ANNUAL REPORT

2020-21

NISE
National Institute of Solar Energy

NATIONAL INSTITUTE OF SOLAR ENERGY

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

NATIONAL INSTITUTE OF SOLAR ENERGY

GOVERNING COUNCIL

1.	Sh. Indu Shekhar Chaturvedi, Secretary, Ministry of New and Renewable Energy (MNRE)	President (Ex-officio)
2.	Sh. Vimalendra Anand Patwardhan, Financial Advisor, Ministry of New and Renewable Energy (MNRE)	Member (Ex-officio)
3.	Ms. Vandana Kumar, Joint Secretary (Solar), Ministry of New and Renewable Energy (MNRE)	Member (Ex-officio)
4.	Advisor (Solar), Ministry of New and Renewable Energy (MNRE)	Member
5.	Ms. Suman Sharma, Managing Director, Solar Energy Corporation of India (SECI)	Member
6.	Sh. V.S. Nanda Kumar, Director General, Central Power Research Institute (CPRI)	Member
7.	Sh. Narendra Nath Veluri, Director, Agency for New and Renewable Energy Research and Technology (ANERT), Kerala	Member
8.	Dr. Hanif Qureshi, Director General, Haryana Renewable Energy Development Agency (HAREDA), Haryana	Member
9.	Sh. Ashish Khanna, CEO & MD, Tata Power Solar Systems Limited, Bengaluru	Member
10.	Dr. Dharmappa Barki, Vice President (Solar), Greenko Renewable, Hyderabad	Member
11.	Sh. G. Upadhyay, Director General, National Institute of Solar Energy (NISE)	Member
12.	Dr. Chandan Banerjee, Deputy Director General-I, National Institute of Solar Energy (NISE)	Member
13.	Deputy Director General-II, National Institute of Solar Energy (NISE)	Member
14.	Dr. Ashish Garg, Professor, Dept. of Materials Science & Engineering, IIT Kanpur	Member
15.	Prof. Hiranmay Saha, Visiting Professor, Centre of Excellence for Green Energy and Sensor Systems, Indian Institute of Engineering Science and Technology (IIEST), Shibpur	Member
16.	Dr. Sushil Kumar, Sr. Principal Scientist & Professor (AcSIR), Head – Photovoltaic Metrology Section, CSIR-National Physical Laboratory (NPL), New Delhi	Member
17.	Dr. Shaibal K Sarkar, Associate Professor (Solar PV), Dept. of Energy Science & Engineering, IIT Bombay	Member
18.	Dr. Jai Prakash, Director (Technical), National Institute of Solar Energy (NISE)	Member Secretary

Special Invitee:
Representative nominated by Secretary, Department of Science & Technology (DST), New Delhi

EXECUTIVE COMMITTEE

1.	Director General, National Institute of Solar Energy (NISE)	Chairman
2.	Deputy Director General-I, National Institute of Solar Energy (NISE)	Member
3.	Deputy Director General-II, National Institute of Solar Energy (NISE)	Member
4.	Director (Technical), National Institute of Solar Energy (NISE)	Member
5.	Deputy Director (Admin)/Administrative Officer, National Institute of Solar Energy (NISE)	Member Convener

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

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OVERVIEW

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When it comes to the utilisation of energy and electricity, the world's focus is on renewable power sources. India is playing a significant role in making transition to green energy. India is committed for a target of at least 40% of installed power capacity from renewable energy sources by 2030. To achieve this, Government of India has announced a target of 450 GW of renewable power capacity by 2030. Solar power capacity has increased from 2.6 GW to 40 GW in the last five years. According to 2018 Climate scope report, India is the second most attractive nation for clean energy investment. This is based on key indicators such as Clean Energy Policies, Power Sector Initiatives, Emissions, and Installed Capacities, etc.

For the previous years, Government of India has taken various policy initiatives in the solar sector, such as PM-KUSUM scheme for agricultural applications, regulatory interventions, development of solar parks, skill development initiatives and employment in renewable energy sector.

National Institute of Solar Energy (NISE) plays a crucial role by supporting Ministry of New and Renewable Energy (MNRE) in implementation of the National Solar Mission (NSM) and carrying out Research and Development (R&D) activities in the field of solar energy. NISE engages in R&D and testing of solar components, developing and assisting in standard and certification, solar photovoltaic technology consultancy projects, skill development programmes, and development of the rural community by deploying solar products developed at NISE.

