

ANNUAL REPORT 2022-23



National Institute of Solar Energy

(An Autonomous Institute of Ministry of New and Renewable Energy, Government of India)



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2022-23



National Institute of Solar Energy
(An Autonomous Institute of Ministry of New and Renewable Energy, Government of India)
Gurugram - Faridabad Road, Gwal Pahari,
Gurugram - 122003 (Haryana)

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भूपिन्दर सिंह भल्ला, ना.प्र.से.
सचिव
Bhupinder S. Bhalla, IAS
Secretary



भारत सरकार
नवीन और नवीकरणीय ऊर्जा मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF NEW AND RENEWABLE ENERGY



President's Message

As President of National Institute of Solar Energy (NISE), it is my privilege to reflect on the activities of the institute for the year 2022-23.

At the outset, I would like to appreciate the R&D and related activities undertaken by NISE, as they align with the various objectives of MNRE towards the promotion of solar energy in the country.

The NISE journey mirrors the goals set forth by the National Solar Mission. Beyond the charming vistas of NISE's campus, it is a hub of research, development and expertise – a dedicated ecosystem working to propel India to the forefront of the worldwide solar energy landscape. The sunlit hallways of NISE resonate with collaborative endeavours, shared visions and a commitment to fostering sustainable transformation.

In the labs, where innovation meets photons, NISE has achieved impressive milestones. NISE has made significant strides in enhancing the efficiency of PERC-type solar cells, playing a vital role in meeting the nation's renewable energy targets. The NABL-accredited labs are a proof of our steadfast commitment to quality, meeting both national and international standards. NISE's story goes beyond traditional solar boundaries.

Apart from R&D and innovations, the institute has been supporting other activities of the Ministry such as ALMM, PLI, Suryamitra programme, etc.

In our pursuit of sustainable energy solutions, I am pleased to introduce the institute's Annual Report for the fiscal year 2022-23. NISE has made significant strides and designed and developed the first working model of large-area secondary reference solar cell. Furthermore, efforts have been made to develop a robust indoor solar cooking system based on thermal energy storage. This report not only highlights a year's worth of accomplishments but also reflects the collective effort of NISE in fostering a brighter, cleaner and more sustainable future.

Bhupinder S. Bhalla
President, NISE & Secretary, MNRE

In the realm of capacity building, NISE conducted a total of 15 International and National level training programs in various domains of solar energy. Notably, under the ITEC program, NISE empowered Mongolian women from rural regions through a three-months hands-on training program, emphasizing the positive impact of solar energy on communities.

The story of NISE is not just about accomplishments but about crafting a narrative of positive change, innovation, and resilience in the realm of solar energy. As we turn the pages of this Annual Report, we extend our heartfelt gratitude to our stakeholders, collaborators, and the dedicated team at NISE. Together, we are shaping a sustainable future through the power of solar energy.


(Lalit Bohra)

Director General

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OVERVIEW

National Institute of Solar Energy (NISE) plays a crucial role in supporting and implementing the initiatives of the Ministry of New and Renewable Energy (MNRE) in the field of solar energy. The activities undertaken by NISE are mainly related to research and development, testing and standardisation, capacity building, managing special projects, etc., in pursuit of the objectives of the National Solar Mission (NSM). During FY 2022-23, NISE was involved in various activities in line with the institute's mandate by utilising its resources and infrastructure. The details of the activities performed during the year are represented in this annual report. Chapter 2 presents the introduction of the institute, its vision, thrust area, and its objectives. Chapter 3 details the activities of various technical divisions pertaining to research, development, and demonstration in solar photovoltaic cells, solar photovoltaic systems, solar thermal and green hydrogen. Chapter 4 represents the testing and standardisation activities of the various laboratories at NISE, such as Solar Cell Testing Lab, Solar PV Module Testing Lab, Solar Inverter Testing Lab, Battery Testing Lab, Solar Water Pump Testing Lab, Solar Light /LED Testing Lab, and Calibration Lab. Skill Development and Capacity Building programs taken up by NISE are provided in Chapter 5. Chapter 6 outlines the outreach activities of NISE, including technical consultancy services, Customer Service Cell (CSC) and implementation of the Approved List of Models and Manufacturers (ALMM). Chapter 7 presents the general activities and facilities, including administrative activities of

NISE. Publications and patents for the year are given in Chapter 8. Finally, the audited financial accounts of NISE for FY 2022-23 have been presented in Chapter 9.

1.1 Key Highlights

Following are the key highlights of NISE during the year 2022-23:

- i. Successfully completed MNRE funded project entitled “Development of high efficiency (21%/19%) PERC type of c-Si/mc-Si solar cells,” and successfully elevated the benchmark efficiency of PERC type solar cells to 22.17%.
- ii. Design and developed a first working model of a large area secondary reference solar cell.
- iii. Successfully completed MNRE funded project entitled “Design and Development of High Efficiency Solar Water Pump” and developed a state-of-the-art testing & R&D facility that can test solar water pumps up to 50 hp capacity.
- iv. NISE has concluded a Ramanujan Fellowship project titled “Buried contacts high efficiency crystalline radial p-n junction Si nanorod solar cell.”
- v. During the year, NISE has applied for two (2) patents and published nine (9) research papers in international journals of repute, and five (5) research papers in international conferences.
- vi. Performance analysis studies were carried out

- on Bifacial modules to estimate the optimum fixed tilt for South-facing Bifacial module for 100 cities of different climatic zones in India.
- vii. Afterlife reliability and performance analysis of mono-crystalline silicon PV module has been performed on the modules that were installed in NISE campus during the year 1999-2000. It was observed that some of the modules can be reused with updated power rating for maximizing their utilization and thus reduce electronics waste.
 - viii. NISE participated in the National Renewable Energy Laboratory (NREL) Pyrheliometer Comparisons (NPC-2022) event at their Solar Resource Research Laboratory in Golden, Colorado, USA. During the event, primary radiometric sensors of NISE were compared with other primary sensors from the world standard groups and the latest traceability from IPC 2021 was transferred to the sensors. The calibration facility at NISE can now transfer these latest radiometer calibration factors to various radiometric sensors that are used in India.
 - ix. NISE was part of a collaborated project between a large global network of PV module manufacturers and PV testing laboratories which aim to design a protocol for Light-elevated Temperature - Induced Degradation (LeTID) detection and screen a large and diverse set of prototype modules for LeTID.
 - x. During the year, a total of 15 numbers of International (4 nos.) & National (11 nos.) level training programs were conducted wherein 521 (123 International & 398 National) participants were trained in various domains of solar energy.
 - xi. NISE conducted a 3 months hands on training for 28 Mongolian women, primarily from the rural regions of Mongolia, for utilizing solar energy for the betterment of their communities under the Indian Technical and Economic Co-operation (ITEC) program.
 - xii. Under Suryamitra Skill Development program, a total of 139 empaneled training centers were allocated batches in the month of March 2023. Also, for the FY 2021-22 targets, 94 batches were allocated to the empaneled centers during the month of October 2022.
 - xiii. During the year, a total of 8 technical consultancy services were carried out by NISE to various public and private companies including UNICEF, Solar Energy Corporation of India, Jaquar and company Pvt. Ltd etc.
 - xiv. NISE laboratories have successfully tested 97 samples through the Customer Service Cell.
 - xv. During F.Y 2022-23, NISE conducted ALMM inspection of 66 solar PV module manufacturing plants in India with a cumulative installed manufacturing capacity of 13 GW.

1.2 Governing Council

The affairs of NISE are managed by a Governing Council (GC) headed by Secretary, MNRE. The GC of NISE comprises of members from related industries, research institutions, Government departments, and experts in the field of solar energy. In FY 2022-23, one GC meeting was held on 1st December 2022 (13th GC meeting).

1.3 Executive Committee

The Executive Committee (EC) of NISE takes decisions related to technical, administration, policy, finance & accounts-related matters and

improves the overall functioning of NISE. EC has five members: Director General, NISE (Chairman), Deputy Director General-I, Deputy Director General-II, and Director as members and Deputy Director (Admin)/Administrative Officer as Member Convener. During the year, a total of three (03) EC meetings were conducted on 2nd May 2022, (43rd EC Meeting), 1st November 2022 (44th EC Meeting), and 20th March 2023 (45th EC Meeting).

FC has three members: Financial Advisor, MNRE as the Chairman, Joint Secretary (Solar), MNRE and DG (NISE). During the year, two (02) meetings of the FC were conducted on 22nd November 2022 (12th FC meeting) and on 16th February 2023 (13th FC meeting). The Finance Committee has approved the Audited Accounts, and the Audited Reports for FY 2022-23 in the meeting held on 19th October 2023.

1.4 Finance Committee

The Finance Committee (FC) of NISE approves the annual accounts of NISE before submission to the GC and Annual General Meeting (AGM). The



INTRODUCTION

National Institute of Solar Energy (NISE) is an autonomous institute of the Ministry of New and Renewable Energy (MNRE), Government of India, mandated for research and development, testing and calibration of solar components, capacity building, and development of solar products and applications. NISE is located in a 200-acres lush green campus at Gwal Pahari, on the Gurugram-Faridabad road in Haryana. The institute is approximately 22 km away from the Indira Gandhi International Airport and 30 km from the New Delhi railway station. NISE is registered as a society under the Haryana Registration and Regulation of Societies Act, 2012 (Registration No. is HR-018-2013-01092).

The technical support of NISE complements the requirements of MNRE towards making India a self-reliable renewal power-producing nation and accept the series of challenges that intervened amidst the implementation of the National Solar Mission (NSM) by the Ministry. NISE has established itself in the solar energy sector through continuous efforts by developing newer technologies and standards and catering to the changing needs of the industry. Furthermore, NISE envisions accelerating the proliferation of the renewable energy sector by intently working together with the Government of India.

2.1 Vision of NISE

To establish itself as one of the world's premier referral leading institute in the field of Solar Energy through Resource Assessment; Research & Development; Design, Development, and

Demonstration of solar energy technologies for various applications; Testing, Certification, and Standardisation; Monitoring and Evaluation; Economics and Policy Planning; Human Resource Development and active collaborations with prominent National & International organisations.

2.2 Objectives

The main objectives of the NISE are as follows:

- (i) To function as the National Research Organization for undertaking and/or sponsoring Research and Development Projects on various aspects of solar energy technologies
- (ii) To act as an Apex Organization for Testing, Certification, development of specifications, and standards
- (iii) To create skilled manpower and offer consultancy services on Solar energy technologies.

2.3 Quality Policy of NISE

NISE is committed to providing performance evaluation and testing services for Solar Cells, PV Modules, Solar Water Pumping System, Inverters, Charge Controllers, Batteries, Advanced Lighting System and calibrating services for Solar cells, PV Modules, Pyrheliometer, and Pyranometer. The test facilities established at NISE meet the requirements to conduct the tests as per the National/International Standards.



Figure 2.1: Aditya Bhawan Building of NISE



Figure 2.2: Surya Bhawan Building of NISE

This is being achieved by using the best engineering practices, continuous upgradation of the infrastructure, and updating of the state-of-the-art test facilities, test methods, test personnel and continual improvement in the effectiveness of the Quality Management System as per International Standard ISO 17025:2017.

2.4 Organisation Structure of NISE

The rules of affairs at NISE are managed by a Governing Council chaired by Secretary, MNRE, and an Executive Committee chaired by Director General, NISE. An organisational chart of the structure and management of NISE is shown in Figure 2.3.

The Governing Council comprises of 18 members from industry, premier institutions, MNRE, NISE and experts from other reputed organisations. The council is chaired by the Secretary of MNRE who is the ex-officio President, NISE. The Executive Committee, headed by DG, NISE has five members to manage the day-to-day affairs of NISE and to take decisions on matters under the power delegated to it. The Finance Committee of NISE has three members comprising of Financial Advisor (MNRE) as the Chairman, Joint Secretary (Solar), MNRE and DG (NISE). The Deputy Director Generals are supported by Directors, Administrative officer, Deputy Directors, Assistant Directors, and Executive Assistants for various technical and administrative activities.

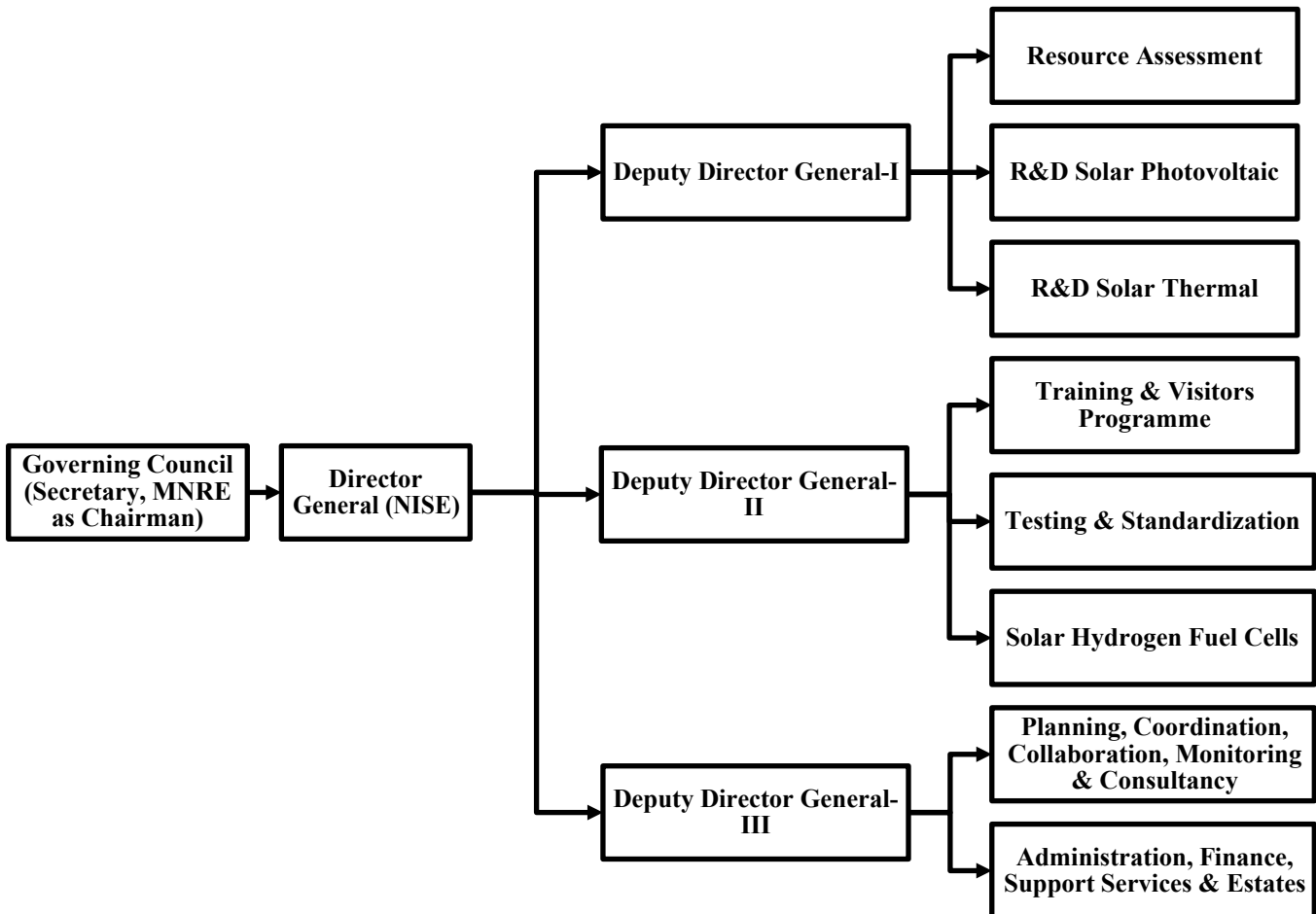


Figure 2.3: Organisational Structure of NISE

2.5 Thrust Areas

The basic function of NISE is to serve as a technical focal point in solar energy-related areas. NISE is committed to performing at its best in all spheres relating to solar energy and continually provides assistance and guidance with a high-quality standard in its work. NISE recognises the development process and continuously relates to significant and notable changes in the solar industry. NISE has the following thrust areas for its contribution and knowledge exploration.

i. To work increasingly in frontline areas that transcend discipline, the following thrust areas form part of this effort:

- Research and Development in Solar Photovoltaic and Solar thermal systems
- Solar Resources Assessment
- Testing of Solar Systems and devices (both large and small).
- Standardization and Certification
- Database Management and Information dissemination
- Capacity Building, training, teaching and visitor's programme
- Development of Solar Energy Products & Hybrid System
- Consultancy Services, Monitoring, and Collaborations (National and International)
- Innovations, solar product development & commercialisation
- Solar Hydrogen and Fuel Cell

ii. To have a perception and value system

appropriate to the pursuit of high engineering science to meet the critically evaluated need of the industry.

- iii. To maintain and foster interactive linkages with leading technological Institutions and Institutes of research in India and abroad.
- iv. Interface between Government, Industry, Academia and Individuals.

2.6 Major Activities

Major activities of the institute include:

- i. Assisting the Ministry in implementing the NSM objectives through appropriate mechanisms, evolving Science & Technology (S&T) programmes and projects, managing special projects, overseeing and coordinating with all relevant stakeholder agencies in the pursuit of the above objectives.
- ii. The institute is responsible for providing thrust to R&D in solar energy and related technologies under the Mission. It would facilitate work related to demonstration and technology validation projects. The institute will also consider the sector-specific R&D needs to commercialise solar applications. These target sectors could be buildings, rural areas, and industries for lighting and any other applications. The objective of solar application and R&D efforts should also target the replacement of kerosene and diesel used by the sectors stated above.
- iii. The institute is responsible for R&D, resource assessment, training, testing/standardisation work assigned to the institute by the Ministry from time to time. It will maintain a data bank for use by industry and other institutions.
- iv. The institute also undertakes R&D projects on

- different aspects of solar energy technologies, hybrid systems and storage techniques/ systems.
- v. The internal administrative functions, international cooperation projects on research, training, and testing, technology validation are also undertaken by the institute.
 - vi. The institute also works as the Secretariat for the work of the R&D Advisory Council. The Solar Research Advisory Council facilitates the development of a technology roadmap and provides inputs on all matters related to R&D and capacity building to the Mission Steering Group. The institute also works closely with the Solar Energy Corporation of India, set up by the Ministry for the implementation of the Mission.
 - vii. The institution, under the guidance of the Ministry and the Mission Steering Group, is responsible for Coordination with (a) other Centres of Excellence identified under the Mission, (b) R&D projects funded in the field of solar energy in the country, (c) other S&T Ministries/Organisations in the country.
 - viii. The institute strives to bridge the gap between existing R&D institutions and industry and get the industry on board through partnership programmes and projects.
 - ix. The institute collaborates with international S&T organisations for R&D and capacity-building activities in the areas of solar energy assigned to the institute by the Ministry from time to time.
 - x. The institute keeps track of the latest global developments based on technology forecasting and fore sighting relating to solar energy and related technologies, including storage techniques, and provides inputs to the Ministry and the Mission Steering Group for the accelerated development of indigenous solar energy technologies and industry in the country.
 - xi. The institute also provides technical support to other R&D and testing organisations, as considered necessary.
 - xii. The institute assists the Ministry in the preparation of a technology roadmap and the related S&T policies for effective implementation of the S&T component of the Mission.
 - xiii. The institute also coordinates the work of technical monitoring of projects covered under the S&T roadmap for the Mission and undertakes technical studies and evaluations.
 - xiv. The institute is eligible to receive research grants from MNRE, and other Ministries/ organisations, including international funding to carry out various assigned tasks and R&D activities.
 - xv. The institute also supports capacity building and supports students, teachers, and research personnel to work for higher degrees, including Ph.D. The institute would develop suitable linkage with various academic and research organisations for this purpose.
 - xvi. Any other tasks assigned by the Government from time to time.



