve the efficiency, performance and reliability of systems/devices
- To strengthen domestic manufacturing base
- International collaborations

Financial Support:

- 100% financial support to Government/non-profit research organizations/NGOs
- Upto 50% to industry/civil society organization.

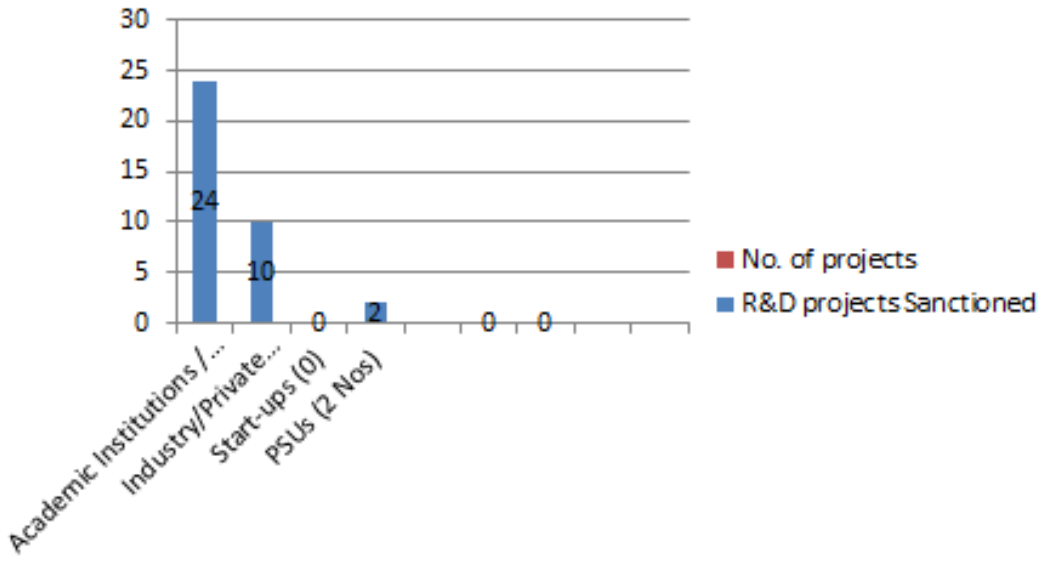
Procedure for Appraisal of the Projects

- Proposals are invited from R&D Organisations/Institutions, Universities and Industries.
- Evaluations of the proposal by identified subject area expert.
- Approved by R&D Project Appraisal Committee (RDPAC). The RDPAC is Chaired by Secretary, MNRE, co-chaired by an eminent scientist and comprise of experts from various new and renewable energy areas and other relevant S&T departments.

Scheme Status

- R&D Policy announced on dated 21.02.2019.
- Sanctioned/ongoing R&D Projects: 33 nos.
  (2017-18 to 2019-20 Period)
- Total budget :Rs.175.87 crore
- Expenditure: Rs. 93.41 crores

Projects sanctioned to Diff. Organisations



Imp. Achievements

- In solar, high efficiency crystalline silicon solar cells of 19.4% efficiency was achieved in lab scale under a project at IIT, Bombay (10 Patents under NCPRE)
- Indigenous Silicon ingot has been prepared at SSN College of Engineering in Tamil Nadu (1 patent)
- Cost effective reliable Solar-powered Clean Drinking Water Systems by NISE (1 patent and transferred to industry)
- 1 MWe Solar Thermal Power Plant with 16 hours thermal storage has set up at Mount Abu by World Renewable Spiritual Trust (WRST), Mumbai which is running successfully (2 Patent and transferred to industry)
- IISc Bangalore has developed a supercritical CO2 Turbomachinery along with high efficiency receiver for solar thermal power plants
- R&D in hydrogen and fuel cells with the focus on production of hydrogen through renewable resources in cost-effective manner, its safe and efficient storage, development of efficient, indigenous and affordable fuel cells for stationary and transport applications, and demonstration of hydrogen and fuel cell technologies in various niche applications

Review of Scheme

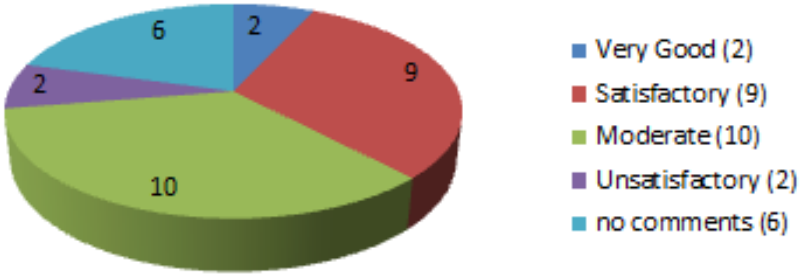
- The Review is being done in two ways panel of Expert,
- First panel of experts of various field like solar, wind, biogas, hydrogen etc reviewed through online feedback and
- The Committee is to review overall R&D Policy and projects of Renewable Energy.