In the Financial Year (FY) 2020-21, NISE has utilised its resources in a well-planned manner for significant progress in the renewable energy sector. This annual report presents various technical and other activities of NISE during the period from 1st April 2020 to 31st March 2021. The first chapter provides an executive overview of various activities. Chapter 2 introduces the institute and its vision, thrust area, and objectives. The detailed activities of various technical divisions of NISE are provided from Chapter 3 to Chapter 8. The various outreach activities of NISE with international cooperation are detailed in Chapter 9 and Chapter 10 respectively. Chapter 11 presents the general activities and facilities, including administration activities of NISE. The details of publications and patents are given in Chapter 12. The audited financial accounts have been presented in Chapter 13.

GOVERNING COUNCIL

The Governing Council of NISE (GC) has its members from industry, research institutions, Government departments, and experts from the field of solar energy. In the FY 2020-21, two GC meetings were held on 11th December 2020 (Tenth GC meeting) & 15th January 2021 (Eleventh GC meeting).

FINANCE COMMITTEE

The Finance Committee (FC) examines and takes decisions, on behalf of the GC in respect of the Annual Budget of the society, budget to start any major activity or any matter referred by GC etc. The 9th meeting of the FC of NISE was held on 12th and 21st Oct 2020 in which it approved the Audited Accounts and Audited Reports for FY 2019-20.

EXECUTIVE COMMITTEE

The Executive Committee (EC) takes the decisions related to administration, policy, finance and accounts related matters and considers for the improvement of the overall functioning of NISE. Four EC meetings of NISE were held on 20th January 2021, 1st Feb 2021, 5th March 2021 and 10th March 2021.

SCIENTIFIC AND OTHER ACTIVITIES OF NISE

NISE acts as a catalyst for the forthcoming solar energy transition in India. Strengthening of laboratories and manpower of NISE has been the core mandate. The experts from NISE have participated in various meetings of MNRE and provided necessary technical inputs. Following is the executive summary of activities conducted in various laboratories/divisions at NISE:

During the FY 2020-21, Solar Radiometer Calibration Laboratory (SRCL) has performed the calibration of 15 sensors from 5 Solar Radiation and Resource Assessment (SRRA) Stations located at different locations in the country. Additionally, 43 number of sensors from commercial and 3 sensors from research institutes were also calibrated.

In the FY 2020-21, the Photovoltaic test facility at NISE has upgraded its facilities with addition of a solar simulator with temperature control. The construction activities are in progress at NISE to upgrade the solar PV pump testing facility up-to 50 hp. During the FY 2020-21 a total of 254 samples were tested and calibrated at NISE in the Solar PV Test facility.

During 2020-21, NISE continued its R&D activities in solar thermal technologies which included, solar dryer-cum-space heating system for Ladakh, low cost portable mini greenhouse based solar dryer, thermal energy storage based solar cold storage and bulk milk cooler, numerical analysis of the cost-efficient parabolic trough solar collector. A total of 300 solar dryer-cum-space heating systems have been installed and commissioned at various locations in Ladakh.

NISE continued the implementation of an R&D project entitled "Setting up of a Centre of Excellence on Hydrogen Energy" in the campus supported with the financial assistance from the MNRE. The project aims at augmenting in-house hydrogen production capacity of the existing hydrogen refuelling facility by installing another alkaline electrolyser.

During 2020-21, NISE has been involved in implementation of 5 externally funded projects, and 5 numbers of in-house R&D projects. NISE is on its way of establishing an Advanced PV Characterisation Laboratory in the Aditya Bhawan for housing the testing and characterisation equipment under a single roof. As part of the project, NISE established a laboratory space of 140 sq. m, ISO Class 8 clean room to install all the testing and characterisation facilities. NISE has procured and commissioned Spectroscopic Ellipsometer, Optical Microscope, Semi-Automatic Four Probe Resistivity Meter, Surface Profilometer and Spectral Response Measurement System (QE-SRMS) under this project.

During the year 2020-21, NISE has imparted trainings (both online and offline mode) to wide variety of participants from 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. A total of 12 numbers of national and international level training courses were conducted in which 453 participants were imparted training.

The technical staff of NISE continued their efforts in publishing research articles and reports on various evolving topics of solar energy. NISE signed MoUs with 16 national organisations and 1 international organization during the year 2020-21. Nine (09) research papers/book chapters were published in reputed international/national journals during 2020-21. NISE has also applied for two patents during 2020-21.