RESEARCH DEVELOPMENT AND DEMONSTRATION

NISE has established itself as a leading research institute in the field of solar energy by undertaking innovative RD&D projects on various solar energy technologies, throughout the years. Areas of RD&D activities includes Solar photovoltaic cell,

Solar photovoltaic module, solar thermal, green hydrogen and allied applications. During the year, 11 RD&D projects were carried out at NISE as listed in Table 3.1.

Table 3.1. List of RD&D projects undertaken by NISE during the year

Sl. No.	Project	Project objectives	Funding Agency
1.	Development of high efficiency (21%/ 19%) PERC type of c-Si/mc-Si solar cells A joint project between NISE and BHEL	<ul style="list-style-type: none"> To develop Passivated Emitter and Rear Contact (PERC) type solar cells with benchmark efficiencies in the country 	MNRE
2.	Design, development and qualification of large area (156 mm x 156 mm), secondary reference solar cells	<ul style="list-style-type: none"> To develop large area (156 mm x 156 mm) secondary reference solar to replace conventional small area (20 mm x 20 mm) secondary reference solar cell 	DST
3.	Buried contacts high efficiency crystalline radial p-n junction Si nanorod solar cell	<ul style="list-style-type: none"> To develop a solar architecture that enables the use of low grade silicon to achieve a high efficiency around 22% 	SERB
4.	Performance Analysis of Bifacial Module in different climatic zones in India	<ul style="list-style-type: none"> To estimate the optimum fixed tilt for South-facing Bifacial module for 100 cities of different climatic zones in India 	NISE
5.	After lifetime reliability and performance analysis of PV modules	<ul style="list-style-type: none"> To study the reliability and performance analysis of mono-crystalline silicon PV module after its lifetime 	NISE

6.	Effect of UV irradiation on PV modules and their simulation in newly designed site-specific accelerated ageing tests	<ul style="list-style-type: none"> To design accelerated UV stress testing condition for different climatic zones of India 	NISE
7.	Simulation of Solar Photovoltaic technologies for efficiency enhancement	<ul style="list-style-type: none"> To enhance the efficiency of PV module technology by utilization of maximum light without compromising the electrical properties 	NISE
8.	High-Efficiency Solar Water Pumping Systems	<ul style="list-style-type: none"> 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%) 	MNRE
9.	Optimization of Solar Photovoltaic Based Water Pumping Performance with DC Motor	<ul style="list-style-type: none"> To carry out optimization studies for solar photovoltaic based water pumping with DC motor 	SERB-TARE
10.	Atmospheric water generator using desiccants for generation of pure water from air	<ul style="list-style-type: none"> To design and develop a lab-scale prototype for generating water from air using desiccants 	NISE
11.	Setting up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Gurugram	<ul style="list-style-type: none"> To operate and maintain the existing PV based green hydrogen production cum dispensing station at NISE To augment the green hydrogen production capacity to 15 Nm³/hr from the existing 5 Nm³/hr Facilitating completion of field trials and demonstration of hydrogen fueled vehicles at NISE, and To create awareness programmes on different aspects of hydrogen energy 	MNRE

Project wise major research activities carried out at NISE are detailed as under:

3.1 Development of high efficiency (21%/ 19%) PERC type of c-Si/mc-Si solar cells

This MNRE funded project was taken up in collaboration with Bharat Heavy Electricals Limited Amorphous Silicon Solar Cell Plant (BHEL ASSCP), Gurugram. The main objective of the project was to develop Passivated Emitter and Rear Contact (PERC) type solar cells with benchmark

efficiencies in the country. During the year, several samples have been characterized by using optical microscopic, surface profilometry and electro-chemical capacitance voltage profilometer. Optical microscopy was also used to characterize laser ablation of Aluminium oxide by green nano laser and textured top surface of full-grown solar cell, as shown in Figure 3.1 Surface profilometry was used to measure stress in cells during different processing steps.

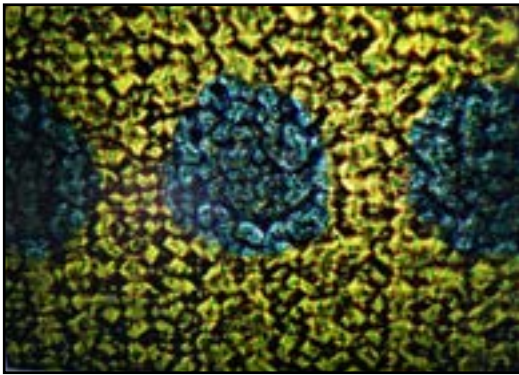


Figure 3.1: Laser ablation Aluminium oxide

The project's focus was on the process optimization that has yielded significant advancements across various stages. In the diffusion phase, enhancements were made to both emitter thickness and doping profiles. Under Plasma enhanced chemical vapor deposition (PECVD), a multi-faceted approach was adopted, encompassing the exploration of mono and bi-layer configurations. This included the strategic implementation of a sandwiched SiO_x layer for front passivation, alongside a dynamic combination of AlO_x , SiON_x , and SiN_x for the dielectric stack. To comprehensively understand the implications of metallization laying, a stress analysis was also undertaken. Collectively, these process optimization strides mark a substantial leap forward, with the potential to greatly enhance the efficiency and reliability of the overall photovoltaic technology.

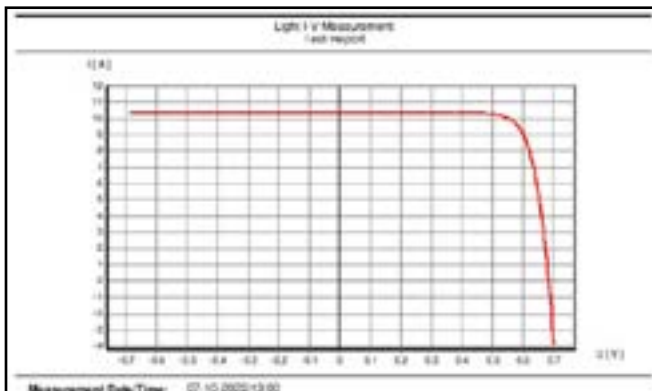


Figure 3.2: Characteristic I-V Curve of the developed Champion PERC Cell

The project was completed on 31st December, 2022 with successfully elevating the efficiency benchmark of PERC type solar cells to 22.17 % within a specific batch of cells and thus underscores the project's significant contribution to enhancing the viability and effectiveness of PERC solar cell technology.

3.2 Design, development and qualification of large area (156 mm x 156 mm) secondary reference solar cells

NISE is working on a DST-funded project to indigenously design, develop and qualify large area (156 mm x 156 mm) secondary reference solar cell to replace the conventional small area (20 mm x 20 mm) secondary reference solar cell. This will reduce the influence of measurements inhomogeneity of solar simulators and thereby increasing the measurement accuracy. These reference cells can also be employed for measuring solar irradiation and eventually monitoring solar panel/plant performance.

During the year, manpower recruitments in various positions under the project have been completed and a vacuum annealing furnace was procured and installed at NISE. Procurement for remaining equipment is in process. Experiments are being conducted on complete cells, bare silicon wafers and textured silicon wafers before and after metallization. The experiments include vacuum annealing, minority carrier lifetime testing and light induced degradation of the samples at various profiles.

The work on stabilization of solar cells is undergoing and its anodized aluminium casing has been developed. The first prototype model developed at NISE is shown in Figure 3.3



Figure 3.3: Secondary Reference Solar Cell Package developed at NISE

3.3 Buried contacts high efficiency crystalline radial p-n junction Si nanorod solar cell

NISE has concluded a Ramanujan Fellowship project titled “Buried contacts high efficiency crystalline radial p-n junction Si nanorod solar cell.” The project aims to design and fabricate a solar cell architecture that will enable the use of low-grade silicon material to produce high efficiency cell with efficiency around 22%. During this year focus was given to synthesizing monosize silica

microparticles with different diameters and coating of closed pack monolayer of silica particles on the surface of silicon wafers (Figure 3.4). From this closed pack layer, non-closed pack monolayer was obtained using reactive ion etching and this non-closed pack layer was used as a mask to obtain size control Si microwire/nanorod arrays (Figure 3.5). The project was completed on 1st November, 2022. NISE has now taken up further works for optimization of the diffusion process for the fabrication of nanorod solar cells.

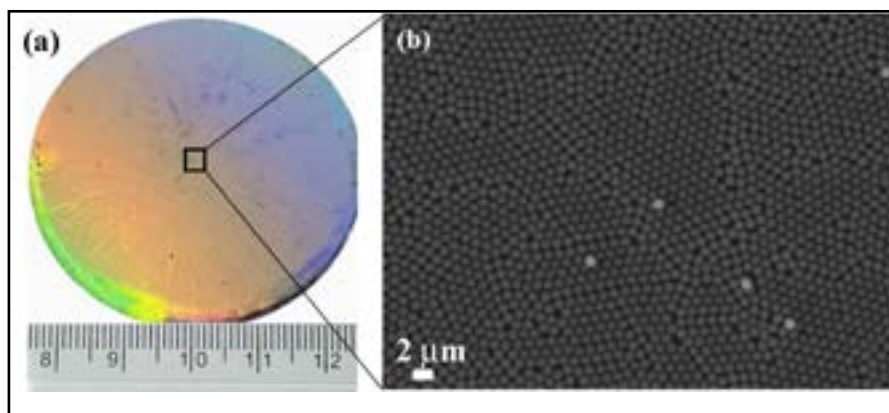


Figure 3.4: (a) Closed pack monolayer pattern of SiO₂ microparticles on 2-inch Si wafer under white light illumination, (b) SEM image of the closed pack monolayer of SiO₂

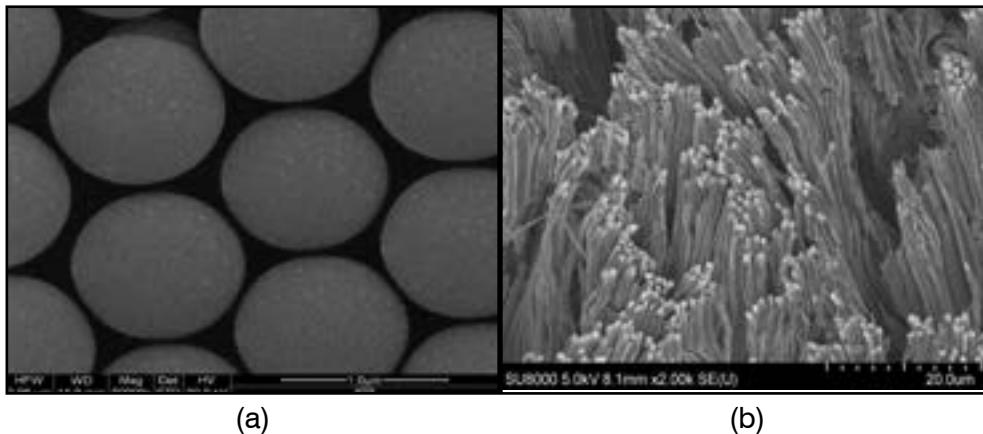


Figure 3.5: (a) SEM images of non closed pack monolayer of silica particles obtained after RIE process (b) FESEM images of Si microwire arrays

3.4 Performance Analysis of Bifacial Module in different climatic zones in India

The project aims to estimate the optimum fixed tilt for South-facing Bifacial module for 100 cities of different climatic zones in India. The optimum tilt varies from 23° in Alleppey (Kerala) to 43° Gilgit Baltistan (Jammu & Kashmir). The annual energy output of bifacial Module at optimal tilt was also studied for 100 Cities of India using System Advisor Model (SAM) software.

It was observed that, Pasighat, Arunachal Pradesh has the minimum annual energy output of 1427.8kWh/kWp while Aksai Chin, Leh has the maximum annual energy output of 2325.7 kWh/kWp. It was further observed that optimal tilt increases with increase in latitude. The highest and lowest bifaciality gain value observed among the 100 cities of India was 11.7% for Itanagar, Arunachal Pradesh and 7.9% for Gwalior, Madhya Pradesh respectively. The estimated Annual Energy Output (kWh/kWp) of Bifacial PV Power Plant for 100 cities in India is given at Figure 3.7.



Figure 3.6: Bifacial solar PV modules at vertical tilt (5 kWp)

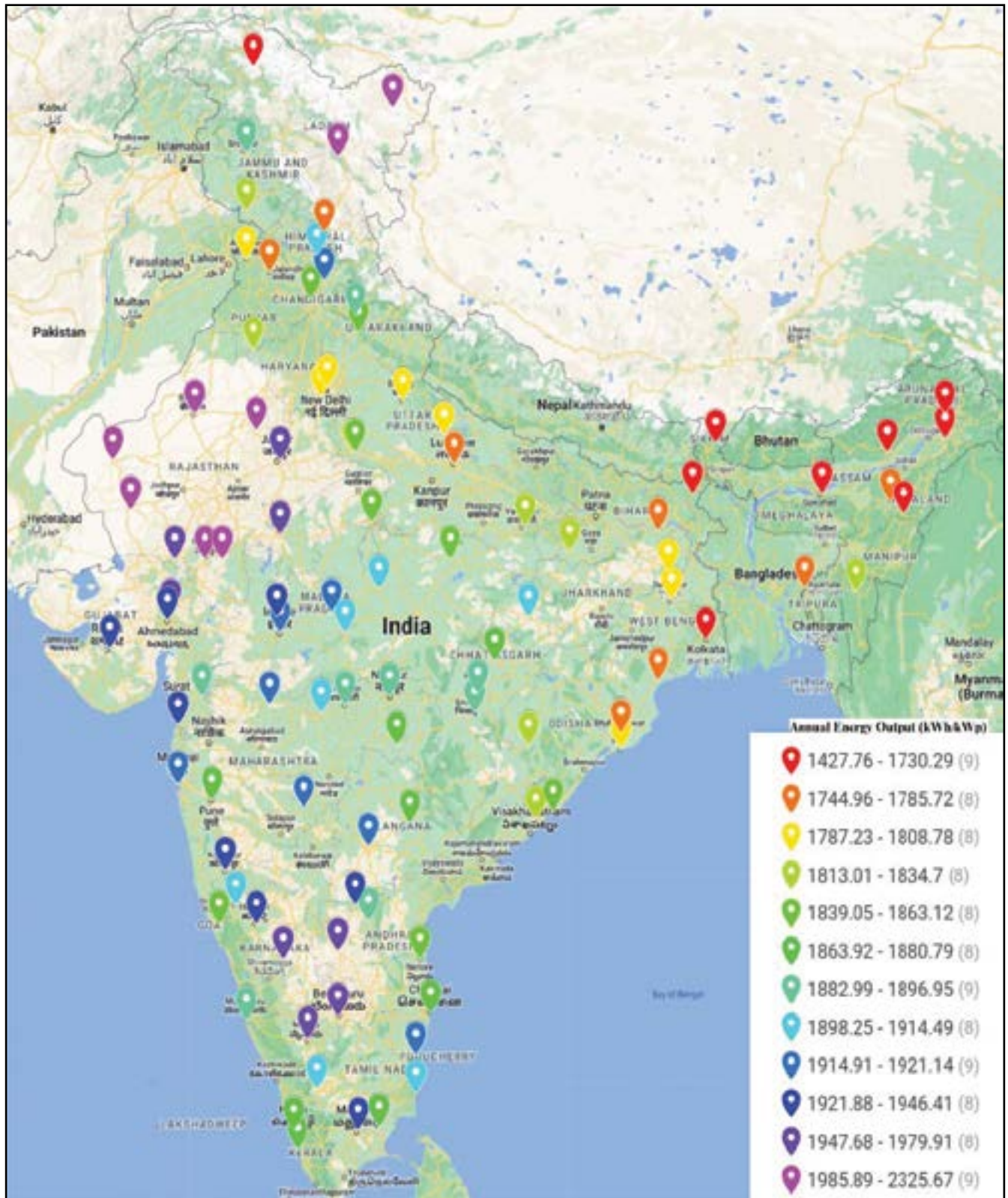


Figure 3.7: Estimated Annual Energy Output (kWh/kWp) of Bifacial PV Power Plant for 100 cities in India

3.5 After lifetime reliability and performance analysis of PV modules

In this study, reliability and performance analysis of mono-crystalline silicon PV module after its lifetime (as declared by manufacturer datasheet; around 20-25 years) has been performed that were installed in NISE campus during the year 1999-2000 and are still generating power. Visual inspection, indoor Current-Voltage (I-V) characteristics at Standard Test Condition (STC), Electroluminescence (EL) imaging, Infrared (IR) imaging, and insulation tests were performed for all the PV modules. The modules show average

power degradation of 0.95 % per year. Figure 3.8 shows the defects observed during visual inspection, EL imaging, an IR imaging in two different PV modules with more than 20 years field exposure at NISE.

Detailed degradation rates per year for all the electrical parameters of the PV module are shown in Figure 3.9, wherein it can be observed that the degradation in Voc after initial 10 years (2000–2010) and in last 12 years (2010–2022) consecutively is around 0.02% (per year) and 0.16% (per year). These results indicate that the junction quality and the shunt resistance of the of the PV modules has not degraded significantly.