Review of Solar PV

Solar (SPV-14 nos) : Panel: 1

1. Prof. Vikrarn Kumar, Emeritus Professor, IIT Delhi
2. Prof. J. Vasi, IIT Bombay
3. Dr. Sudip Bhattacharya, Former GM-head BHEL

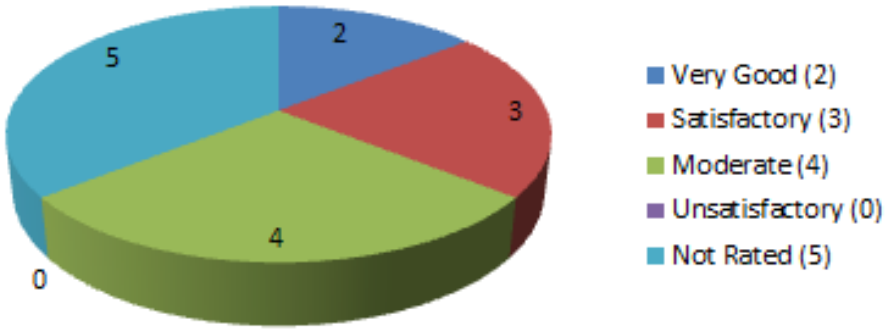
Reviewed 14 R&D Project in which 7 projects in details



Review of Solar Thermal R&D

- Prof. S. Srinivasa Murthy, IISc., Bangalore
- Prof. J. Vasi, IIT, IIT Bombay

Reviewed 9 R&D projects and 4 projects in details

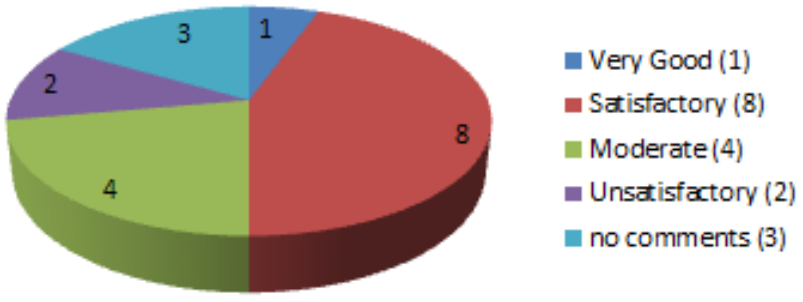


Review of Fuel Cell, Hydrogen & Storage Tech R&D Projects

New Technology (11 nos): Panel;2

1. Prof. S. Srinivasa Murthy, IISc., Bangalore
2. Prof. S.N. Upadhyay, Emiritus Professor, IIT BHU

Reviewed 11 R&D Project in which 4 projects in details

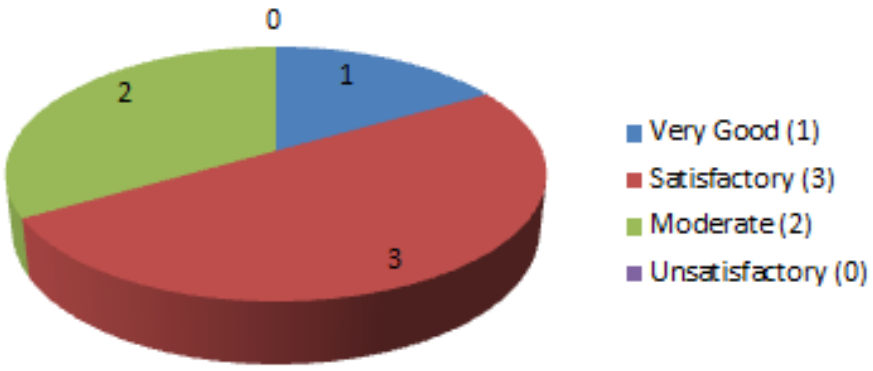


Review of Bio Gas

Bio Gas: Panel:3

1. Dr. Manju Sharma, Institute of Chemical Technology, Mumbai
2. Dr. Shailey Singhal University of Petroleum & Energy Studies, Dehradun.