ADMINISTRATION AND FINANCE

CAG Audit of NISE was conducted successfully in the financial year 2020-21.

INTRODUCTION

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NISE is an autonomous institute under the MNRE, Government of India, mandated for R&D, solar component testing and certification, capacity building, and solar product and application development. The technical support of NISE complements the requirements of MNRE to become a self-reliant renewable power producing nation and accept the series of challenges intervened in amidst of implementation of the NSM. NISE has established in the solar energy sector through continuous efforts by developing newer technologies, developing standards, and catering to the changing needs of the industry. Furthermore, NISE envisions in accelerating the proliferation of the renewable energy projects by intently working together with the Government of India.

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, R & D, design, development, and demonstration of solar energy technologies for various applications, testing, certification, and standardization; monitoring and evaluation, economic and policy planning; human resource development and active collaborations with prominent national & international organisations etc.

OBJECTIVES

The main objectives include (i) To function as the national research organization for undertaking and/or sponsoring R&D projects on various aspects of solar energy technologies; (ii) To act as an apex organization for testing, certification, development of specification, and standards; and (iii) To create skilled manpower and offer consultancy services on solar energy technologies.

THE INSTITUTION

NISE is situated at Gwal Pahari on Gurugram-Faridabad Road in Haryana. The institute is linked through open and wide roads. It is about 22 km away from the nearest airport, 30 km away from New Delhi Railway station, and at a distance of approx. 25 km away from MNRE. The institute has continuous connecting services via road through commuting facilities outside its premises.

The institute has a 200-acre campus which is registered as a society under the Haryana Registration and Regulation of Societies Act, 2012 (Registration No. is HR-018-2013-01092). The campus is beautifully landscaped with green vegetation and R&D projects such as Swajal, 1 MW solar thermal power plant, 500 kW_P solar photovoltaic power plants, 150 kW_P solar rooftop photovoltaic power plant and 120 kW_P solar photovoltaic power plant for hydrogen facility to harness the solar energy to the maximum extent. The campus area includes the energy-efficient buildings known as Aditya Bhawan and Surya Bhawan with conference halls, seminar rooms, committee rooms, guest houses, and a library. The halls and rooms are furnished with modern amenities, projectors, sound systems with a seating arrangement for more than 150 individuals. The library has the latest updated standards, journals/conference papers both international/national, magazines, newspapers, and more than 3000 books. The authorisation and bookings are made convenient through the e-online library portal, easily accessible from the NISE website. The Surya Bhawan also comprises of the Administrative Department, Skill Development Division, and International Solar Alliance (ISA) Secretariat. Figure 2.1 shows the Aditya Bhawan, and Figure 2.2 shows the Surya Bhawan buildings of NISE.

The Aditya Bhawan of NISE, designed on the principles of solar passive architecture is exclusively a technical

block comprising of "state-of-the-art" testing facilities, laboratories, and workshops. NISE is having world-class,well-equipped testing facilities and R&D rooms spaced at Aditya Bhawan. The solar radiation data centres with suitable equipments are also located within the campus for the collection of real-time solar radiation data.

NISE has guest house facilities for trainers, staff and international delegates with cafeterias in both buildings to serve them with sumptuous food. NISE campus has an ATM at its main gate together with other amenities such as playing field, gyms, indoor games, yoga halls, etc. within the premises.

QUALITY POLICY OF NISE

NISE is committed for providing performance evaluation and testing services for solar cells, PV modules, solar water pumping system, inverters, charge controllers, batteries, lighting systems. NISE also provide calibration facility 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, NISE

Figure 2.2 Surya Bhawan, 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.

ORGANISATION STRUCTURE OF NISE

The affairs at NISE are managed by a GC chaired by Secretary, MNRE and, an EC chaired by Director General, NISE. An organisation chart of the structure and management of NISE is shown in Figure 2.3. The third GC was reconstituted by the MNRE, Government of India, on 15th January 2021, to manage the affairs and funds of NISE in accordance with the Memorandum of Association, Rules, Regulations, and By-laws of NISE.