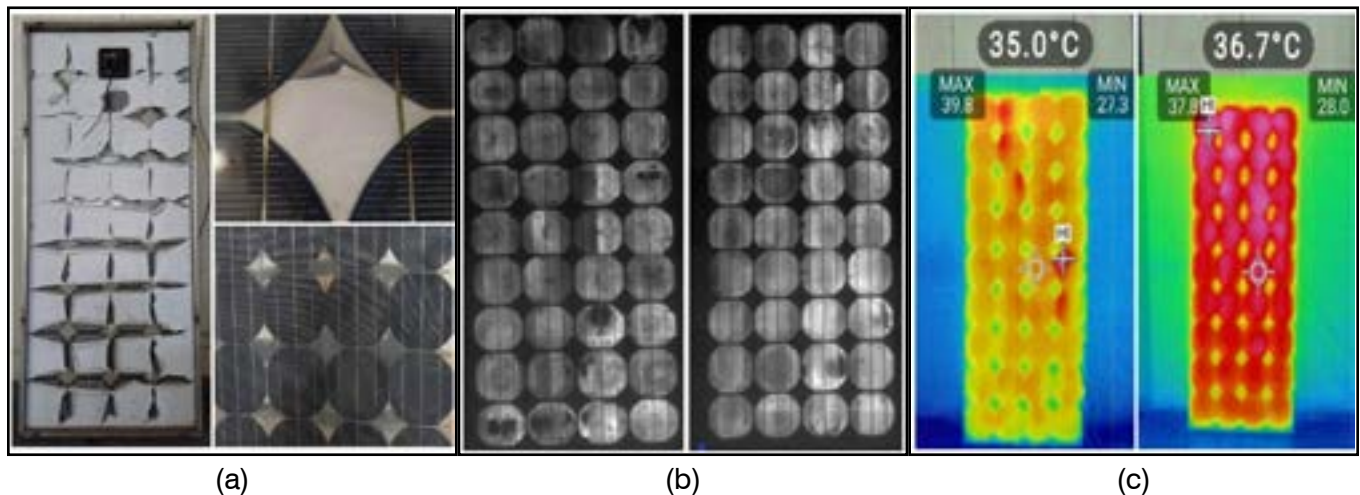


Figure 3.8: Defects observed in PV modules that were operational in field for more than 20 years during (a) visual inspection, (b) EL imaging and (c) IR imaging

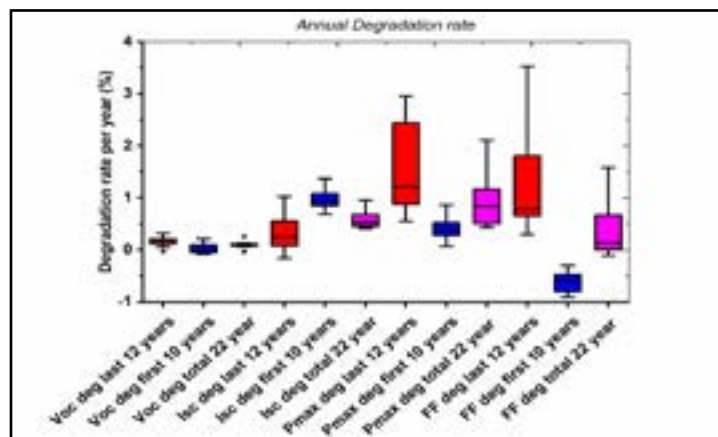


Figure 3.9: Annual degradation rate of the electrical parameters of Mono-C-Si PV module after its lifetime

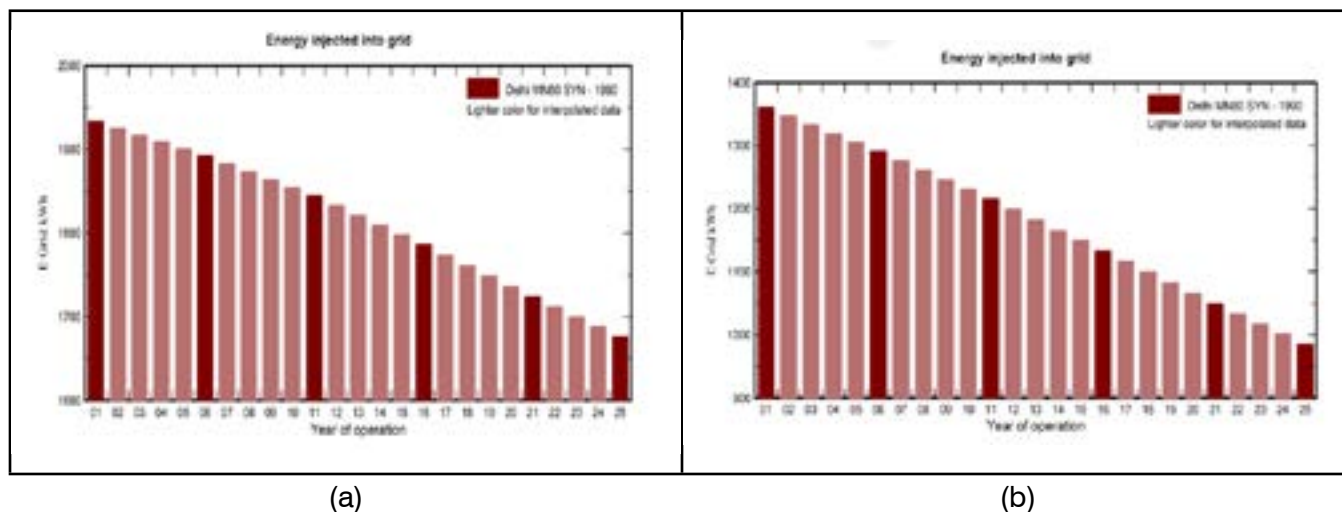


Figure 3.10 (a) Energy estimation of the power plant using the initial I-V data (year 2000) of PV module. (b) Energy estimation of the power plant using the I-V data (year 2022) of 22 years field exposed PV modules

Based on the study, a 1kWp AC SPV plant has been simulated in PVSyst consisting 15 PV modules of 78.4Wp each according to their initial STC data in the year 2000, Figure 3.10 shows the simulated energy data of power plant for the 22 years field exposed PV module. It was observed that some of the modules can be reused after their lifetime with updated power rating. For calculating the energy yield, one should use the current degradation rate and some crucial test should be performed to ensure the safety and performance of these refurbished PV modules. The visual inspection, EL imaging, IR imaging and the insulation test can predict the expected performance and safety of the modules. Reusing the PV module will maximize their utilization and reduce the electronics waste which will be generated from targeted use of solar PV modules.

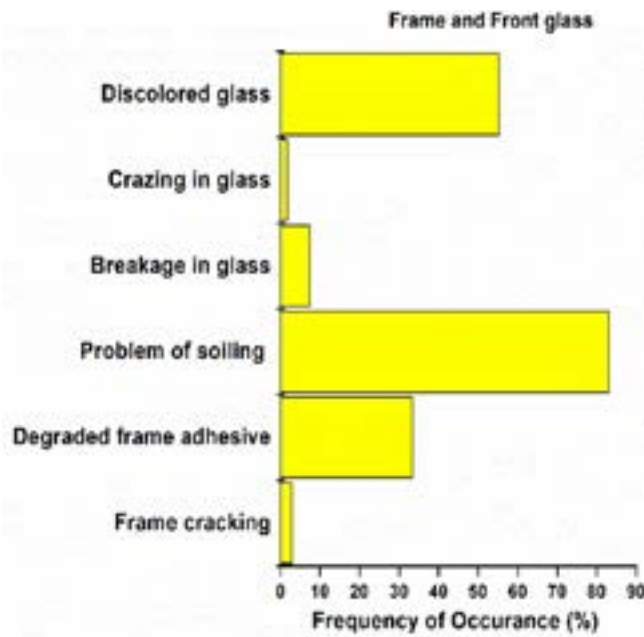
3.6 Effect of UV irradiation on PV modules and their simulation in newly designed site-specific accelerated ageing tests

One of the significant environmental stress factors for degradation in the PV module is UV irradiation

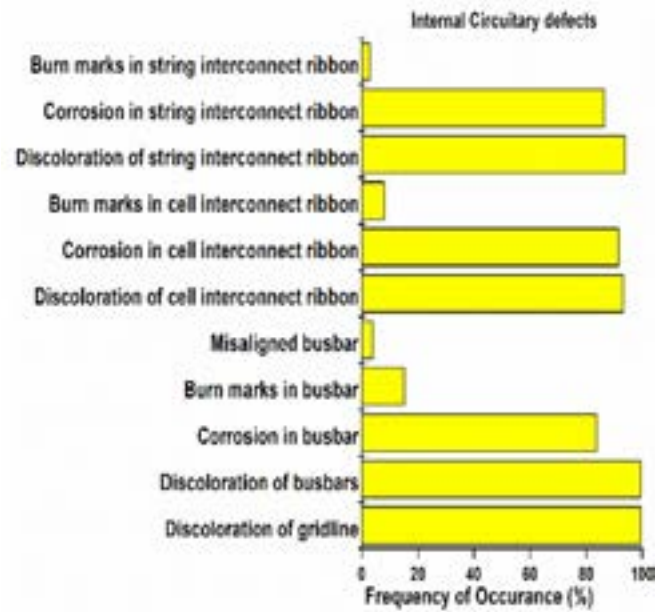
exposure in the field during its operational lifespan. NISE, in this study, has carried out a degradation analysis of 20-year field-operated PV modules.

Based on the literature resources, efforts have been made to analyze the role of UV irradiation on the degradations that happened during 20 years of field operation of the PV modules. Average P_{max} , I_{sc} and V_{oc} degradation are found to be 1.49 %/year, 0.59 %/year and 0.29 %/year after 20 years of exposure, respectively. The effect of UV irradiation and temperature in indoor conditions has been analyzed for the 20 years of field-exposed PV modules. The effect of browning in the module is also studied in this research work at the cell level. Figure 3.11 demonstrates various defects which are observed after 20 years of the field operation at NISE.

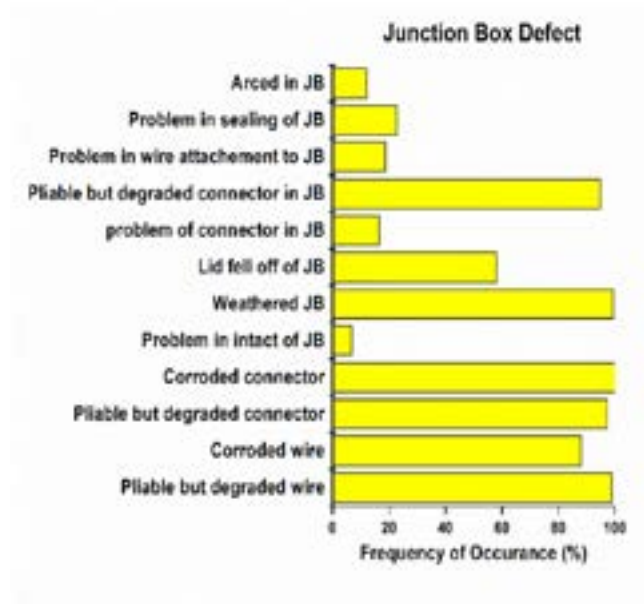
A comparison of electrical parameters has been done with two modules (Module 1 & Module 2) having same model number but different defects after 20 years of field exposure at NISE. Figure 3.12 demonstrate the solar cell wise distribution of different electrical parameters of Module 1 & Module 2.



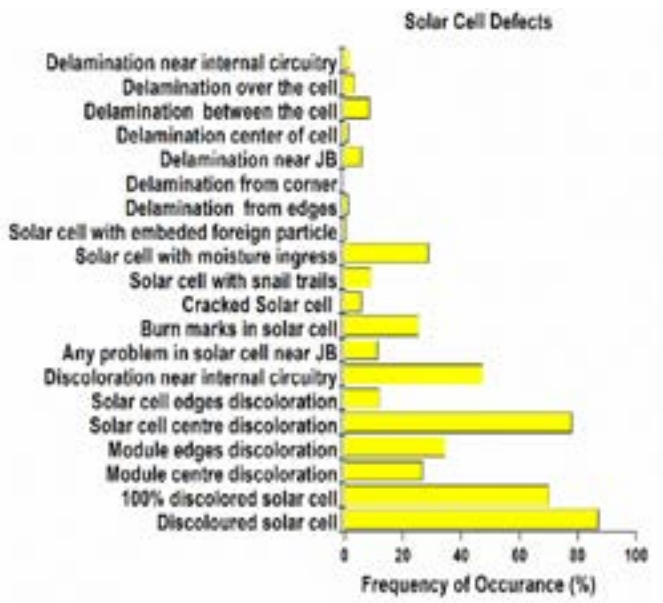
(a)



(b)

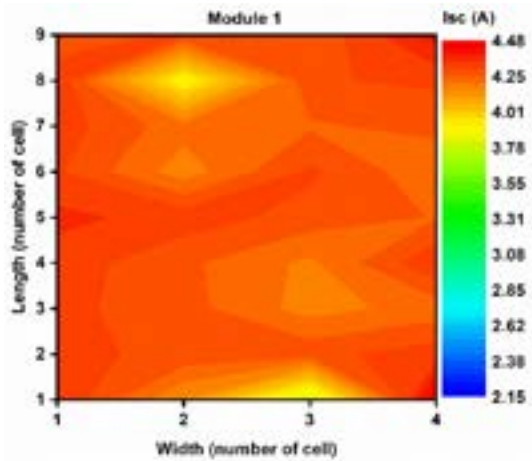


(c)

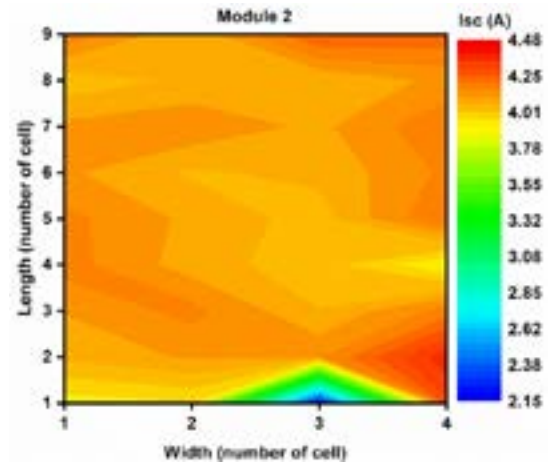


(d)

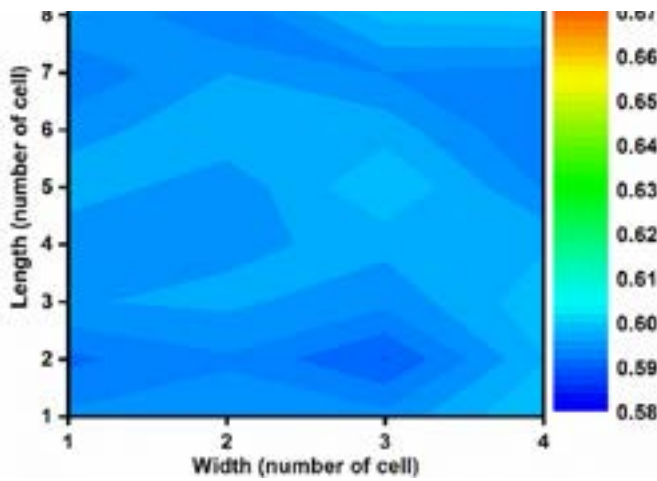
Figure 3.11: Distribution of defects of PV modules in (a) Frame & front glass, (b) Internal circuitry, (c) Wire, connector & junction box, and (d) Solar cells.



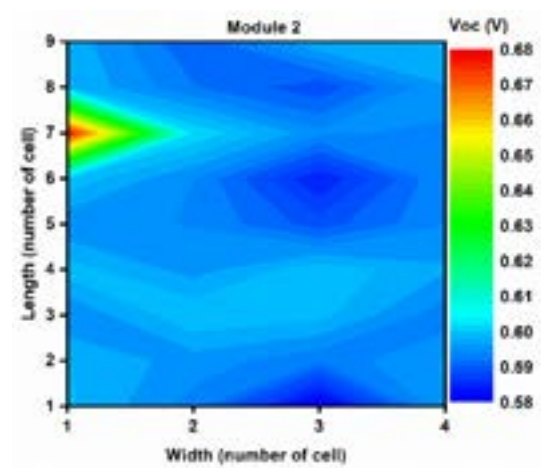
(a)



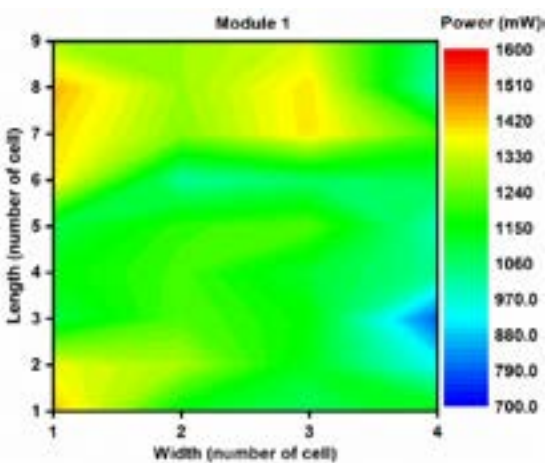
(b)



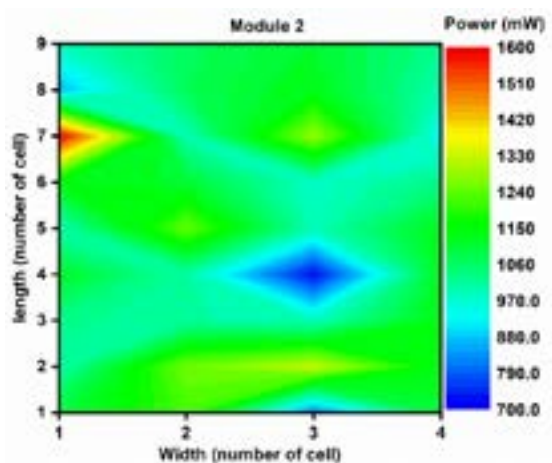
(c)



(d)



(e)



(f)

Figure 3.12: Distribution of: (a) I_{sc} of module 1, (b) I_{sc} of module 2, (c) V_{oc} of module 1, (d) V_{oc} of module 2, (e) Maximum power of module 1, and (f) Maximum power of module 2

3.7 Simulation of Solar Photovoltaic technologies for efficiency enhancement

Moth eye-like nanostructured anti-reflection coatings are an innovative concept for the fabrication of advanced and efficient solar cells due to their low reflection attributes when applied on the top of a cell. However, owing to its high surface area and low aspect ratio, the minority carrier lifetime and wide-angle light collection may be compromised, and these are treated as the major barriers to using such moth eye like nanostructured anti-reflection coatings in real cases. To overcome this problem, this work has been aimed to introduce a 'cross fertilized' biomimetic structure between the 'moth eye' and 'cacti', so that maximum light can be utilized without much compromising the electrical properties. Detailed experimental and

theoretical analyses on the optical and structural properties of such cross-fertilized nanostructures were carried out, giving emphasis on some crucial parameters like wide-angle light collection, unified photon-electron harvesting capabilities, and surface recombination velocity. Figure 3.13 shows the transformation of the developed silicon nanostructures from low aspect ratio (moth eye) to high aspect ratio (cactus) geometries through FESEM images.

Finally, practical implementation of this optimized geometry has been carried out by the formation of 'nano-cone'-based black c-Si structures through a metal-assisted chemical etching technique, followed by the fabrication of black p-c-Si/n-a-Si:H flexible solar cells. Figure 3.14 shows the electric field profiles for the biomimetic structure with aspect ratio- 3 at the different wavelengths.