Reviewed 3 Bio Gas R&D Project in details

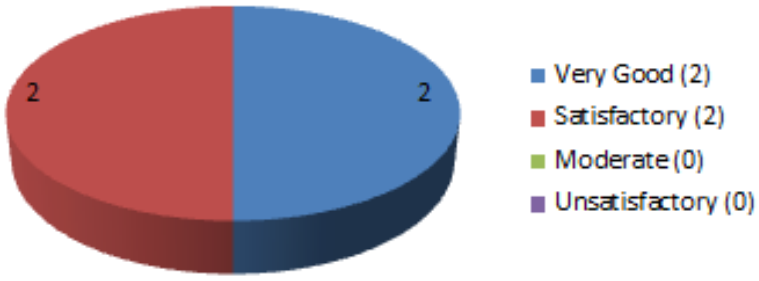


Review of Wind Energy

Wind Energy (2 nos): Panel 4

1. Dr NS Prasad, TERI, New Delhi
2. Dr. Nilanjan Saha IIT Madras

Reviewed 2 R&D projects in details



Thank You

Conclusion and Recommendations

Policy Recommendations:-

- Remodelling the scheme broadly around the practice followed by Arpa-e* or DARPA** programs of US:
    - We could invite competitive proposals from industry in collaboration with academia/research institutions that could deliver on a specified user need while pushing the technology envelope.
    - Deliverables including the performance and qualification requirements could be should be clearly spelt out.
    - There should be independent test houses to ascertain performance of products developed.
    - There should be support for guaranteed purchase up to a specified quantum provided the products meets the specified qualification and the price.
- The focus of science departments (DST) could be on laboratory development leading to proof-of concept level development and that of user ministries on commercialisation / market entry of a developed technology, MNRE should focus on translating the technology from low TRL to high TRL ready for commercialisation.
- Support for 100% grant for the industry is important and should be incorporated in the policy. A project can be evaluated and funded according to the gap in viability. For industry, funding should be in graded manner. 100% for first level research and 50% for prototype/product developmental research and viability gap funding for larger size demonstration projects.
- Involvement of the industry from the initial level of R&D should be high. This will expedite commercialization of technology.
- Increasing budget and more projects should be taken up be in a time bound manner.

Technical Recommendations

- There is need to maintain a centralized database/dashboard to avoid duplicity of projects funding and display of projects available at different TRL levels for taking to further TRL level or to commercialization.

- PMC review meetings should be more frequent with major emphasis on monitoring the progress viz a viz sanctioned objectives and at least one in a year on site visit for evaluations of the sanctioned project should be done during the project duration. Besides, intermittent progress review meetings can be conducted through video conferencing in a year.
- Proposal review time of R&D projects should be shortened for timely processing.
- Involving industry at research and demonstration stages are very important and industrial validation of technology should be mandatory.

1. Solar PV

- Indigenous technology development in the field of Solar cells, inverters, Flexible solar cells-roll to roll, pervoskites, Agri RE tech and PV–CSP-wind-storage hybrid should be encouraged. Proposal review time should be shortened. R&D roadmap for 2021 - 2030 with clear targets should be made.
- Emphasised development of commercially viable microgrids in urban and rural areas as a better means of reaching the unreached as well as creating a pull for distributed solar generation

2. Solar Thermal

- Growing solar integration in our grids there would be additional system and grid costs in the transmission and distribution domain which can be minimised with large capacity through solar thermal with thermal storage along with strong performance guarantee.
- Commercial scale PV CSP hybrid is a need of an hour as the storage cost of CSP is significantly lower as compared to existing PV with Li ion battery storage and support to be given with strict cost target so as to make them cost competitive.
- Potential for integration of existing coal based power plants with CSP for pre-heating, hybridisation should be emphasized.
- Solar thermal with supercritical CO2 Brayton cycle which can significantly reduce the viable plant capacity
- There is huge scope in solar thermal cooling and industrial heat application and for domestic industry in CSP as almost all components can be locally manufactured.

3. Bio Gas

- Bio energy should be one of the key areas of the project and the need for some large commercial project is the need of an hour.
- Clean cooking fuel is an important thrust area and compressed biogas has huge potential for cooking applications.
- Utilisation of surplus agri residue as well as other significant biomass resources for energy production is an important thrust area in the country even in the context of thrust to rural/tribal economy.
- For Bio gas projects, logistic supply and managements should also be the part of R&D projects as most of the project fails due to improper supply of feedstocks. Focus should be laid on development of decentralized models and feedstock agnostic technologies.
- Research areas such as improvement in process operations, microbiology of the digester, consortium design and dynamics should also be considered for R&D proposals.

4. Fuel cell and Hydrogen tech.

- Emphasised on the potential cost competitiveness of fuel cell based electric and hydrogen based commercial transportation in comparison with diesel.
- Significant emphasis to be given to hydrogen infrastructure that includes storage cylinders. Carbon composite cylinders are a mature technology and India could become an export hub due to low cost of labor.
- Combined Heat, Power and Cooling running on Fuel cells for distributed generation can be a very large market for fuel cells and should be a thrust area in the field of Hydrogen. Small Distributed Generation applications such as telecom towers are a huge market to be explored.

5. Wind

- LiDARs are important for research and scaling up of projects. Hence, MNRE will require a policy that focuses on increased number of LiDAR installations and Horizontal/Vertical Axis turbine.

- Indian islands (Andaman and Nicobar as well as Lakshwadweep) can easily be taken as offshore wind installation as one wind turbine (5MW) would be suffice to power these islands as well as drinking water by desalination.
- There should be a Centre of excellence of Wind Energy Technology to explore new research in wind energy.