There are 18 members including Secretary, MNRE, who is ex-officio President, NISE. The GC consists of members from industry, premier institutions, MNRE, NISE and experts from reputed organisations. The EC has five members headed by DG, NISE to manage the day to day affairs of NISE and to take decisions on matters under the powers delegated to it. During the period of report, three EC meetings were held under the chairmanship of DG, NISE. The FC of NISE have three members comprising of Financial Advisor, MNRE as Chairman and Joint Secretary (Solar), MNRE and DG, NISE as its member. The Deputy Director Generals are supported by Directors, Administrative officer, Deputy Directors, Assistant Directors, and Executive Assistants for various technical and administrative functions.

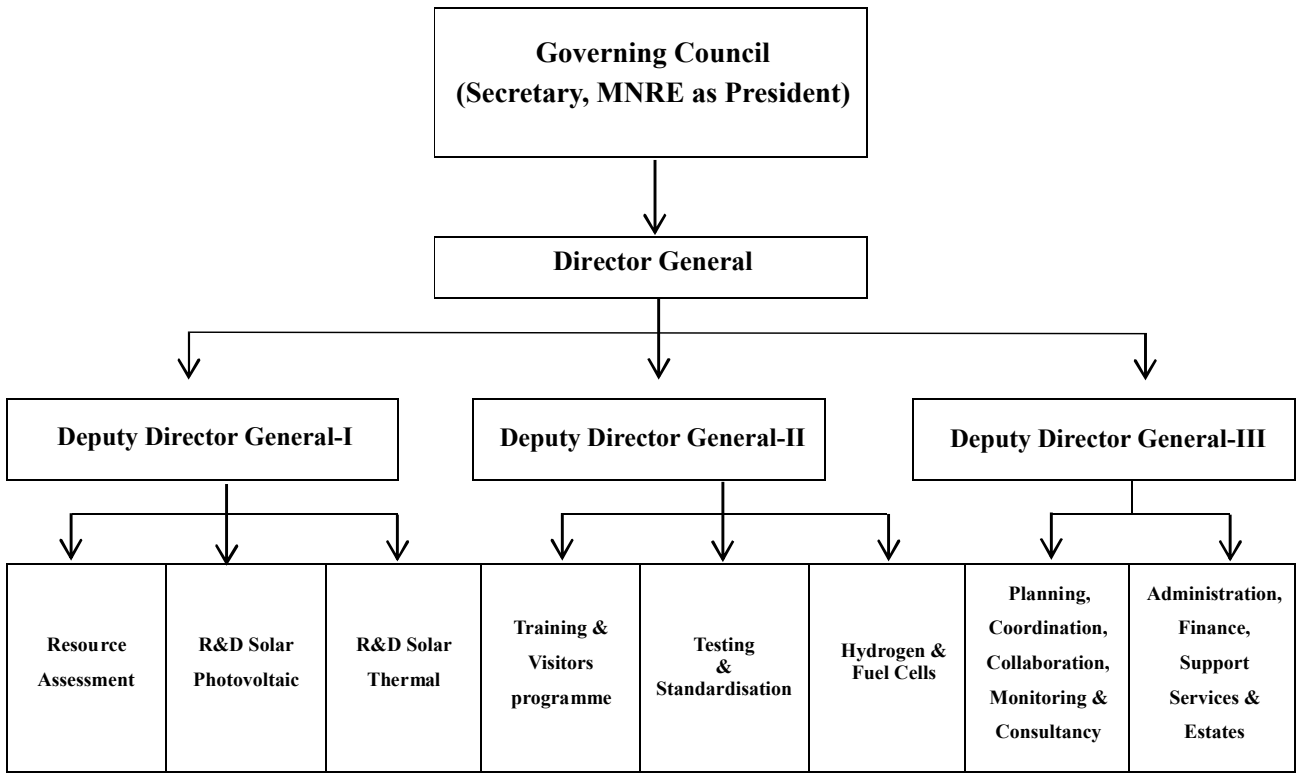

Figure 2.3 Organisation Structure of NISE

THRUST AREAS

The basic functions of NISE is to serve as a technical focal point in solar energy related areas. NISE is committed to perform at its best in all spheres relating to solar energy and continually provide assistance and guidance with high standard of quality in its work. NISE recognises the process of developments and continuously relate for significant and notable changes taking place in solar industry. NISE has the following thrust areas for its contribution and exploration of knowledge in this area.

(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).
- Standards and Certification.
- Database Management and Information dissemination.
- Capacity Building, training, teaching and visitors programme.
- Collaborations, Monitoring and Consultancy Services.
- Development of Solar Energy Products & Hybrid System.
- Consultancy Services, Monitoring, Collaborations (National and International)
- Innovations, solar product development & commercialization.
- Hydrogen and Fuel Cells.