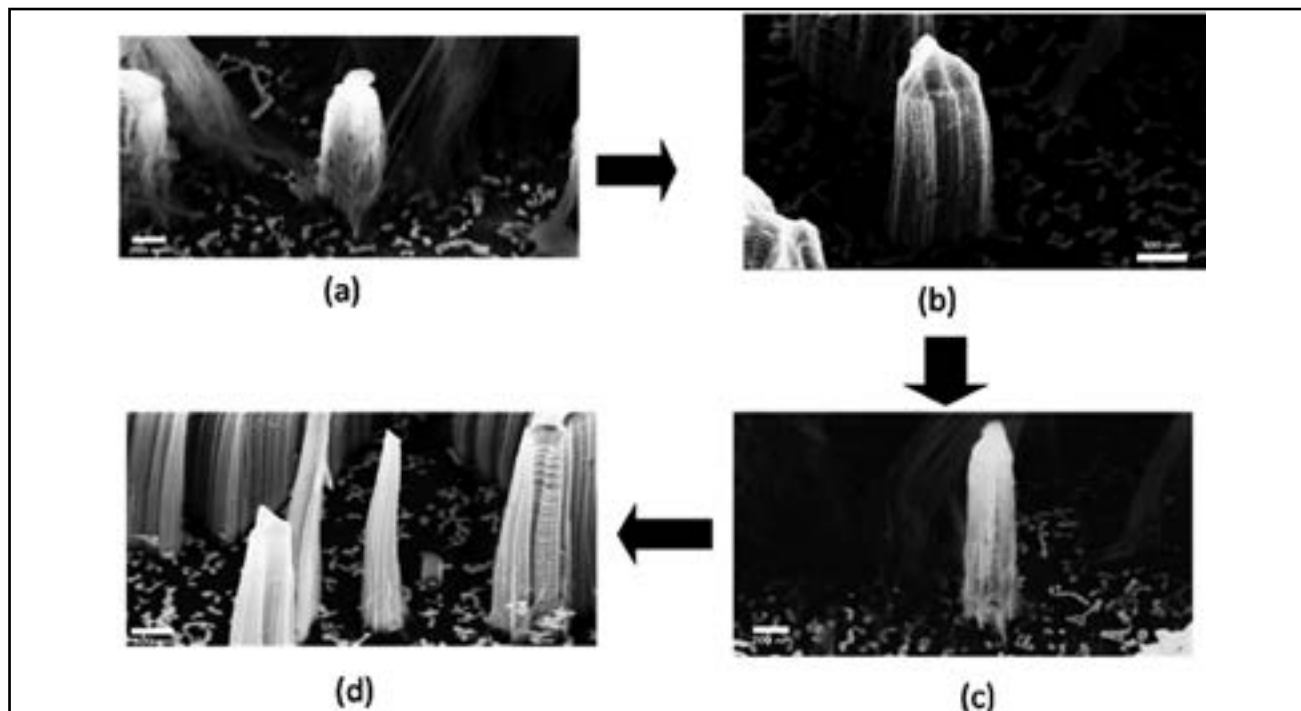


Figure 3.13: Field emission scanning electron microscope images showing the transformation of the developed silicon nanostructures from low aspect ratio (moth eye) to high aspect ratio (cactus) geometries: (a) moth eye-like silicon nanostructures after 20 min of etching, (b) & (c) the formation of intermediate structures obtained after 40 and 50 min of etching, respectively, and (d) the cacti-like structure formed after 60 min of chemical etching

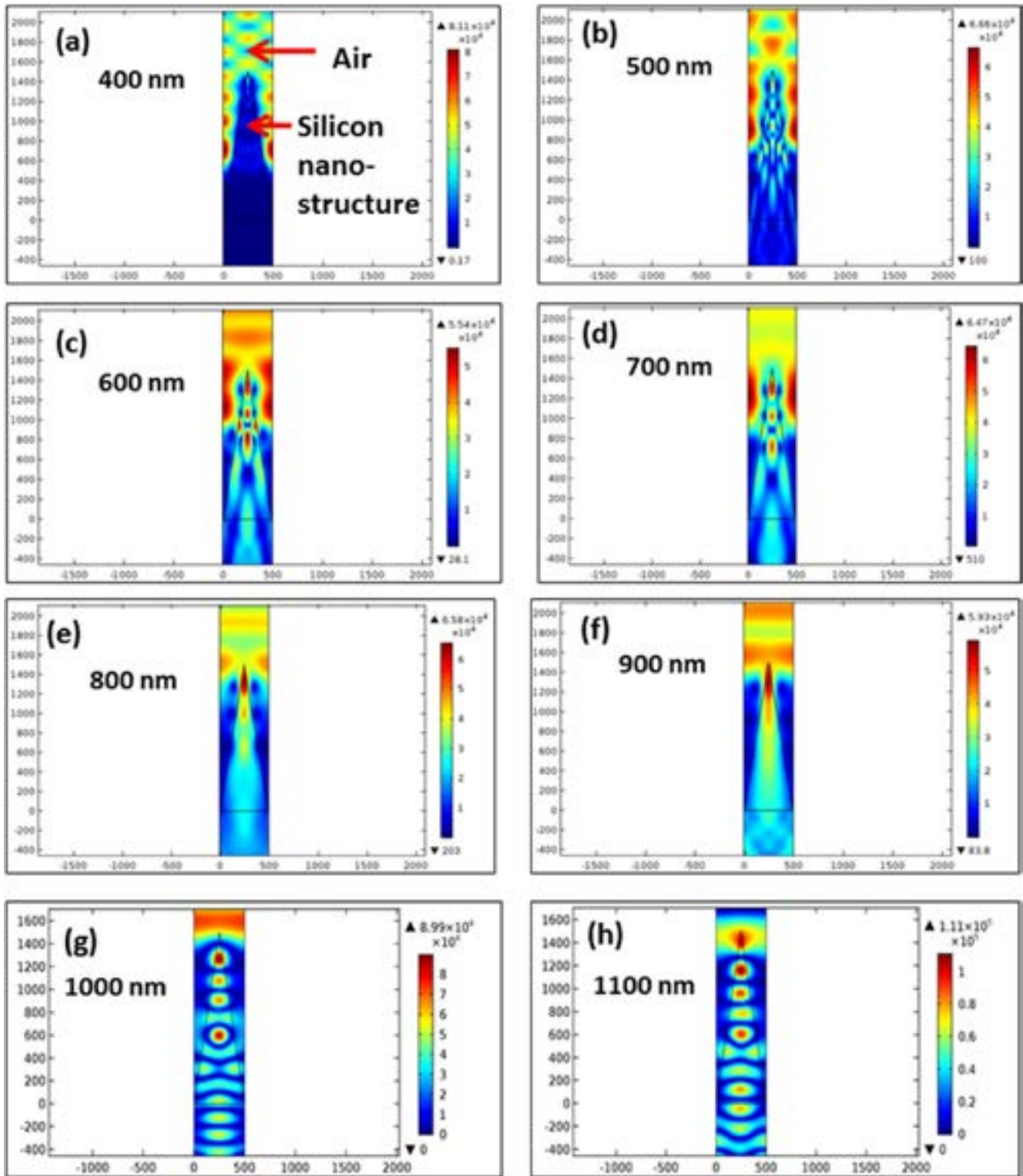


Figure 3.14: Electric field profiles for the biomimetic structure with aspect ratio- 3 at the wavelengths (nm) : (a) 400 (b) 500 (c) 600 (d) 700 (e) 800 (f) 900 (g) 1000 and (h) 1100.

3.8 Design and Development of High Efficiency Solar Water Pump Project

The main objective of this MNRE funded project is 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%) and creation of a state-of-the-art testing facility for SWP system. The project was completed in February 2023 with the following deliverables:

(i) Establishment of state-of-the-art testing and R&D facility for solar water pumps:

The state-of-the-art testing and R&D facility has been developed at NISE. The test facility is unique of its kind and can test solar water pumps up to 50 hp capacity, as shown in Figure 3.15. Solar array simulators have been installed for hot and cold profile testing and manual and automatic PV panels tracking structures have been installed for regular testing activities as well as for various R&D activities.

(ii) Enhancing efficiency & water output of

solar water pump controllers: Solar Water Pump Controller Efficiency is affected by change in temperature, radiation, and head. Tests have been conducted in NISE's SWP lab to find out the parameters that affect the controller efficiency and to enhance the part-load efficiency which occurs at intermediate/partial radiation and head/load. In addition, NISE studied the impact of different module technologies on the system performance, e.g., tested the solar water pump with bifacial PV panels.

(iii) Testing accuracy of remote monitoring system for solar water pumping applications:

Tests for comprehending the accuracy of remote monitoring systems have been performed. NISE found that even though voltage, current, and power were measured accurately, an error was reported in measuring the flow rate, i.e., in some cases there is a difference of 5% or more between the reported flow rate (via the RMS system) and the measured flow rate.



Figure 3.15: Solar water pump lab

- (iv) **Designing and testing micro-irrigation system:** Various micro-irrigation system has been tested and based on the analysis a draft specification for less than 1 hp pumps has been prepared and shared with MNRE and stakeholders for their comments and suggestions. Low Cost and High Efficiency, Portable & Rugged 'Micro Irrigation Systems' with small motor pump prototype from junk has been developed for demonstration purpose. The benefits of such system includes (i) working in the absence of electricity as compressed air can be stored and (ii) increased pump life as there is no moving parts.
- (v) **Test protocols and specifications:** Test protocols have been prepared for solar water

pumps up to 50 hp capacity. Various micro-irrigation system has been tested and based on the analysis, a draft specification for less than 1 hp pumps has been prepared and shared with MNRE and stakeholders for their comments and suggestions.

- (vi) Grid Connected Pump Controller system performance was analyzed (Table 3.2) and the document has been prepared.
- (vii) NISE studied the impact of different module technologies on the system performance, e.g., tested the solar water pump with bifacial PV panels (Figure 3.16). A joint report was prepared in collaboration with industry on ways to increase daily water output of a solar water pumping system using bifacial PV modules.

Table 3.2. Grid Connected Pump Controller system performance

Grid fed inverter testing (Unit Generation)			
Method	Start	End	Net Unit Generation (kWh)
Auto Tracking	13.4	24.6	11.2
Fixed Tilt (43 degree)	68.8	76.1	7.3
Manual Tracking (43 degree)	76.1	85.4	9.3



Figure 3.16: Solar Water Pump Test Setup using Bifacial Module



Figure 3.17: Solar powered micro-irrigation farm being developed at NISE campus

- (viii) A solar powered micro-irrigation farm is being developed at NISE campus in collaboration with M/s Spowdi India as shown in Figure 3.17. This demo farm showcases a futuristic micro-irrigation system that can help deal with the challenges of watering farmland in a more efficient way.
- (ix) A bilingual survey form is being prepared for agriculturists to record field data and socio-economic impact.

(SERB TARE) 2021 under Collaborative Research with Vel-Tech University, Chennai.

The methodology adapted for optimization of solar photovoltaic based water pumping performance with DC motor encompasses purchase of solar pump, solar modules, and solar controller. Installation of solar modules will be of horizontal, fixed tilt angle (latitude angle with reference to the location and +/- 15 deg), adjustable tilt angle (three times a day), and automatic tracking method.

3.9 Optimization of Solar Photovoltaic based Water Pumping Performance with DC Motor

The project was accepted in December 2021 in Science and Engineering Research Board – Teacher’s Associateship for Research Excellence

3.10 Atmospheric water generator using desiccants for generation of pure water from air

Project aims to develop a lab-scale prototype for generating potable water from air using desiccants.

The proposed model will use an evacuated solar air heater as heat source and desiccant shall be integrated in the system such that maximum surface area of desiccants is exposed to the air flow inside the solar air heater. This will help in improving the charging and discharging efficiency of the desiccant. During the year initial lab models were designed and developed for testing.

A lab scale prototype was designed and developed at NISE (Figure 3.18) wherein about 4 kg silica gel was used as desiccant and produced 450mL of water was collected on a daily basis. Further design improvement and optimization is in progress.



Figure 3.18: Lab scale prototype of the atmospheric water generator developed at NISE

3.11 Setting Up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Haryana

RD&D Project entitled “Setting Up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Haryana” was sanctioned by MNRE on 28th February 2019. The main objective of the project was to operate and maintain the existing solar powered green hydrogen generation and dispensing station already established at NISE campus. The project also included augmenting green hydrogen production capacity by setting up an additional 10 Nm³/hr electrolyser.

The existing facility comprises an alkaline electrolyser of 5 Nm³/hr hydrogen production capacity, a two-stage reciprocating compressor to raise the pressure of hydrogen up to 550 bar, a high-pressure hydrogen storage tank of about 60 kg capacity and an H35 hydrogen dispenser which can dispense hydrogen at 350 bar to the vehicles @1 kg/min. This facility is powered by a 120 kWp SPV system installed on the roof of one of the buildings of NISE. This is India’s first solar-based green hydrogen-generating facility.

During the year, augmentation of green hydrogen production capacity was undertaken with the addition of a 10 Nm³/hr alkaline electrolyser, as shown Figure 3.19. NISE’s total hydrogen production capacity will increase to a total of 15 Nm³/hr (about 1.35 kg/hr) when both electrolysers become operational. The new electrolyser has been installed at the NISE hydrogen

facility and commissioning is in progress. NISE is integrating the new electrolyser to the dispenser. in the process of reviving the existing station and



(a)

(b)

Figure 3.19: (a) Solar PV based Green Hydrogen production-cum-dispensing facility at NISE, (b) Installation of new electrolyser at NISE hydrogen generation facility



TESTING AND STANDARDISATION

4.1 TESTING

NISE has been maintaining a National Accreditation Board for Testing & Calibration Laboratories (NABL) accredited laboratory for testing of Solar PV modules, Solar PV lighting systems, solar inverters & batteries, and solar water pumps. NISE also has a fully developed testing facility for solar cells, solar thermal systems, and solar resource assessment. NISE further supports customised development testing of solar technologies as per the requirements of the customer. NISE has set up a full-fledged Customer Service Cell (CSC) for availing the testing services from the institute.

List of testing facilities established at NISE:

1. Advanced Solar Cell Characterisation Facility
2. Solar Photovoltaic Testing Facility (PVTF) Laboratory
3. Advance SPV system and lighting laboratory
4. Power Electronics Laboratory
5. Battery Test & Characterisation Laboratory
6. Solar Photovoltaic Pump Test Facility
7. Solar Radiation Resource Assessment (SRRA)

4.1.1 Advanced Solar Cell Characterization Facility

NISE has state-of-the-art Advanced Solar Cell Characterization Laboratory with ISO class

8 clean room facility. The lab houses several advance cell characterization tools including i) Spectral Response Measurement System (QE-SRMS), ii) Spectroscopic Ellipsometer, iii) Optical Microscope, iv) Semi-Automatic Four Probe resistivity meter, v) Electrochemical Capacitance Voltage (ECV) Profiler, vi) Surface Profilometer and vii) Field Emission Scanning Electron Microscopy (FESEM) with EDS facility.

The lab uses instruments for measuring textured and thin film solar cell optical constants. The facility has equipment for Automatic single and multi-point mapping of sheet resistance and resistivity of silicon wafers and solar cells, measuring film thickness, roughness and 2- dimensional stress, surface texture, laser ablation and LBSF microstructure analysis of front side metallisation.

The laboratory has the capability of doing testing as per the following standards:

- i. IEC 60904-1:2020 - Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics.
- ii. IEC 60904-7: 2019 - Photovoltaic devices - Part 7: Computation of the spectral mismatch correction for measurements of photovoltaic devices.
- iii. IEC 60904-8: 2014 - Photovoltaic devices - Part 8: Measurement of spectral responsivity of a photovoltaic (PV) device.



Figure 4.1: Advanced Solar Cell characterization laboratory with ISO class 8 clean room facility at NISE

4.1.2 PV Module Testing Laboratory

NISE has an NABL accredited PV module testing laboratory as ISO/IEC 17025:2017. The facility is

also recognised by Bureau of Indian Standard (BIS) for PV Module Testing as Type 2 category facility. At present the lab is NABL accredited for following test standards:

Standard No.	Details
IEC 61215-1-1: 2016/ IS 14286-1-1: 2019	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IEC 61215-1-2: 2016/ IS 14286-1-2: 2019	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules
IEC 61215-1-3: 2016/ IS 14286-1-3: 2019	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules
IEC 61215-1-4: 2016/ IS 14286-1-4: 2019	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-4: Special requirements for testing of thin-film Cu (In,Ga)(S,Se) ₂ based photovoltaic (PV) modules

IEC 612151-1- 2021 (DML testing facility is under procurement)	Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IS/IEC 61701: 2011 and IEC 61701:2020	Salt mist corrosion testing of photovoltaic (PV) modules
IEC 61853-1	Photovoltaic (PV) module performance testing and energy rating - Part 1: Irradiance and temperature performance measurements and power rating
IEC TS 62804-1:2015	Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation - Part 1: Crystalline silicon
IEC TS 60904-1-2:2019	Photovoltaic devices - Part 1-2: Measurement of current-voltage characteristics of bifacial photovoltaic (PV) devices

NISE also offer testing of PV module as per following standards and test specification (NABL accreditation under process):

- i. IEC 61853-2: 2016 - Photovoltaic (PV) module performance testing and energy rating - Part 2: Spectral responsivity, incidence angle and module operating temperature measurements.
- ii. IEC 61853-3:2018 - Photovoltaic (PV) module performance testing and energy rating - Part 3: Energy rating of PV modules.
- iii. IEC 61853-4:2018 - Photovoltaic (PV) module performance testing and energy rating - Part 4: Standard reference climatic profiles.
- iv. Performance and reliability of module cleaning device as per in-house developed testing procedure.
- v. Light induced degradation (LID) testing and Light and elevated temperature-induced

degradation (LeTID) testing of PV module as per the standard and customer requirement.

- vi. Climate specific model based accelerated testing of PV module to evaluate the module performance & reliability under harsh climatic conditions.
- vii. Testing of new and innovative products as per the customized testing procedure.

This laboratory has taken up various R&D activities to analyze the performance and reliability of PV modules in indoor and outdoor conditions. During this year, the laboratory has upgraded its facilities with addition of Impulse voltage tester, Ignitibility test facility, Peel test facility as per IEC 61730-1,2. The lab is in the process of obtaining NABL accreditation for calibration of reference module as per IEC 60904-4 and characterization of solar simulator as per IEC 60904-9 standard.