(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.

MAJOR ACTIVITIES

The main functions 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 the 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 replacement of kerosene and diesel being 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 Corporation of India set up by the Ministry for implementation of the Mission.

VII. The Institution under the guidance of the Ministry and the Mission Steering Group is responsible for Coordination with the (i) other Centres of Excellence identified under the Mission, (ii) R&D projects funded in the field of solar energy in the country, (iii) other S&T Ministries/Organizations 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 the 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 latest global developments based on technology forecasting and foresighting 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 the 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 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.

NISE is a technical hub for all solar linked activities, standardisation, designing, consultancy, and skill development programs. The institution is committed to deliver quality in all the efforts put in to promote and grow solar energy in India. The institution aims to address the gaps and work towards the NSM in the most significant procedure.

NISE believes on the technology evolutions. This helps to anticipate and prepare for future challenges. New opportunities for innovation will be the major focus for future growth. Preparing the solar Industry for a cost optimised solution, with emphasis on quality shall also be included in the forthcoming plans

SOLAR RADIATION RESOURCE ASSESSMENT

3

As part of Solar Radiation Resource Assessment (SRRA) initiative of MNRE, one Advanced Monitoring Station (AMS) and one Solar Radiation Resource Assessment (SRRA) station have been established at NISE campus. The SRRA stations generate high quality (one minute) solar radiation data 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. The institute has ongoing R&D project for calibration of solar radiometers of SRRA stations of MNRE. Baseline Surface Radiation Network (BSRN) is the global network of solar radiation measurement stations from various countries monitored by World Meteorological Organisation (WMO). As a part of the BSRN network, the SRRA station of NISE is listed as Station No. 56, with site specifications as plain terrain, medium black soil.

SOLAR RADIATION CALIBRATION LABORATORY

The Solar Radiation Calibration Laboratory (SRCL) at NISE is operational since 2016 for calibration of solar radiation measuring sensors from National Solar Radiation Network of MNRE (Figure 3.1). The laboratory is established following the WMO guidelines where calibration is performed as per the International Standards Organisation (ISO). It has highly precise reference standard sensors such as primary standard sensor/Absolute Cavity Radiometer (Highest Solar Radiation Standard) and number of secondary standard reference sensors for achieving radiometric calibration traceable to World Radiometric Reference (WRR) scale with high accuracy and precision. In addition, the facility also caters the calibration needs of various Government/ private organisations in the country.

Figure 3.1 NISE team involved in calibration activities

Calibration Status of SRRA Stations

NISE has been assigned the task of calibrating 52 SRRA stations across India. During the FY 2020-21, SRCL has performed the calibration of 15 sensors from 5 SRRA stations located at different locations in the country. Additionally, 43 sensors from commercial and 3 sensors from research institutes were also calibrated. The details of different SRRA stations calibrated are given in Table 3.1.

Table 3.1 Calibration Status of SRRA Stations, 2020-21

S. No	SRRA Stations	State	Calibration Date	Type and No. of Sensor Calibrated		Total
				Pyranometer	Pyrheliometer	
1	Abu Road	Rajasthan	10-02-2021	2	1	3
2	Balotra	Rajasthan	10-02-2021	2	1	3
3	Bagora	Rajasthan	10-02-2021	2	1	3
4	Kota	Rajasthan	10-02-2021	2	1	3
5	Ajmer	Rajasthan	10-02-2021	2	1	3

SOLAR PHOTOVOLTAIC TECHNOLOGIES 4

INTRODUCTION

The use of solar photovoltaic technologies is increasing day by day. Two important aspects of PV technologies are performance in the field conditions and long term reliability. To ensure the outdoor performance and reliability, various Indian and international standards are available. Prior to deployment of PV applications, it is required to characterise the product/ system according to the set parameters as per the corresponding standard. NISE, with an ISO 17025 accredited laboratory, performs testing and certification of solar PV components according to the national/ international standards. The laboratories at NISE are accredited by the National Accreditation Board for Testing & Calibration Laboratories (NABL) and has facilities for comprehensive testing of solar PV components. The laboratories are continuously up-grading its testing facilities in line with the latest testing standards and developments in the market.