Figure 4.2: Solar Photovoltaic Testing Facility (PVTF) at NISE

4.1.3 Power Electronics Laboratory

Power Electronics Laboratory (PEL) at NISE is an NABL accredited laboratory as per ISO/IEC 17025: 2017. The lab is equipped for testing of all types of power conditioning units (PCUs) up to 100 kVA including hybrid, standalone, Grid-tied inverters

(GI), and Pump Controllers. The facility is also recognized by BIS for IS 16169: test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters. The lab under takes the following NABL accredited tests as per IEC/IS standards:

Standard No.	Details
IEC 61683:1999	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency
IS 16169/ IEC 62116:2008	Test procedure of islanding prevention measures for utility - interconnected photovoltaic inverters
IEC 61727:2004	Photovoltaic (PV) systems - Characteristics of the utility interface

IS16797:2019/ IEC 62509:2010	Battery charge controllers for photovoltaic systems - Performance and functioning of the charge controller
EN50530:2010	Overall efficiency of grid connected photovoltaic inverters
IEC 60068-2 -1: 2007	Environmental test A: Cold
IEC 60068-2 -2: 2007	Environmental test B: Dry heat
IEC 60068-2 -14:2009	Environmental test N: Dry heat change of temperature
IEC 60068-2 -14:2005	Environmental test Db: Damp heat cycle



Figure 4.3: Power Electronics Laboratory setup at NISE

4.1.4 Battery Test & Characterization

Battery Test & Characterization at NISE is an NABL accredited laboratory and is involved in testing the performance, reliability and life cycle of major secondary battery storage technologies,

including Lead-acid, Nickel-Cadmium and Lithium-Ion Batteries. The laboratory is equipped with the latest technologies like deep cycle battery testers, a programmable power supply, advanced hardware and software, a data logger, and a

temperature-controlled water bath. The laboratory is also recognised by BIS for IS 16270: 2014- secondary cells and batteries for solar photovoltaic

application general – requirements and methods of test services. The lab under takes the following NABL accredited tests as per IEC/IS standards:

Standard No.	Details
IS 16270:2014	Secondary cells and batteries for solar PV application- general requirements and methods of test
IS 1651:1991	Stationary cells and batteries, lead acid type (with plante positive plates)
IS 13369:1992	Stationary lead acid batteries (with Tubular positive plates) in Monobloc Containers
IS 15549:2005	Stationary Valve Regulated Lead Acid Batteries- Specification
IEC 61427	Secondary cells and batteries for PV energy systems- General requirements and methods of test
IS 16047 (Part 3): 2018	Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes-Secondary Lithium Cells and Batteries for Portable Applications Part 3 Prismatic and Cylindrical Lithium Secondary Cells, and Batteries Made From Them (First Revision)



Figure 4.4: Battery Test & Characterization Laboratory setup at NISE

4.1.5 Advanced SPV system & lighting laboratory

Solar Photovoltaic (SPV) and Lighting laboratory at NISE is a well-established lab for performance and reliability testing of off-grid solar applications. The laboratory is equipped for testing as per below IEC/IS standards (NABL accreditation under process):

- i. IES LM-79-08/IS 16106: 2012 - Method of Electrical and Photometric Measurements of Solid-State Lighting products
- ii. Testing of solar lighting systems as per MNRE specifications

The lab has upgraded its test facility for testing the remote monitoring system of solar lighting system and is also equipped to carry out test of solar

lighting system as per customer specification.

4.1.6 Solar Water Pump Test Facility

NABL accredited Solar Water Pump (SWP) Laboratory at NISE (Figure 4.6) is well-equipped, fully-automated, state-of-the-art testing facility for conducting performance testing of PV based water pumps against national and international standards/guidelines. In order to cater the futuristic demands for high powered solar water pumps in India, the test facility has been upgraded for testing of up to 50 hp solar water pumps. The facility is equipped with the latest test equipment and can cater to testing of all available major pump systems including submersible, surface, AC and DC systems. The laboratory has also tested various SWPs under innovative Distributed Renewable Energy (DRE) solutions for rural livelihood applications.



Figure 4.5: Advanced SPV system & lighting laboratory at NISE

The lab undertakes the following tests as per IEC/IS standards:

Standard No.	Details
MNRE guidelines on testing procedure for solar photovoltaic water pumping systems	Annexure – I, II and III of circular no. F. No. 41/3/2018-SPV division dated 17.7.2019 and 02.02.2023
	MNRE specification for Solar PV water pumping systems for micro pumping application (2016-2017)
	MNRE test methods for SPV water pumping systems (2014-15)
IEC 62253	Performance measurements of photovoltaic (PV) pumping systems in stand-alone operation
IS 17429:2020	Solar Photovoltaic Water Pumping Systems - Testing Procedure - Guidelines
IS 17018: Part 1 2018 [RD: IS 9283:2018, IS 3043:1987, and IS 9079:2018]	Solar photovoltaic water pumping systems - Centrifugal Pumps.

NISE also offers testing of solar PV water pumps as per following standards and test specification:

- i. MNRE specifications no. 32/645/2017-SPV of KUSUM Programme specifications and testing procedure for solar water pumping systems.
- ii. MNRE test methods for SPV water pumping systems (2015-16) & (2017-18).



Figure 4.6: Solar Water Pump Test facility for up to 50hp at NISE

4.1.7 Solar Radiation Calibration Laboratory (SRCL)

Solar Radiation Calibration Laboratory (SRCL) at NISE has been operational since 2016 to calibrate solar radiation measuring sensors from the National solar radiation network of MNRE. The laboratory was established following the World Meteorological Organisation (WMO) guidelines, where calibration was performed as per the ISO standards. It has a highly precise reference standard sensors such as the primary standard sensor/Absolute Cavity Radiometer (Highest Solar Radiation Standard) and a number of secondary standard reference sensors for achieving radiometric calibration traceable to the World Radiometric Reference (WRR) scale with high accuracy and precision.

An Advanced Monitoring Station (AMS) and a Solar Radiation Resource Assessment (SRRA) station was established at the NISE campus under the SRRA initiative of MNRE. The SRRA stations are used to generate high-quality solar radiation data (1 minute) of various parameters

such as Global Horizontal Irradiance (GHI), Diffuse Horizontal Irradiance (DHI), Direct Normal Irradiance (DNI), Spectral DNI, Ground Reflected radiation and Infrared radiation. As a part of the Baseline Surface Radiation Network (BSRN), a global network of solar radiation measurement stations from various countries monitored by the WMO, the SRRA station of NISE is listed as Station No. 56, with site specification as plain terrain, and medium black soil.

On 26th September 2022, NISE participated in the National Renewable Energy Laboratory (NREL) Pyrheliometer Comparisons (NPC-2022) event at their Solar Resource Research Laboratory in Golden, Colorado, USA. During the event, the primary radiometric sensors of NISE was compared with other primary radiometric sensors from the world standard groups and the latest traceability from IPC 2021 was transferred to these sensors. The calibration facility at NISE can now transfer these latest radiometer calibration factors to various radiometric sensors used in India. During the event, one reference pyranometer was also calibrated for the latest traceability.



Figure 4.7: (Left) SRRA station facility at NISE. (Right) Primary absolute cavity sensors from NISE participating in the International Pyrheliometer Comparisons at NREL, Colorado, USA held on 26th September 2022

4.2 STANDARDIZATION

NISE has been working with various organisations such as BIS, MNRE and industry partners to develop testing methodology / protocols for various solar technologies.

4.2.1 International interlaboratory study on light- and elevated temperature-induced degradation in solar modules

During the year, NISE was part of a collaborated project between a large global network of PV

module manufacturers and PV testing laboratories which aim to design a protocol for Light-elevated Temperature - Induced Degradation (LeTID) detection and screen a large and diverse set of prototype modules for LeTID. During the year, a joint publication by using the results of the inter lab comparison has been published. Results across labs indicate the reproducibility of LeTID testing is within $\pm 1\%$ of maximum power (PMP). Overall, this work has helped inform the creation of a forthcoming standard technical specification for LeTID testing of PV modules, IEC TS 63342 ED1.



SKILL DEVELOPMENT & CAPACITY BUILDING

The institute extends capacity building opportunity for skilling up young minds across the world by conducting skill development programmes, training, short term courses, client specific courses on solar photovoltaic technology. NISE has imparted trainings (both online and offline mode) to wide variety of Government Departments, Schools, Colleges, Armed Forces, Nodal agencies and Public Sector Undertaking companies through short term training courses specifically devised according to the need of the participants. Additionally, International training programs were also organised for active growing solar environment and sustainability. The training curriculum launched for various training programmes were developed, scrutinized and duly improved by industry experts, renowned professors and professional experts.

During the year, a total of 15 numbers of

International (4 nos.) & National (11 nos.) level training programs were conducted wherein 521 (123 International & 398 national) participants were trained in various domains of solar energy.

5.1 International Training Program

NISE organizes international solar training program under the Indian Technical and Economic Co-operation (ITEC) sponsored by the Ministry of External Affairs, Govt. of India. This program is generally of three-week duration wherein the participants are imparted training on various solar energy technologies. The program also provides a platform for mutual knowledge sharing among countries in the field of solar energy. During the year, NISE has conducted a total of 4 ITEC programme and has trained 123 participants from different countries.

Table 5.1. International participation of delegates in ITEC and e-ITEC for FY 2022-23

S No.	Program Name	Number of Programs	Duration of Program (Days)	Date	Number of Participants
1	ITEC Programme on Solar Energy Technologies & Application	1	21	22 nd Aug to 09 th Sep 2022	27
2	e-ITEC Programme on Solar Energy Technologies & Application	2	3	19 th – 23 rd Sep 2022	40

				03 rd -07 th Oct 2022	28
3	Special ITEC Programme on Solar Energy Technologies (Off-Grid Applications) for Mongolian women	1	90	10 th Nov 2022 to 30 th Jan 2023	28
	TOTAL	4			123



Figure 5.1: Participants of International Training Programme (ITEC) on Solar Energy Technologies and Applications

A notable achievement under the ITEC program during the year included a 3 months special training program from 10th November 2022 to 30th January 2023 conducted by NISE to train 28 rural women from Mongolia. During these 3 months, 28 women, primarily from the rural regions of Mongolia, were trained at NISE by a specifically designed program curriculum for utilising solar energy for the betterment of their communities. The curriculum included hands on training activities in

off-grid solar technology with rural applications like simple rooftop solar installation, LED assembly and solar water pumping systems. These women were also trained to take up assignments as entrepreneurs for self-employment. During the course of the program, these women have learnt to design, assemble, install, and maintain solar panels, batteries and off grid solar systems.



Figure 5.2: Mongolian Women Participants of International Training Programme (ITEC) on Solar Energy Technologies (Off-Grid Applications)

5.2 National training program

NISE conducts training programs in solar energy for aspirants from government departments, schools, colleges, nodal agencies, private and public sector companies through courses devised explicitly according to the need of the participants.

The trainings are imparted by the scientific officials of NISE as well as domain experts from academia and industry.

During the year, NISE has conducted a total of 11 national training program and has trained 398 participants as detailed at Table 5.2.

Table 5.2. National training programs conducted by NISE during FY 2022-23

S No.	Training/ Program	Number of Programs	Duration of Program (Days)	Date	Number of Participants
1	3 Days Training Programme for MES Officials	2	3	2 nd to 4 th June 2022 9 th Feb to 11 th Feb 2023	37 41

2	3 Days Online Training Program on Design of Solar PV Systems	3	3	23 rd to 25 th Jan 2023	20
				14 th to 16 th March 2023	20
				27 th to 29 th March 2023	18
3	Induction Training Program for CEA Officers	2	1	29 th Sept 2022	32
				21 st Oct 2022	38
4	Certification Programme for Engineer Trainees from Azure Power India Pvt. Ltd.	1	5	11 th to 15 th July 2022	24
5	Capacity Building Program on solar energy-based pumping System (Offline-Mode)	2	3	28 th to 30 th Nov 2022	60
				01 st to 03 rd Dec 2022	60
6	01 Day Online Training on “Hydrogen Energy: Production, Storage and Utilisation”	1	1	28 th March 2023	48
	TOTAL	11			398



Figure 5.3: Participants of Azure Power Training Program



Figure 5.4: Participants of MES Training Program

5.3 Suryamitra Skill Development Program

Suryamitra Skill Development Programme was designed with an objective to develop a skilled and employable workforce (Suryamitras) for catering to the needs of Solar PV industries and EPC projects. These participants were trained to perform jobs related to Installation, Commissioning and Operation & Maintenance of a Solar PV system in EPC projects. Further, on completion of the training program, Suryamitras were offered

positions such as technician, supervisor, and managers in Solar PV organizations and also an opportunity to emerge as an entrepreneur in the Solar PV Industry. During the FY 2022-23, a total of 139 empanelled training centres were allocated batches in the month of March 2023 against the given target of training 4200 Suryamitras by MNRE. Also, for the given target of training 3000 suryamitras by MNRE for the FY 2021-22, 94 batches were allocated to the empanelled centres during the month of October 2022.

Table 5.3. The state-wise detail list of the Suryamitra Skill Development Programme

S. No.	State	Trained	Undergoing Training as on 31.03.2023	Total no. of Suryamitra	Total no. of Placed
1	Andaman and Nicobar Islands (UT)	0	0	0	0
2	Andhra Pradesh	0	90	2015	1219
3	Arunachal Pradesh	0	30	30	0
4	Assam	0	60	1542	866
5	Bihar	0	0	1886	1139
6	Chandigarh (UT)	0	30	238	150
7	Chhattisgarh	0	28	2209	1138
8	Dadra and Nagar Haveli and Daman & Diu (UT)	0	0	0	0
9	Delhi (UT)	0	0	702	338
10	Goa	0	0	321	201
11	Gujarat	0	60	3253	2027
12	Haryana	0	58	1503	664
13	Himachal Pradesh	0	30	474	182

14	Jammu and Kashmir (UT)	0	60	696	164
15	Jharkhand	0	30	846	466
16	Karnataka	0	61	1813	770
17	Kerala	0	30	825	452
18	Ladakh (UT)	0	0	30	0
19	Lakshadweep (UT)	0	0	30	0
20	Madhya Pradesh	0	180	4673	2298
21	Maharashtra	0	207	4414	2342
22	Manipur	0	0	150	50
23	Meghalaya	0	0	30	0
24	Mizoram	0	0	0	0
25	Nagaland	0	0	60	0
26	Odisha	0	120	2457	1090
27	Puducherry (UT)	0	30	62	19
28	Punjab	0	119	434	266
29	Rajasthan	60	360	3533	2281
30	Sikkim	0	0	0	0
31	Tamil Nadu	30	135	3553	1946
32	Telangana	0	90	3721	2100
33	Tripura	0	0	178	57
34	Uttar Pradesh	0	264	4760	2115
35	Uttarakhand	0	30	1032	594
36	West Bengal	30	108	4179	2033
	Total:	120	2210	51649	26967



(a) Aspire Disruptive Skill Foundation, Gujarat



(b) KWatt Solutions Pvt. Ltd., Bhopal



(c) MITCON Consultancy and Engineering services Ltd.



(d) Salt Lake Institute of Engineering and Management

Figure 5.5: Suryamitra Training Programme conducted at various affiliated institutes in India

5.4 International Solar Alliance (ISA) Fellowship Program facilitated by NISE

One of the major activities of ISA is the exchange of officials and technology specialists for participation in the training program on different aspects of solar energy in the member countries. NISE facilitates the ISA Fellowship Program for

undergraduate students of ISA member countries. The fellowship will enable them to augment their knowledge in the field of solar technology, its management, economics, etc. The Program is part of the ISA's efforts to support Capacity Building and Knowledge Dissemination in its current and prospective member States. The program is financially supported by the ISA.



Figure 5.6: Glimpse of ISA Fellowship Program facilitated by NISE



OUTREACH ACTIVITIES

6.1 Technical Consultancy Services

NISE offers various consultancy services pertaining to all domains of solar energy technologies, such as Solar photovoltaic, Solar thermal, green hydrogen, and balance of systems. The division provides specialised technical services to stakeholders, i.e., facility owners, investors, financial institutions, armed forces, banks, etc., for various aspects of solar project implementation and performance mapping. Various services offered by NISE included, but not limited to:

- a) Field-level testing of solar components and systems
- b) Inspection and assessment of Solar Power plant /system/ manufacturing facility
- c) Technical document vetting, such as tender

documents, detailed project reports, solar power plant design etc.

- d) Due diligence and troubleshooting of Solar power plant
- e) Pre-feasibility studies of solar-related projects

During the year, a total of 8 technical consultancy assignments were carried out by NISE including field level inspection, field testing for various solar projects and due diligence studies on a specific block of Solar PV power plant at Paavgada solar park. NISE is also providing technical support to Solar Energy Corporation of India (SECI) for development, validation and implementation of qualitative requirement and acceptance test procedures for setting up of 3000 MW per annum cells and module manufacturing facility in India.

Table 6.1: Details of Technical Consultancy Services offered by NISE during 2022-23

S.No	Vendor Name	Project Description
1	Karnataka Renewable Energy Development Limited, Bengaluru	Due Diligence Studies in 50MW Paavgada Solar Park
2	Jaquar and company Pvt. Ltd	Field Testing of PV modules
3	PES Engineers Pvt. Ltd	Due Diligence Studies in 10 MW canal Top Solar PV power plant
4	UNICEF	Technical support for Solarization of Public Health Care Facilities in India
5	Solar Energy Corporation of India	Qualitative monitoring of PV module manufacturing facility.



Figure 6.1: Site Visit by NISE Technical Team to Public Health Care facility in Arunachal Pradesh under UNICEF project for assessing the solarization potential

6.2 Customer Service Cell

The Customer Service Cell (CSC) at NISE is centrally responsible for the management of testing and calibration services offered by NISE. CSC enables its customers to avail of testing services from the online portal available at the NISE website. This testing portal allows easy access to the selection of testing services, payment, and release of reports. NISE offers a comprehensive range of testing services (IEC, BIS, MNRE specifications etc.) that facilitate testing as per National /International standards for various solar energy products and their components. NISE offers world-class testing and calibration services through its various labs,

i.e., i) Solar Cell Testing Lab, ii) Solar PV Module Testing Lab; iii) Solar Inverter Testing Lab; iv) Battery Testing Lab; v) Solar Water Pump Testing Lab; vi) Solar Light /LED Testing Lab; vii) Solar Thermal Systems Testing Lab, viii) Calibration Lab. CSC is a gateway to testing, calibration, and consultancy services through all the above-listed labs. CSC caters to all possible needs of the customer from the application stage to test progress and report handling. CSC has also proactively taken various quality interventions in its operations and improved the services of various labs. During the year, 97 samples were successfully tested in various labs at NISE.

6.3 Approved List of Models and Manufacturers (ALMM)

To ensure reliability of Solar PV products and to protect the consumer interests and ensure better energy security of the country, MNRE on 02.01.2019, has issued “Approved Models and Manufacturers of Solar Photovoltaic Modules (Requirements for Compulsory Registration) Order, 2019”. The order provides for the enlistment of eligible models and manufacturers of solar PV cells and modules complying with the BIS Standards and publishes the same in a list called the “Approved List of Models and Manufacturers” (ALMM). Only the models and manufacturers included in this list will be eligible for use in

Government/ Government assisted Projects/ Projects under Government Schemes & Program, installed in the country, including Projects set-up for the sale of electricity to the Government. NISE had been designated as an implementation support agency for processing applications and carrying out inspections, verifications, and quality checks on behalf of MNRE.

During F.Y 2022-23, NISE conducted ALMM inspection of 66 manufacturing plants with a cumulative installed manufacturing capacity of 13 GW. Since inspection, NISE had recommended a total of 97 PV module manufacturing plants under ALMM with a total manufacturing capacity of 24.7 GW.



General Facilities & Activities

NISE has state-of-art facilities for training, lecture rooms, a library, sports, an IT cell etc. NISE encourages its staff to take an active part in various activities. The events, i.e., celebrations of functions, debates, lectures, etc., are organised with full enthusiasm.

7.1 Library

The NISE Library possesses a vibrant collection

of 8320 consisting of books, journals and other reading material. Besides books and journals, the library also has an extensive National and International Standards collection. The library uses e-Granthalaya software for the circulation of books. Facilities and services of the library are availed by staff, visitors and trainees at NISE, a photograph of the library is shown in Figure 7.1. A book exhibition (Figure 7.2) was organized by NISE on 24th and 25th November 2022.



Figure. 7.1: Photograph of library facility at NISE.