ADVANCED SOLAR CELL CHARACTERISATION FACILITY

Recently established advanced solar cell characterisation facility at NISE have installed 06 major equipments to characterise solar cells (Figure 4.1). Spectroscopic ellipsometry (JA Woolam M2000) installed at NISE is capable of measuring optical constants of textured as well as thin films. The four probe resistivity setup (Napson cresbox) is equipped with automatic single-point and multiple-point mapping of sheet resistance and resistivity of silicon wafer or solar cell. Surface profilometer (Bruker Dektak XT) is capable of measuring film thickness, roughness and 2D stress. The Olympus BX61 optical microscope is used for observation of surface texture, laser ablation and LBSF microstructure; qualitative and quantitative analysis of front side metallisation. All these equipments are capable of measuring optical, morphological and electrical properties of silicon wafer and solar cells of different size ranging from 2 inch to 6 inch. The I-V and EQE measurement systems are used for estimating power conversion efficiency and other properties of solar cells.

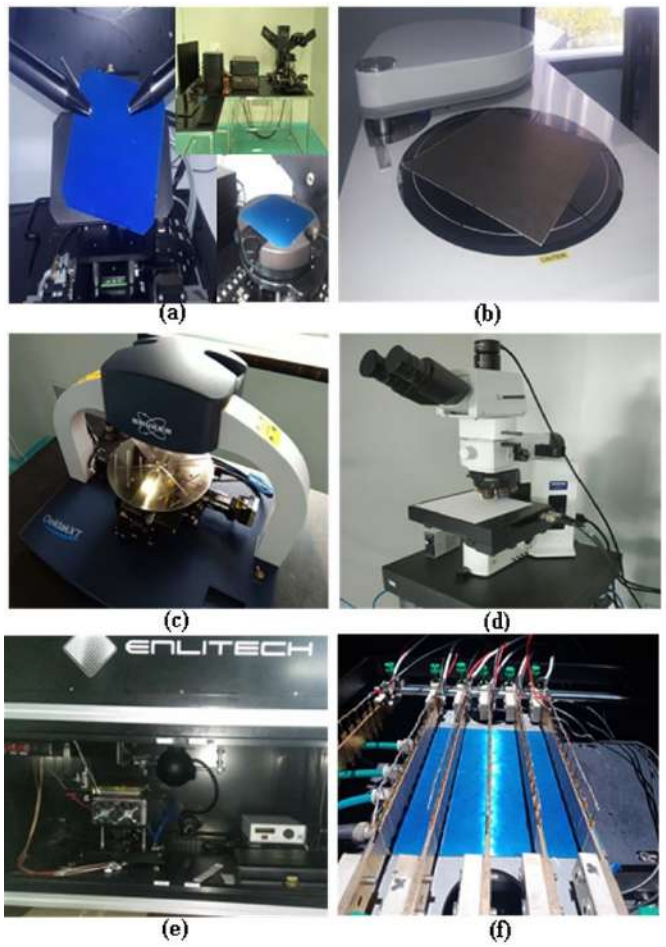

Figure 4.1 Solar cell characterisation facilities at NISE (a) Spectroscopic ellipsometry, (b) Four point probe resistivity, (c) Surface profiler, (d) Optical microscope, (e) Quantum efficiency measurement system and (f) I-V system

SOLAR PHOTOVOLTAIC TESTING FACILITY (PVTF)

Photovoltaic Module Testing Facility

The Photovoltaic Module Testing Facility at NISE is NABL accredited laboratory as per ISO/IEC 17025: 2017

Table 4.1 List of Standards

Standard No.	Details
IEC 61215-1-1: 2016/IS 14286-1-1: 2019 (NABL accreditation for some parts)	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 61701 (NABL accredited)	Salt mist corrosion testing of photovoltaic (PV) modules
IEC 61853-1 & 61853-2, 61853-3, & 61853-4 (Spectral response system for only solar cell is available)	Photovoltaic (PV) module performance testing and energy rating - Part 1, 2, 3 & 4: Irradiance and temperature performance measurements, power rating, spectral responsivity, incidence angle and module operating temperature measurements, energy rating of PV modules, standard reference climatic profiles
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

standard for qualification testing and customised Testing as per customer requirements. This facility is recognised by Bureau of Indian Standards (BIS) for PV module testing as Type 2 category facility. The laboratory is well equipped with facilities for testing as per IEC/IS standards given below in Table 4.1.