Figure 7.2: Book exhibition at NISE

7.2 Sports Facilities

The sports facility developed at NISE ensures the quality and opportunity for its employees to participate in sports and physical activities. As sports is an integral part of discipline and stress management, quality programme schedules, diet and yoga sessions are organised for the staff and trainees at NISE. A well-trained coach within the institute imparted access to the gym, yoga, and indoor activities. International Yoga Day was celebrated in NISE on 21st June 2022. A photograph of the Yoga event is shown in Figure 7.3

7.3 Information Technology (IT) Cell

NISE has a robust IT division to look after the e-office, website management, portals

(testing services, Suryamitra skill development programme, Varunmitra skill development programme and recruitment portal etc.), CCTV surveillance, software and hardware support for research and day-to-day activities, data repository, GeM procurement, online Tender wizard etc. IT division also maintains an inventory repository for proper asset maintenance and management.

7.4 Independence Day Celebration

Independence Day is one of the national festivals of India, which was celebrated on 15th August, 2022 with great zeal and respect throughout the country. Like every year, Independence Day was celebrated with great enthusiasm in NISE. Photograph from Independence Day celebrations organised at NISE is shown in Figure 7.4.



Figure. 7.3: Photograph of Yoga Event 2022 at NISE



Figure. 7.4: Photograph of Independence Day 2022 celebration at NISE

7.5 Republic Day Celebration

Like every year, Republic Day (Figure 7.5) was celebrated with great enthusiasm in NISE on 26th January, 2023. The flag was unfurled in the

courtyard of Aditya Bhawan of the institute by Dr. Chandan Banerjee, DDG NISE. A small parade was also organized by the security personnel of the institute on this occasion.



Figure 7.5: Republic Day celebration



Figure 7.6: Republic Day celebration

7.6 Women's Day Celebration

Like every year, Women's Day was celebrated with great enthusiasm in NISE on 8th March 2023. On

this day, all women in the institute participated in a painting and quiz competition. Glimpse of the celebration is shown in Figure 7.7 and Figure 7.8.



Figure 7.7: Women Day Celebration at NISE



Figure 7.8: Prize Distributed to Women Staff at NISE

7.7 Vigilance Awareness Week

Like every year, this year also Vigilance Awareness Week was organized at National Institute of Solar Energy from 31st October to 06th November, 2022. On this occasion, all the officers and employees of the institute took “Integrity Pledge” online. NISE

followed this endeavour actively. All the institute’s officers and employees pledged to continue striving towards a corruption-free nation by taking the “Satyanistha Pledge”. A glimpse of the celebration is shown in Figure 7.9 and Figure 7.10.



Figure 7.9: Vigilance awareness week at NISE



Figure 7.10: Pledge taking ceremony during Vigilance awareness week at NISE

7.8 Promotion of Official Language

An official language section was established at the institute to implement the official language policy of the Government of India. Its functions are i) Implementation of the Official Language Policy of the Govt. of India, ii) Translation of work to the Hindi language, and iii) Publications in Hindi. During the year, concerted efforts were made to ensure proper compliance with the provisions of the Official Language Act - 1963 and Rules were framed thereunder. For the promotion of the official language policy and to create a more conducive environment for the officials to do more work in Hindi, various programmes/schemes were undertaken, which included,

- i) To make the institute's revamped website bilingual
- ii) All documents coming under section 3(3) of the OL Act 1963, e.g. Press Release, Tender Notices, Rules, General Orders, Notification and other Documents to be laid in the parliament were prepared bilingually
- iii) Letters received in Hindi were invariably replied to in Hindi, and Rule (5) of the Official Language Rules 1976 was fully complied.
- iv) A display board has been installed at the entrance of the Surya Bhawan in the institute and a new Hindi word is demonstrated daily at the reception.

- v) Standard forms were prepared in Hindi and uploaded on the website of NISE for the convenience of officers/staff.
- vi) The Annual Report 2021-22 of the institute was printed in both Hindi and English languages.
- vii) All navigation boards, general boards, nameplates and rubber stamps etc., in the institute are bilingual.

Quarterly meetings of the Official Language Implementation Committee were held to review the progress made in implementing the Official Language policy. The divisions were advised to achieve the targets specified by the Department of Official Language, Ministry of Home Affairs (MHA), Govt. Of India. During the year, various measures were taken as per Section 3 (3) of the Official Languages Act, 1963, to effectively implement the Official Language Policy in the institute. Special emphasis was laid on increasing originating correspondence in Hindi. 'Hindi Pakhwada' was organised from 14th September 2022 to 28th September 2022 (Figure 7.11 and Figure 7.12) to create awareness and to increase the use of Hindi in official work. Various competitions like Hindi essay writing, poetry, and dictation were organised among the officers and employees of the institute. In these competitions, the officers and staff of the institute enthusiastically participated. Based on their performances, mementoes, certificates and cash prizes were awarded to the participants by the NISE officers.



Figure 7.11: Closing Ceremony of Hindi Pakhwada



Figure 7.12: Prize Distribution ceremony of Hindi Pakhwada at NISE

7.9 Right to Information Act

Institute is implementing the Right to Information (RTI) Act, 2005, as per the guidelines issued by the Department of Personnel and Training (DoPT), Central Information Commission and Ministry of Home Affairs. The procedure/other details regarding seeking information under RTI Act, 2005 are available at the institute's website, www.nise.res.in.

The institute has designated CPIOs and appellate authorities to respond to the RTI applications and the first Appeals following subjects assigned to them. A list of CPIOs and first Appellate authorities is given in Table 7.1. Respective CPIOs and First Appellate Authorities replied to RTI applications/

Appeals within the stipulated timelines to the extent possible.

The progress report in terms of RTI application/First Appeals received, disposed-off, and pendency during the year (from 01st April 2022 to 31st March 2023) is given in Table 7.2.

7.10 Administration & Staff

The Government of India has sanctioned 41 regular posts, including Director General. The institute has framed recruitment rules for 40 sanctioned regular scientific, technical and administrative posts. The GC approved the rules in its 3rd meeting on 6th April 2015. The status of filling up the posts is given in Table 7.3.

Table 7.1: Name and Designation of the CPIOs and Appellate Authorities in NISE under Right to Information Act, 2005

S. No.	Subject	CPIO	Appellate Authority
1	All matters concerning Research and Development, Technology and Laboratory and Technology	Dr. Jai Prakash Deputy Director General (Tech.)	Dr. Chandan Banerjee Deputy Director General
2	All Administrative Matters (Except Financial Matters) & Public Grievance Officer	Shri Rahul Kumar Administrative Officer	
3	All Financial Matters	Shri Sandeep Sehrawat Dy. Director (Admin)	

Table 7.2: Status of RTI Application received during 2022-23

Item	Received	Replied	Pending as on 31-03-2023
RTI Application`	80	69	11
First Appeal Authority	11	11	0

* As per the Quarterly report submitted on RTI Portal.

Table 7.3: Recruitment status at NISE

S. No.	Name of the post	Level	No. of Posts		Total	Status
			Tech.	Admin		
1.	Director General	14	1	0	1	· 1 Vacant*. *Additional Charge of DG was given to Shri Lalit Bohra, Joint Secretary, MNRE
2.	Deputy Director General	13A	3	0	3	Post filled: 02(UR) Offer of Appointment of 01 post of DDG (UR) has already been issued
3.	Director	12	2	1	3	All Posts filled. Director(Tech):02(UR) Director (Admin):01(UR)
4.	Deputy Director	11	6	2	8	All Posts filled. Dy.Director(Tech) : 05(UR),01(OBC) Dy. Director(Admin) : 02(UR)
5.	Administrative Officer	11	0	1	1	All Post filled AO:01(UR)
6.	Assistant Director	10	7	2	9	Post filled : 07 Technical & 01 Admin Assistant Director(Tech): 04(UR), 01 (UR, PwD), 01(OBC), 01(SC) Assistant Director(Admin):01(UR) Under process: Screening completed for Advertisement issued for 01 post (UR) of Admin
7.	Office Secretary	9	0	1	1	01 Post(UR) under process for Re-designation
8.	Office Secretary -I	8	0	3	3	Post advertised for 01 post (UR). Screening completed. Post under process for Re-designation: 02(UR)

9.	Executive Officer	8	4	0	4	Posts advertised for 04 post (03-UR, 01:OBC): Screening completed
10.	Executive Assistant-I	7	8	0	8	Post filled: 05 post(UR-02,OBC:02,SC:01) Posts advertised for 03 post(02-UR,01-EWS): Screening completed

Note:

01 post of DG-NISE Advertised by MNRE.

28 Posts filled.

9 Post Advertisement is under process.

03 Posts are under process for Re-designation of Posts

UR-Unreserved, SC-Schedule Caste, OBC-Other Backward caste, PwD-Person with Disability.



PATENTS AND PUBLICATIONS

During the FY 2022-23, various divisions of NISE have applied for two (2) patents and published nine(9) research papers in international journals of repute, and five (5) research papers in international conferences. The details are as follows:

PATENTS

During 2022-23, the following patents applications were forwarded to Technology Information, Forecasting and Assessment Council (TIFAC) for filing:

1. Design and packaging of large area secondary reference solar cell
2. A cost effective compact forced convection based mini- Greenhouse drying system

PUBLICATIONS

1. Singh, Y., Yadav, V., Sahoo, U., Malan, A., Kumar, S., Tripathi, A. K., Kumar, R., Singh, P., & Banerjee, C. (2023). Experimental investigation of an innovative solar dryer integrated with the thermal energy storage system. *International Journal of Ambient Energy*, Vol.44, Issue.1, Pg 1969 – 1979.
2. Nikhil, P. G., Singh, S. K., Singh, J. P., Sahoo, U., Ravi, M., & Banerjee, C. (2023). A Mathematical Model of Threshold Solar Irradiance for Computing the Quality Hours of Sunshine. *International Journal of Renewable Energy Research*, Vol.13, No.1.
3. Laarabi, B., Rajasekar, N., Nikhil, P. G., & Barhdadi, A. (2022). Characterization of dust particles in South India and investigation on soiling image analysis for photovoltaic application. *Environmental Science and Pollution Research*, 81635–81646.
4. Bora, B., Rai, S., Dhar, A., & Banerjee, C. (2023). Effect of UV irradiation on PV modules and their simulation in newly designed site-specific accelerated ageing tests. *Solar Energy*, Volume 253, Pages 309-320.
5. Roy, A. B., Dhar, A., Chowdhury, M., Das, S., Mukherjee, N., & Kundu. A. (2023). Cross-fertilized biomimetic structures achieved through nanosphere lithography on an ultrathin wafer for flexible black c-Si SHJ solar cells. *Materials Today Chemistry*, Volume 29, 101446.
6. Saini, A., Abdelhameed, M., Rani D., Jevasuwan, W., Fukata, N., Kumari, P., Srivastava, S. K., Pathi, P., Samanta, A., & Dutta, M. (2022). Fabrication of periodic, flexible and porous silicon microwire arrays with controlled diameter and spacing: Effects on optical properties. *Optical Materials*, Volume 134, Part A, 113181.
7. Karas, J., Repins, I., Bora, B., Banerjee, C. et al (2022). Results from an international interlaboratory study on light- and elevated temperature-induced degradation in solar modules. *Progress in Photovoltaics: Research and Applications*, Volume 30, Issue 11, Pages 1255-1269.

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9. Malakar, S., Arora, K. V., Nema, K. P., & Yadav, V (2023). Recent trends and applications of evacuated tube solar collector in food processing and air heating: a review. *Environmental Science and Pollution Research*, Springer.
10. Singh, J. P., & Banerjee, C. Performance Analysis of Bifacial PV Module in Different Climatic Zones of India. *International Conference on Advances in Energy Research*, IIT Bombay, 07 – 09 July, 2022
11. Sharma, A., Parmar, R., & Kumar, S. Performance analysis of solar water pumping system with real-time outdoor conditions and 3 validations with MATLAB/SIMULINK. *SSRN journal*.
12. Sharma, A., Parmar, R., & Kumar, S. Solar Water Pumping System Real-Time Testing & MATLAB Simulink Validation. *SSRN journal*.
13. Tiwari, G., Malan, A., Yadav, V., & Gakkhar, N. Numerical Investigation on Charging of Thermal Energy Storage for Medium Temperature Applications. *Emerging Trends in Mechanical and Industrial Engineering: Select Proceedings of ICETMIE; 2022; 277-286; 2023; Springer Nature Singapore*.
14. Kumar, N. M., Bora, B., Dhar, A., Yadav, D., Singh, J. P., & Banerjee, C. After Lifetime Reliability and Performance Analysis of PV Modules. *International Conference on Advances in Energy Research*, IIT Bombay, 07 – 09 July, 2022.
15. Kumar, N. M., Bora, B., Dhar, A., Yadav, D.,

CONFERENCE PAPER



Finance and Accounts

NISE has both an Internal Finance Division (IFD) and a Finance & Accounts Division (F&A) which look after the concurrence and preparation of accounts, respectively. IFD scrutinises and concurs with all financial proposals for payments, whereas the F&A division deals with budget preparation, maintenance of accounts and audit functions. NISE is registered with Income Tax as well as GST and

complies with all the statutory provisions of both the Act. The statutory auditor of NISE is appointed out of the panel of Chartered Accountants provided by CAG. The annual accounts are approved by the Finance Committee (FC) before submission of the same to the Governing Council (GC) and Annual General Meeting (AGM).





ROHITKJAIN & CO
CHARTERED ACCOUNTANTS

INDEPENDENT AUDITOR'S REPORT

To the Members of NATIONAL INSTITUTE OF SOLAR ENERGY

Report on the Financial Statements

We have audited the financial statements of **NATIONAL INSTITUTE OF SOLAR ENERGY** ("The Institute"), which comprise the balance sheet as at 31st March 2023, and the statement of Income & Expenditure for the year ended and a summary of significant policies and other explanatory information.

Responsibility of Management for the Financial Statements

1. The Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position and financial performance of the Institute in accordance with the accounting principles generally accepted in India. This responsibility also includes maintenance of adequate accounting records in accordance with the provisions of the Act for safeguarding of the assets of the Institute and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statement that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibilities for the Audit of the Financial Statements

1. Our responsibilities is to express an opinion to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.



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2. As part of an audit in accordance with Standards on Auditing, we exercise professional judgment and maintain professional scepticism throughout the audit. We also:
 - Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
 - Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.
 - Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.
3. Materiality is the magnitude of misstatement in the financial statements that, individually or in aggregate, makes it probable that the economic decision of a reasonably knowledgeable user of the financial statements may be influenced. We consider quantitative materiality and qualitative factors in (i) planning the scope of our audit works and in evaluating the results of our works; and (ii) to evaluate the effects of any identified misstatements in the financial statements.

Report on Other Legal and Regulatory Requirements

1. The internal control system of the Institute needs to be strengthened. During the course of our audit, some statutory, administrative and financial lapses were found, which are given in the **Annexure A** attached in summarized form. The details of such observation were provided to the management separately which they have noted for the future compliance and kept on record along their comments.
2. We report that:
 - (a) We have sought and obtained all the information and explanation which to the best of our knowledge and belief were necessary for the purpose of audit;
 - (b) In our opinion, proper books of account as required by law have been kept by the Institute so far as it appears from our examination of those books.
 - (c) The Balance Sheet and the Statement of Income & Expenditure dealt with by this Report are in agreement with the books of accounts.
 - (d) In our opinion, the aforesaid balance sheet & Income & Expenditure dealt with by this report complies with the Accounting Standards issued by the Institute of Chartered Accountants of India.



Opinion

In our opinion and to the best of information and according to the explanation given to us, the aforesaid financial statements, **read together with the annexure attached**, give the information required by the Act in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India.

- a) In the case of the Balance Sheet, of the state of affairs of the Institute as at March 31.2023;
- b) In the case of the Statement of Income & expenditure, of the **excess of income over expenditure** for the year ended on that date;

For M/S Rohit KC Jain & Co,
Chartered Accountants
(FRN: 020422N)



(Ritesh Wahal)
Partner

M. No. 517197

UDIN: 23517197B6VU885405

Place: New Delhi

Dated: 12th sept. 2023

Annexure -A

Annexure to the Independent Audit Report on the Financial Statement of National Institute of Solar Energy for the F.Y 2022-23 as Referred in the said Report.

1. It has been observed that NISE has given advances to CPWD for capital expenditure, it was found that an amount of Rs. 6.74 cr. is outstanding for settlement as on 31.03.2023, the details of opening balance and advance given in the FY 2022-23 are as follows:

ADVANCE GIVEN	
DATE	AMOUNT
As on 01.04.2022	4,31,39,540.00
08 Dec 2022	54,67,581.00
08 Dec 2022	52,95,780.00
14 Dec 2022	39,35,906.00
28 Mar 2023	32,26,178.00
28 Mar 2023	64,06,000.00
TOTAL	6,74,70,975.00

2. It has been observed that Income-Tax Refund for the AY 2015-16 and 2016-17 of Rs. 21,66,219 and Rs. 16,12,615 respectively is pending for receiving. NISE is bearing interest loss on the said amount. The amount is in the nature of revenue, it is suggested that NISE may consult to their consultants for recovery of the same.
3. It has been observed that an amount of Rs. 2,66,55,548/- has been received by NISE on account of construction of World Museum. Since a long time has elapsed and amount received is outstanding as on the date.
4. Following advances given under Surya Mitra training program in previous years and Utilization Certificate of the same was not submitted to NISE:-

NAME	DATE OF ADVANCE GIVEN	AMOUNT OUTSTANDING
Chief Executive Odisha Renewable Energy OREDA	01 May 2018	4,17,600
Govt. Polytechnic College Kerala	13 Oct 2015	6,29,160
Rajasthan Renewable Energy Corporation	10 Feb 2017	6,42,000

5. It has been noticed that an advance amount of Rs. 2,07,31,550/- given to C-DAC is outstanding from more than 3 years.

Party Name	2020-21	2021-22	2022-23
C-DAC	2,07,31,550/-	2,07,31,550/-	2,07,31,550/-



6. It has been observed that an amount of Rs. 17,03,460/- for EMD is outstanding for payment. It is suggested that the EMD amount may be refunded to persons pertains with the completed work.
7. It has been observed that an advance amount of Rs. 29,00,74,956/- is appearing under ALMM Scheme, for which no revenue has been recognized during the year.



CORPUS/CAPITAL FUND AND LIABILITIES		AS AT MARCH 31, 2023		AS AT MARCH 31, 2022	
SCHEDULE		TOTAL		TOTAL	
1	Corpus/Capital Fund Gross Corpus/ Capital Fund Less : Accumulated Depreciation Net Corpus/ Capital Fund	1,62,47,47,216 52,40,48,800	1,10,06,98,416	1,49,79,17,509 43,32,75,837	1,06,46,41,672
2	Current Liabilities & Provisions	1,05,83,02,112	1,05,83,02,112	49,92,54,774	49,92,54,774
	Total		2,15,90,00,528		1,56,38,96,446
ASSETS		AS AT MARCH 31, 2023		AS AT MARCH 31, 2022	
3	Fixed Assets Gross Block Less : Accumulated Depreciation Net Block	1,15,85,65,995 52,40,48,800	63,45,17,195	1,13,70,05,620 43,32,75,837	70,37,29,783
4	Current Assets, Loans & Advances	1,52,44,83,334	1,52,44,83,334	86,01,66,663	86,01,66,663
	Total		2,15,90,00,528		1,56,38,96,446
11	SIGNIFICANT ACCOUNTING POLICIES AND NOTES TO ACCOUNTS				

As per our Audit Report of even date
For M/s Rohit KC, Jain & Co.
Chartered Accountants
(FRN-020422N)







(Rishabh Wadhwa)
(Partner)
M. No. 517197
UDIN: 23517197B6VU085405
Place: Gurugram
Dated: 12th Sept. 2023



For NATIONAL INSTITUTE OF SOLAR ENERGY

(Chandan Banerjee)
Dy. Director General

(Lalit Bohra)
Director General

NATIONAL INSTITUTE OF SOLAR ENERGY (An Autonomous Institute of Ministry of New & Renewable Energy, Govt. of India) Gurgaon-Faridabad Road, Gwalpohari, Gurgaon, Haryana-122003		INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH 2023	
PARTICULARS	Schedule	Amount in ₹	
		2022-23 TOTAL	2021-22 TOTAL
INCOME			
Receipts from Testing & Operations	5	9,27,81,255	9,33,65,785
Grants/Subsidies utilised for Revenue Expenditure	6	17,78,36,114	42,34,75,798
Interest Earned	7	1,29,45,640	81,64,445
Other Income		27,96,158	32,41,563
Interest Earned on Grant Account		56,32,886	1,11,37,932
Interest Earned on CMA Account		30,27,522	-
Depreciation (As per Contra)	3	9,07,72,966	9,60,15,076
Provision Written back (F.Y. 2021-22)		5,20,070	89,46,513
Total (A)		38,63,14,911	64,43,47,102
EXPENDITURE			
Establishment Expenses	8	4,20,27,867	4,32,29,877
Other Administrative Expenses	9	7,06,66,571	6,72,69,183
Operational Expenses	10	9,92,95,302	34,32,19,140
Interest Payable on Grant Account		85,60,508	1,12,68,319
Depreciation (As per Contra)	3	9,07,72,966	9,60,15,076
Total (B)		31,14,23,214	56,10,07,595
Net Surplus/(Deficit) for the year		7,48,91,696	8,33,45,507
Provision for Taxation		-	-
Balance being Surplus/(Deficit) for the year transferred to General Reserve (A-B)		7,48,91,696	8,33,45,507
SIGNIFICANT ACCOUNTING POLICIES AND NOTES TO ACCOUNTS			
As per our Audit Report of even date			
For M/s Rohit KC Jain & Co.			
Chartered Accountants			
(FRN-020422N) Jain & Co. Chartered Accountants			
 (Ritesh Wahi) (Partner) M. No.517197 UDIN:2351484860085405 Place: Gurugram Dated: 12th Sept. 2023			
For NATIONAL INSTITUTE OF SOLAR ENERGY			
 (Chandan Banerjee) Dy. Director General			
 NISE Gurugram National Institute of Solar Energy (An Autonomous Institute)			
 Director General			

NATIONAL INSTITUTE OF SOLAR ENERGY (An Autonomous Institute of Ministry of New & Renewable Energy, Govt. of India) Gurgaon-Fardabad Road, Gwalpahari, Gurgaon, Haryana-122003			
RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH 2023			
RECEIPT	AMOUNT	PAYMENT	AMOUNT
Opening Bank Balances		Statutory Liabilities	
-In Saving bank accounts	1,36,90,676	-Goods and service tax	1,90,63,458
-In Sweep accounts	14,80,29,057	-TDS under Income Tax	1,70,95,621
-In Current bank accounts	8,69,751	-TDS Under GST	12,12,173
-In Nostro account	35,532	-National Pension Scheme	64,38,519
Grant Received During the Year	25,07,86,937	Salary Expenses	
		-Salary to Contractual Manpower	76,61,669
Received from Debtors		-Salary to Regular Employees	2,82,79,622
-Receipt For Guest House	6,93,647	Deposit and Advances	
-Receipt From Recruitment	12,90,954	Advance to CPWD	2,43,31,445
-Receipt From Processing Fees	12,81,008	Refund of EMD	1,90,086
-Receipt From Testing	73,61,998	Refund of UNICEF	47,70,748
-Receipt From Consultancy	64,09,658	Refund of Security Deposit	1,12,653
-Receipt From Training Domestic	46,24,787		
-Receipt From AEMM	6,62,68,784	Payment made from CNA Account	
-Others	20,043	FOI Scheme-4110	4,96,62,090
		Refund of Grant and Interest to MNRE	2,97,01,645
Deposits and Advances		Payment to creditors of capital	3,31,26,008
-Receipt For SA Fellowship Prog.	4,50,30,745	Payment under ISA Fellowship	2,46,90,801
-Earnest Money Deposit	54,750	Fixed Deposit	4,99,29,920
-Security Deposit	3,48,042	Other	
-T1	1,16,000	Refund of Recruitment fees	8,000
		Refund of Testing Fees	1,84,363
Interest Received		Bank Charge	1,80,441
-Interest on Income Tax Refund	13,45,157	Payment to creditors of goods and services	7,49,76,940
-Bank Interest on Revenue	23,95,229	Other	33,680
-Interest on CNA Account	30,27,522	Payment to SNA/TP	6,30,36,700
-Interest on Saving Bank Grant	2,66,523	TDS Deduction	9,67,925
-Interest on Sweep	37,98,634	Advance with staff	98,71,820
		Closing Bank Balance	
Receipts From Fixed Deposit	2,98,43,361	-In Saving bank accounts	9,61,428
		-In Sweep accounts	12,18,38,238
Amount Received in CNA Account		-In Current Bank accounts	7,08,794
-FOI Scheme-4110	2,46,33,736	-In CNA accounts	85,76,54,038
-E&D Scheme-4112	39,13,91,639		
Refund From Income Tax	1,83,33,337	Total	1,22,35,20,085
Received from staff against adjustment of advances	3,22,467		
Statutory Liabilities			
-TDS Deducted on account of creditors	4,10,918		
-TDS Deducted on account of creditors GST	2,22,412		
Other Receipts	1,47,922		
Total	1,22,35,20,085	Total	1,22,35,20,085

As per our Audit Report of even date

For M/S. S&A JCA & Co.

Chartered Accountants

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For NATIONAL INSTITUTE OF SOLAR ENERGY



(Chandan Bhanu)
Dy. Director General





(J.P. Puri)
Director General



SCHEDULE 1- CORPUS/ CAPITAL FUND		Amount in ₹	
		AS AT MARCH 31, 2023	AS AT MARCH 31, 2022
		Total	
General Reserve			
Balance as at the beginning of the year	30,95,31,979	22,29,63,742	
Add : Transfer of Income tax Reserve	-	32,22,739	
Add : Excess of income over expenditure during the year	7,48,91,696	8,33,45,007	30,95,31,979
Corpus Fund			
Balance of Grant/ Received from Govt. Non-Refundable			
Opening Balance(Refer Grant Sheet)	1,00,00,000	1,00,00,000	
Add : Amount received during the Year	-	-	
Closing Balance	1,00,00,000	-	1,00,00,000
Capital Reserve			
Grants adjusted against purchase of assets			
Opening Balance	1,12,17,59,703	1,00,37,04,050	
Add : Addition during the period	2,70,32,684	11,80,56,653	
Closing Balance	1,14,87,92,387		1,12,17,59,703
Grant utilised for advances given during the year			
Opening Balance	5,66,25,827	6,13,34,025	
Add : Net Adjusted during the Year	2,49,05,327	(2,47,05,196)	
Closing Balance	8,15,31,154		5,66,25,827
Total		1,62,47,47,216	1,49,79,17,509



 NATIONAL INSTITUTE OF SOLAR ENERGY <small>(An Autonomous Institute of Ministry of New & Renewable Energy, Govt. of India) Gurugram-Faridkot Road, Gurugram, Haryana-122003</small>				
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023				
	AS AT MARCH 31, 2023		AS AT MARCH 31, 2022	
	Amount in ₹	Total	Amount in ₹	Total
SCHEDULE 2- CURRENT LIABILITIES AND PROVISIONS				
Current Liabilities				
Bonded Creditors				
- For goods and services			11,942	
- For 1 year	5,411			
- For more than 1 year	4,48,514	4,51,925	3,35,284	3,48,206
- Creditors For Capital Goods				
- For 1 year			1,31,50,873	
- For more than 1 year	86,41,726	86,41,726	8,61,162	1,41,14,035
- Creditors For Surveys/ Training Programme				
- For more than 1 year	3,31,474	3,31,474	2,49,938	2,49,938
Deposits				
- Earned Money Deposits				
- Security Deposits	17,33,460		17,12,766	
- Deposit (Others)	7,34,739		4,56,747	
- Deposit (SUIIB)	77,241		1,31,064	
- Deposit (UNICEF)	9,49,440		10,35,000	
- Advance Received from Customers-ALMM	29,03,74,956		49,47,266	
- Advance Received from Customers	48,68,714	48,68,714	30,41,15,878	31,75,76,188
Deposits - Central Nodal Accounts				
- Under IRRO Scheme - 4110	2,46,33,736			
- Under R&D Scheme - 4112	54,17,29,840	56,63,63,580		
Statutory Liabilities				
- TDS Payable under Income Tax	20,45,270		89,93,532	
- GST Payable (Incl TDS under GST)	4,91,134	27,36,404	24,08,779	94,02,691
Other Current Liabilities				
- Salary & Remuneration Payable (Incl. National Pension Fund)	14,300		25,835	
- Interest refundable to Ministry	1,83,38,223		2,83,26,810	
- Advances received against training (BIA)	2,37,51,273		91,75,300	
- Other misc. liabilities	19,225	4,31,89,621	77,936	3,46,05,661
Balance of Grants Payable to Government of India	12,69,89,176	12,69,89,176	11,93,03,622	11,93,03,622
Provisions				
Provision for Expenses	82,48,523	82,48,523	38,57,824	38,57,824
Total		1,03,83,92,112		49,92,54,374




NATIONAL INSTITUTE OF SOLAR ENERGY (An Autonomous Institute of Ministry of New & Renewable Energy, Govt of India) Gurgaon-Faridkot Road, Gurgaon, Haryana-122003													
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023													
PARTICULARS	Rate	GROSS BLOCK						DEPRECIATION				NET BLOCK	
		As at 01.04.2022	Additions before 30.09.2022	Addition After 01.10.2022	Sales/ Acquisition during the year	As at 31.03.2023	As at 01.04.2022	Current Depreciation in M+C	Current Depreciation in on D	Total Current Depreciation 31.03.2023	Total Depreciation (G+J)	WDV as on 31.03.2023 (F-K)	WDV as on 31.03.2022
A	B	C	D	E	F	G	H	I	J	K	L	M	
Building/NOE	15.00%	62,43,63,378	-	-	-	52,43,65,378	3,60,87,229	-	3,60,87,229	38,15,86,120	49,17,85,058	38,08,72,280	
Desktop Computers	40.00%	1,45,79,372	-	-	-	87,83,400	23,18,388	-	23,18,388	1,11,61,790	14,27,582	57,95,870	
Printers and other IT Peripherals	31.00%	3,78,05,518	-	19,55,131	-	1,58,87,694	33,71,274	1,46,635	34,67,908	1,93,55,652	2,04,05,047	3,31,41,824	
Air Conditioner	15.00%	24,91,982	-	7,44,056	-	14,45,493	1,59,825	18,200	1,75,125	16,24,618	11,14,374	15,45,494	
Misc. Assets Guard House/ Office	15.00%	2,22,03,089	-	3,37,113	-	1,33,68,873	14,01,782	16,283	14,12,066	1,47,81,939	80,76,263	93,45,216	
Scientific & Laboratory Equipments	15.00%	30,71,30,515	38,80,172	86,20,438	-	10,88,87,434	3,06,14,747	8,48,531	3,13,67,278	13,81,58,712	18,14,37,443	20,60,38,146	
Vehicles	15.00%	9,13,381	-	-	-	4,20,874	71,353	-	71,353	5,11,627	4,64,334	4,26,687	
Furniture & Fixtures	10.00%	1,87,28,630	2,70,740	5,19,298	-	34,82,027	12,29,254	30,864	12,60,118	47,42,346	1,18,78,510	1,20,22,820	
Laptop	40.00%	26,28,554	-	-	-	11,24,427	8,01,011	-	8,31,011	12,26,438	9,01,518	15,02,527	
Other Assets (Training)	15.00%	86,02,190	-	-	-	48,80,063	8,61,319	-	8,61,319	54,21,382	31,80,808	37,42,127	
Software	40.00%	60,88,182	-	11,42,424	-	51,91,529	6,03,081	2,28,481	8,31,562	60,23,981	9,16,555	71,07,652	
500 KW Power Plant	15.00%	6,87,67,662	-	-	-	2,31,39,071	69,93,269	-	69,93,269	3,81,32,460	3,96,29,202	4,66,32,986	
Transformer	15.00%	18,29,723	-	-	-	5,43,562	1,63,076	-	1,63,076	7,03,038	9,25,799	10,88,271	
Assets under Solar Tower	15.00%	1,88,18,715	-	-	-	26,00,855	24,42,379	-	24,42,379	65,48,234	1,38,68,481	1,63,15,860	
Books/Standards and Periodicals	40.00%	17,88,669	-	32,20,071	-	5,44,269	3,43,716	6,44,814	9,85,730	15,36,110	30,88,830	8,54,289	
RO System	10.00%	2,36,400	-	-	-	72,269	23,721	-	23,721	95,980	1,34,420	1,58,141	
Scientific & Laboratory Equipments (2021 Project)	15.00%	-	-	14,91,000	-	-	-	1,11,825	1,11,825	1,11,825	13,79,175	-	
Total		1,13,79,95,638	41,26,912	1,74,28,483	-	1,18,88,65,995	8,89,36,923	19,37,843	9,08,72,766	52,40,48,800	83,45,87,195	78,37,29,216	



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NATIONAL INSTITUTE OF SOLAR ENERGY (An Autonomous Institute of New & Renewable Energy, Govt of India) Gurgaon-Faridkot Road, Gurgaon, Haryana-122002		AS AT MARCH 31, 2023		AS AT MARCH 31, 2022	
		Total		Total	
Current Assets					
Balances with Bank:					
-Savings & Current Accounts	16,69,634		14,45,60,427		
-Auto Savings Accounts	12,19,38,208		14,86,29,657		
-Central Nodal Accounts	65,76,94,568				
-Fixed Account		79,11,62,430	85,532		16,26,45,016
Fixed Deposits:					
Fixed Deposits - Core & Project Grant	4,26,09,078		6,96,64,371		
Fixed Deposits - Revenue	6,39,65,656		8,32,41,245		
Fixed Deposits - ALMM	33,30,00,000		33,50,00,000		
Fixed Deposits - Corpus Fund	14,25,79,505	80,29,69,391	6,65,74,514		57,44,60,225
Sundry Debtors:					
Sundry Debtors	80,000		73,985		
-For 1 Year	87,26,662	87,86,722	86,70,429		87,44,025
-For More than 1 Year					
Debtors Under ALMM (For 1 Year)	83,000	80,000	2,43,000		2,43,500
Loan & Advances & other assets					
Advances and other amounts recoverable in cash or kind or for value to be received					
- Advances for capital assets					
-For 1 Year	2,43,71,445		1,65,54,296		
-For More than 1 Year	6,38,71,060	8,62,02,525	4,51,27,183		8,44,81,472
- Advances for training programs					
-For 1 Year	19,67,205		25,93,754		
-For More than 1 Year	22,25,972	41,80,222	95,14,887		81,08,341
- Advance to Vendors	75,05,100		6,60,037		
- Balances with Staff (incl. interest Accounts)	1,25,691	74,23,811	1,83,079		15,43,716
Deposits					
- Security Deposits	3,15,966		3,15,965		
- O&T (Input Credit and GST Paid on Advances)	2,30,65,342		2,03,37,532		
- TDS Recoverable (F.Y. 2022-23)	84,34,486		1,79,92,609		
- Advance Tax-income Tax Refundable (F.Y. 2014-15 & 2015-16)	37,79,824	3,45,00,207	37,79,834		4,24,20,238
Total		1,32,44,83,334			86,81,84,683



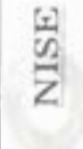

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 NATIONAL INSTITUTE OF SOLAR ENERGY (An Autonomous Institute of Ministry of New & Renewable Energy, Govt. of India) Gurgaon-Faridkot Road, Gwalpohari, Gurgaon, Haryana-122003		2022-23		2021-22	
		Total		Total	
SCHEDULES FORMING PART OF INCOME AND EXPENDITURE ACCOUNT AS AT 31ST MARCH 2023					
SCHEDULE 5- RECEIPTS FROM TESTING AND OPERATIONS					
Amount in ₹					
Receipts from Testing					
- Testing of Solar Components	61,58,550		61,58,550	37,79,234	37,79,234
Receipts under ALMM					
- Application Fees	4,47,81,725			4,65,72,175	
- Inspection Fees	2,67,50,000		7,15,31,725	2,90,00,000	6,95,72,175
Other Operational Receipts					
- Receipts from Trainings and Seminars- For Domestic Participants	34,63,000			11,22,474	
-For International Participants	37,69,232			4,20,000	
- Administrative/Overhead Charges	39,13,378			1,10,88,655	
- Consultancy Fees	39,45,370		1,50,90,980	73,83,247	2,00,14,376
Total			9,27,81,255		9,33,65,785



(Signature)

 NATIONAL INSTITUTE OF SOLAR ENERGY (An Autonomous Institute of Ministry of New & Renewable Energy, Govt. of India) Gurgaon-Faridabad Road, Gwalpahari, Gurgaon, Haryana-122003				
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023				
	2022-23		2021-22	
	Total		Total	
Grants Received during the year (Core Grants)	16,00,00,000		13,66,41,000	
Less : Grant Refunded	5,57,188		-	
Add: Grant Unutilised brought forward from Previous year	5,57,185	15,00,00,000	18,10,764	13,84,51,764
Grants Received during the year (Project Grants)	9,36,64,755		16,26,21,437	
Less : Grant Refunded	1,57,26,906		6,32,104	
Add: Grant Unutilised brought forward from Previous year	11,87,46,634	19,66,84,483	33,71,91,415	49,91,80,748
Grant Adjusted towards Revenue Expenditure :				
Current Year Expenditure-NISE	21,19,89,740		45,37,18,200	
Less : Expenses adjusted towards current year Revenue	2,59,74,100		2,65,84,507	
Less: Provision made against Revenue Expenditure	81,79,526		36,57,894	
	17,78,36,114		42,34,75,798	
Less: Expenses Adjusted against Previous Advances	60,87,224	17,17,48,850	1,54,54,410	40,80,21,388
Less : Grants utilised for purchase of Fixed Assets	2,56,41,244		8,49,56,832	
Less : Grants utilised for Advances against Capital Expenses	2,43,31,445		1,80,62,850	
Less : Grants utilised for Advances against projects	19,67,256		83,22,720	
Less: Grant utilised for Advance against General Expenses	50,06,467	5,79,46,412	64,900	11,03,07,302
Grants Payable to Government of India		12,69,89,181		11,93,03,822



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		2022-23		2021-22	
		Credited in Revenue	Total	Credited in Revenue	Total
SCHEDULE 7 - OTHER INCOME					
Bank Interest					
- Interest earned on Saving accounts	77,362		3,64,424		
- Interest earned on Auto Sweep accounts	23,17,867		22,67,038		
- Interest earned on F.D	37,56,575		23,08,370		
- Interest earned on Corpus Fund	54,48,879		21,81,540		
Sub Total of Bank Interest	1,16,00,683		71,21,372		
Interest on Income Tax Refund	13,45,157	1,29,45,840	10,43,073		81,64,445
Miscellaneous Income					
- Guest House Charges	6,50,800		3,66,900		
- Other Income	21,47,358	27,98,158	28,74,653		32,41,553
Provision Written Back	5,20,070	5,20,070	89,46,513		89,46,513
Total		1,62,64,068			2,03,52,511



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SCHEDULE 8- ESTABLISHMENT EXPENSES		2022-23						2021-22					
		Adjusted with grant	Adjusted against Advances	Provision for Expenses	Charged to Revenue	Total	Adjusted with Grant	Adjusted against Advances	Provision for Expenses	Charged to Revenue	Total		
Consultancy Charges (Contractual Manpower)	18,95,517	-	-	22,42,442	41,37,959	22,51,317	-	-	64,40,986	86,92,303			
Remuneration (Regular Employees)	3,78,85,908	-	-	-	3,78,85,908	3,44,90,707	-	-	98,867	3,45,87,574			
Total	3,97,85,425	-	-	22,42,442	4,20,27,867	3,66,92,024	-	-	65,37,853	4,32,29,877			



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SCHEDULE 9 - OTHER ADMINISTRATIVE EXPENSES	2022-23				2021-22				Amount in ₹	
	Adjusted with grant	Adjusted against Advances	Provision for Expenses	Charged to Revenue	Total	Adjusted with Grant	Adjusted against Advances	Provision for Expenses		Charged to Revenue
Electricity and Fuel Expenses	59,17,253	-	5,20,070	-	64,37,323	42,76,148	-	5,20,070	-	48,96,218
Outsourced Services	1,06,91,323	-	50,50,638	61,74,861	3,07,16,722	2,17,64,205	-	17,00,184	36,62,449	2,72,10,639
Security Services	77,84,323	-	11,12,016	35,73,079	1,24,69,418	1,11,09,686	-	8,89,812	-	1,19,99,498
Training Expense	-	-	-	2,48,236	2,48,236	-	-	-	21,60,022	21,60,022
Miscellaneous Exp./Contingency	57,120	-	-	4,66,831	5,23,951	-	-	-	2,94,295	2,94,295
Office Expenses	4,38,702	25,000	-	5,80,191	10,18,879	14,53,932	25,000	-	5,11,485	18,68,988
Refundment/Impairity	5,74,191	-	1,22,579	1,32,131	7,88,891	2,46,147	-	-	87,532	3,33,679
Legal & Professional Charges	5,77,742	-	64,900	3,37,025	9,79,667	18,30,343	-	-	-	18,30,343
Bank Charges	8,138	-	-	1,407	9,545	16,776	-	-	-	16,776
Gateway/Service charge	-	-	-	1,63,032	1,63,032	-	-	-	95,379	95,379
Horticulture Expenses	7,71,807	-	-	-	7,71,807	6,23,618	-	3,70,865	84,178	9,94,483
Advertisement Expenses	1,55,599	66,044	-	-	2,21,643	-	-	-	-	2,21,643
Guest House Expenses	-	-	-	84,450	84,450	-	-	-	27,515	1,11,965
IT Expenses (Facilitation Charges)	1,25,788	-	-	9,07,842	10,33,630	3,67,189	-	-	-	1,40,869
Seminar/Conference/Training Programmes	5,74,705	-	1,34,836	2,81,824	5,35,365	2,21,240	-	-	5,69,374	2,90,634
Medical Reimbursement	-	-	-	-	-	-	-	-	2,27,663	2,27,663
Solar Dryer Expenses	-	-	-	-	-	-	-	-	8,77,753	8,77,753
Lab Expenses	8,84,126	-	-	5,76,643	14,60,769	14,88,232	-	-	14,88,232	14,88,232
Consumables/ Laboratory/Workshop Exp.	3,89,882	-	-	1,82,766	5,72,648	10,09,478	-	-	6,03,177	10,09,478
Electrical Consumables	97,037	-	-	54,788	1,51,825	1,57,250	-	-	-	1,57,250
Library Books, Periodicals and News paper	8,66,336	-	-	1,83,405	10,49,741	5,80,516	-	-	1,66,624	7,63,145
Postage, Courier, Printing and Stationery	-	-	-	-	-	-	-	-	-	-
Recruitment Expenses	-	-	-	-	-	-	-	-	-	-
Interest & Penalty Interest & maintenance expenses (Building)	14,12,136	64,900	2,06,968	4,16,106	21,00,110	26,14,624	10,48,278	-	1,40,162	3,46,819
Motor Vehicle & Computers	21,51,919	-	29,899	3,05,796	25,11,514	11,19,803	-	24,791	11,75,305	39,63,102
Telephone & Lease line Expenses	66,069	-	-	4,880	70,949	2,52,952	-	-	-	2,52,952
Vehicle Running & Maintenance	12,05,452	-	1,37,742	3,77,859	17,21,053	8,73,666	-	62,172	62,172	9,98,018
Hiring of vehicles Expenses	1,95,007	-	-	11,74,497	13,69,504	2,45,023	-	-	9,98,939	12,41,562
Tour / Travel & Transport	-	-	-	3,79,405	3,79,405	-	-	-	-	3,79,405
Tour / Travel & Transport- International	-	-	-	25,06,245	25,06,245	-	-	-	-	25,06,245
Tour / Travel & Transport- ALMT	-	-	-	-	-	-	-	-	-	-
Board & Committee meeting	1,99,343	-	-	-	1,99,343	-	-	-	11,38,306	11,38,306
Total	4,30,69,666	1,55,944	81,79,338	3,82,61,435	7,06,66,971	4,96,55,794	12,64,563	34,97,894	1,27,51,021	6,73,69,183



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SCHEDULES FORMING PART OF INCOME AND EXPENDITURE ACCOUNT AS AT 31ST MARCH 2023		2022-23					2021-22				
		Adjusted with grant	Adjusted against Advances	Provision for Expenses	Charged to Revenue	Total	Adjusted with Grant	Adjusted against Advance	Provision for Expenses	Charged to Revenue	Total
SCHEDULE 10- OPERATIONAL/PROJECTS EXPENSES		Amount in ₹									
Released to State Nodal Agencies/ TP for Skill Development Programme	6,92,85,280	59,31,280	-	28,77,818	7,80,94,176	29,92,28,362	1,30,53,247	-	-	31,22,86,609	
ITEC Training Programme Expenses (PI)-TP MGA (ITEC)	1,39,83,632	-	-	7,17,426	1,67,01,058	-	-	-	72,937	72,937	
Hydrogen Project Expenses (PO)- Hydrogen)	43,206	-	-	-	43,206	26,42,735	-	-	42,797	36,85,532	
BHEL R&D Project Expenses (PI)- PERC)	8,76,753	-	-	-	8,76,753	19,96,654	-	-	63,30,000	83,26,654	
Solar Radiation Calibration Lab Expenses (SACL) (PO)- SR08)	-	-	-	-	-	6,89,222	-	-	-	6,89,222	
Department of Science and Technology Project Expenses (PO)- WPGST)	-	-	-	-	-	30,28,768	11,91,600	-	-	42,20,368	
Department of Science and Technology Project Expenses (PO)- WPGST-2)	11,69,870	-	-	-	11,69,870	8,11,235	-	-	-	8,11,235	
Solar Water Pumping System Project Expenses (PO)-SWP)	14,15,698	-	-	-	14,15,698	35,77,176	-	-	-	35,77,176	
GSZ Project Expenses	-	-	-	6,91,302	6,91,302	-	-	-	8,02,425	8,02,425	
UNICEF Project Expenses	-	-	-	1,83,677	1,83,677	-	-	-	-	-	
Varanindra Skill Development Programme Expenses (PI)- TP VADURKETA)	1,19,960	-	-	-	1,19,960	96,99,508	-	-	47,474	97,46,982	
Total	8,88,93,799	59,31,280	-	44,70,223	9,92,95,302	32,16,73,660	1,42,40,847	-	72,95,633	34,32,19,140	



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PARTICULARS		Opening Balance 01.04.2022	Received in Ministry	Transfer	Receipt/Transfer during the year 2022-23	Received Through	Utilisation against advances 22-23	Utilisation against Revenue Expenditure 22-23	Utilisation against Admin Charge 22-23	Total Utilisation 22-23	Closing Balance 31.03.2023
National Institute of Solar Energy											
	Grant for Creation of Capital Assets	4,79,088	4,79,008	-	7,00,00,000	-	2,43,31,448	-	-	4,21,47,102	2,78,52,887
	Grant in aid - General	77,858	77,858	-	8,00,00,000	-	10,36,457	4,40,05,182	-	4,90,71,649	28,258
	Grant in aid - Salaries	9,522	9,522	-	4,00,00,000	-	-	3,78,89,958	-	3,78,89,958	21,19,092
	Grant for BHEL R&D Projects (P01- PERC)	14,78,318	-	-	40,00,000	-	-	8,78,733	-	47,42,858	2,35,879
	Grant for Project Hydrogen (P02- Hydrogen)	5,28,02,287	88,96,067	-	1,00,00,000	-	-	43,256	-	25,11,920	8,83,18,967
	Grant- S&I Development Programme	1,85,72,852	19,83,174	-	8,40,00,000	28,77,818	19,87,258	6,72,38,941	40,75,378	7,42,52,536	1,32,45,058
	Grant for S&S&S (Indo US Project)	28,866	-	-	-	-	-	-	-	-	28,866
	Grant- World Renewal Energy Museum	2,86,55,548	-	-	-	-	-	-	-	-	2,86,55,548
	Grant- Solar Paved clean drinking water project (P03-SOPWR)	-3,87,990	-	-	-	-	-	-	-	-	-3,87,990
	Grant - Solar Radiation Sensor Project (P05- SORSA)	16,518	16,519	-	-	-	-	-	-	-	-
	Grant - Vayudootra Skill Development Programme (P18- TP Varanumbra-2)	1,41,746	21,796	-	-	-	-	-	1,19,950	1,19,950	-
	Grant - Solar Pumping Project (P07- SWP/SP)	81,76,483	37,81,365	-	-	-	-	18,15,088	-	14,15,088	-
	Grant - Department of Science & Technology (P06- WPGST-2)	1,22,18,585	-	-	-	-	-	91,68,870	-	26,00,870	95,58,699
	Grant- International Training Programme	-	-	-	1,27,96,937	-	-	1,59,83,032	-	1,59,83,032	-31,86,099
	Total Grant (Balance of Grant payable to Govt. of India)	11,83,83,822	1,42,86,699	77,285	25,07,96,937	28,77,818	3,13,61,188	18,96,63,890	21,95,279	22,98,85,201	51,69,89,178
Contributions for Corpus Fund											
NISE											
	Contribution by ISEDA	1,00,00,000	-	-	-	-	-	-	-	-	1,00,00,000
	Total Grant Received from Govt. Non-Refundable	1,00,00,000	-	-	-	-	-	-	-	-	1,00,00,000



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SIGNIFICANT ACCOUNTING POLICIES AND NOTES TO ACCOUNTS FORMING INTEGRAL PART OF THE FINANCIAL STATEMENTS FOR THE F.Y 2022-2023.

A. SIGNIFICANT ACCOUNTING POLICIES

1. Accounting Convention

The financial statements are prepared on the basis of historical cost convention, unless otherwise stated and on the basis of accrual method of accounting.

2. Grant in Aid

- a) The Institute is getting budgetary support from Ministry of new & Renewable Energy, Government of India. These grants are recurring in nature and are termed as Core Grants. Besides the recurring grants, one-time grants are also received to take up specific projects or activities. Such grants have been classified as Project Grants. The unutilized grants at the end of year have been shown in the financial statements as Grant Payable to Government of India. Grants which are non-refundable are shown as corpus fund under General Reserve.
- b) The Institute has adopted the policy to set off allocable revenue expenses with the internally generated resources i.e., testing, training and Consultancy income in accordance with Rule 229 (iv) of GFR, 2017. The surplus from the same is being shown under the head General Reserve. However, expenses incurred against specific projects and activities have been set off against the grants received for that purpose.

3. Fixed Assets and Depreciation

- a) Fixed assets are stated at cost less accumulated depreciation.
- b) Depreciation has been provided on the basis of rates as prescribed under Income Tax Act 1961.
- c) The fixed assets are funded by the Grants in Aid (Capital) and hence, the charge of over the same is being recognised as a contra item in Income & Expenditure Account.

4. Employee Remuneration & Benefits

All Retirement and other Terminal Benefits such as Gratuity, Leave Encashment and Bonus etc. are not accounted on year-to-year basis and the same are recognized in the year of occurrence of event.

5. Revenue Recognition

Revenue is recognized on accrual basis.



B. Notes to Accounts

1. NISE has created the Corpus Fund as per the guidelines approved by MNRE vide letter No. 354/12/2017 – NSM dated 24.06.2019 during the year. The balance of Corpus Fund as on 31.03. 2023 is Rs. 1425.78/- lakhs (Previous year Rs. 885.74/-).
2. The guidelines for enlistment under “Approved Models and Manufactures of Solar Photo voltaic Modules (Requirements for Compulsory Registration) Order, 2019” issued by MNRE, NISE has been designated as Implementation Support Agency. The inspection/application fee under the said scheme is considered as revenue of the Institute.
3. The accumulated depreciation amounting to Rs. 52,40,48,800/- (current year Rs. 9,07,72,966/-) has been charged to the Income & Expenditure account. Since the Institute is fully aided by the grant from Government of India, the same has been charged to the Grant in Aid (Capital) and is recognised in the Income & Expenditure account as a contra item.
4. The amount of interest earned on grants and payable to MNRE is Rs. 86,60,508/- (previous year Rs. 1,11,37,932/-) and has been shown as contra item in Income and Expenditure account.
5. The Institute has taken over the facilities consisting of 200 acres of land, administrative block, 3 Nos. technical block from erstwhile solar Energy centre (MNRE), the ownership of which is under process of transfer.
6. Addition made during the F.Y. 2022-23 in Capital Reserve (Purchase of Assets) amounting to Rs. 2,70,32,684/- (Previous Year Rs. 11,80,55,653/-).
7. The Income Tax Assessment for AY 2021-22 is under process.
8. The institute was maintaining its income and expenditure on cash basis except statutory liabilities and Capitalized Assets. In view of the transition from cash to accrual system, the provision for expenses during the year has been made for an amount of Rs. 82,46,523/- (Previous year Rs 36,57,824/-).
9. An amount of Rs. 5,20,070/- out of the provision made in previous year, has been written back during the year, as the same has been paid through the grant account.
10. The balances of sundry creditors and debtors are subject to confirmation.
11. Previous year figures have been regrouped and rearranged to make them comparable with those of current year.

For M/s Rohit KC Jain & Co.
Chartered Accountants
FRN 020422N



CA. Ritesh Wahaf
Partner
M. No.: 517197
UDIN: 23517197867VU885405
Place: New Delhi
Date: 12th sept. 2023





राष्ट्रीय सौर ऊर्जा संस्थान
(एन आर नवीकरणीय ऊर्जा संस्थान, भारत सरकार में अखिल सौर ऊर्जा संस्थान)
National Institute of Solar Energy
(An Autonomous Institute of Ministry of New and Renewable Energy, Govt. of India)
मुख्यालय - करीदाबाद मार्ग, ग्वालपहाड़ी, गुरुग्राम - 122 003, हरियाणा, भारत
Gurugram - Faridabad Road, Gwal Pahari, Gurugram -122 003, Haryana, India

To,

Dated: 08.09.2023

M/s Rohit KC Jain & Co.
Chartered Accountants
New Delhi.

Subject:- Management Reply on observation found during the Audit for the FY 2022-23.

Sir,

In reference of observations mentioned in Annexure-1 of the Audit-report for the FY 2022-23, we are submitting the point wise reply: -

1. The various repairing/renovation works assigned to CPWD on the pattern of deposit work of autonomous body, NISE has received information dated 11.09.2023 via email from the CPWD Faridabad division of Utilization of fund (Expenditure status) (Annexure – I). All the work is under process and will be settled down after receiving of final UC (from 05) of completed work. Thereafter, the work will be capitalized.
2. The TDS refunds of Rs. 21,66,219/- has received in institute bank account 04.07.2023 along with interest of Rs. 9,04,779/- for the AY 2015-16 in the current FY 2023-24. The process of TDS refund for AY 2016-17 has already initiated and it will probably be settled in current financial year.
3. The Governing council was appraised about the status for creation of world museum of Renewable Energy at NISE in its 6th meeting held on 10th May, 2018. The Governing Council decided to defer the proposal. NISE will put up the matter in the upcoming Finance Committee meeting for the further action.
4. The advance of 50% fund was released to conduct the skill development program to the abovementioned training partner. The point wise reply is as follows:

दूरभाष / Tel. No. : 0124-285 3060
ईमेल / Email : dgnise.mnre@gmail.com, nise.mnre@gmail.com, वेबसाइट/ Website : www.nise.res.in



- i. The Training Partner has submitted the UC/SOE directly to NISE but at that time program was conducted through SNA i.e., OREDA and the same UC and SOE has not been endorsed by the OREDA. The NISE has communicated the issue multiple times to Training partner and SNA respectively to resolve the matter. The matter is under discussion with the competent authority for further course of action.
 - ii. The NISE has received the copy of UC/SOE from the Govt. Polytechnic College Kerala in current financial year. The matter is under consideration to treat the submitted UC for the settlement of advance.
 - iii. The NISE has sent multiple reminders to Rajasthan Renewable Energy Corporation, but no response has been received from their side, the matter is under discussion with the competent authority for further course of action.
5. The matter of CDAC is currently under MNRE audit observation. CDAC vide letter no. CDAC/MNRE/24012022 dated 24.01.2022 & subsequent mail dated 04.09.2023, has informed that CADC had taken views of its Legal & Quality Department and is in process of initiating sole Arbitration for settling the issues.
 6. The Maximum amount of EMD relates to the training partner associated with the Skill development program (Suryamitra). The Program division has initiated the process for refund of EMD amount.
 7. The abovementioned advances received pertains to ALMM applications and inspection fees from foreign companies. Inspection of foreign companies has not been completed due revised Guidelines of MNRE.

Kindly consider our representation.

Thanking You,

Yours Faithfully,



(Dr. Chandan Banerjee)

Dy. Director General





National Institute of Solar Energy

(An Autonomous Institute of Ministry of New and Renewable Energy, Government of India)

Gurugram - Faridabad Road, Gwal Pahari,
Gurugram - 122003 (Haryana)