In addition, following R&D based testings are also carried out in PVTF lab:

1. Light-Induced Degradation (LID) and Light and elevated Temperature-Induced Degradation (LeTID) testing of PV module as per the available standards and customer requirements.
2. The climate specific model based accelerated testing of PV module. This test is to study the reliable operations of the module under harsh climatic conditions.
3. Testing and standardisation of cleaning device for PV module as per the testing specifications developed by NISE. Model based testing of cleaning devices is performed to check the performance and reliability of the PV modules after specific number of cleaning cycles.
4. Testing and standardisation of PV modules for long term performance and reliability analysis by continuous monitoring. Damage and fault analysis of PV module is also part of the testing.

In the FY 2020-21, the laboratory has upgraded its facilities with addition of a Sun Simulator with temperature control. The facility development for the following test activities is in progress:

IEC 61730-1, 2 Photovoltaic module safety qualification

Outdoor PID testing

Spectral response system for c-Si PV module

Some of the test equipment used for testing of PV modules are shown in Figure 4.2.

Figure 4.2 PV Module Test equipment at PVTF
(a) Temperature controlled Sun Simulator,
(b) Environmental Chamber

Power Electronics Laboratory

The Power Electronics Laboratory (PEL) at NISE conducts testing of all types of Power Conditioning Units (PCUs) including hybrid, standalone and grid-tied inverters, and pump controllers up to 100 kVA. PEL is accredited by NABL as per ISO/IEC 17025: 2017. This facility is recognised by the BIS for 16169: test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters. Figure 4.3 shows the testing facilities of the PEL at NISE. The laboratory is well equipped with facilities for testing as per IEC/IS standards given below:

1. IEC 61683:1999: Photovoltaic systems –Power conditioners –Procedure for measuring efficiency
2. IS 16169/ IEC 62116:2008 Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters
3. CEI IEC 61727:2004 Photovoltaic (PV) systems - Characteristics of the utility interface
4. IEC 62509:2010 Performance and functioning of charge controller
5. EN50530:2010 Overall efficiency of grid-connected photovoltaic inverters
6. IEC 60068-2 -1: 2007 Environmental test A: Cold
7. IEC 60068-2 -2: 2007 Environmental test B: Dry heat
8. IEC 60068-2 -14:2009 Environmental test N: Dry heat Change of temperature
9. IEC 60068-2 -14:2005 Environmental Test Db: Damp heat cycle

Figure 4.3 Power Electronics Laboratory Setup

Forthcoming, the PEL at NISE is involved in the following activities for further enhancement as given below:

1. IS 16221 (Part 2) : 2015/IEC 62109-2 : 2011: Safety of Power Converters for Use in Photovoltaic Power Systems: Part 2 Particular Requirements for Inverters
2. IEC TS 62910:2015: Utility-interconnected photovoltaic inverters - Test procedure for low voltage ride-through measurements

Battery Test & Characterisation Laboratory

The battery test and characterisation laboratory at NISE is recognised by the BIS for IS 16270: 2014- secondary cells and batteries for solar photovoltaic application general - requirements and methods of test services. This laboratory tests various types of battery technologies as given in Figure 4.4. The laboratory follows different national/international standards for a variety of secondary batteries. These batteries are tested with climatic chambers and thermal water bath for a broader range of temperature control and detailed parameter analysis. Figure 4.5 shows the battery test facilities of NISE.

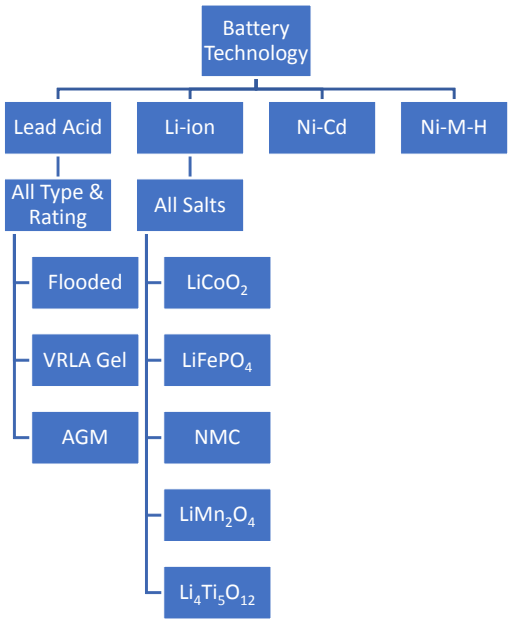

Figure 4.4: Different types of secondary batteries serviced for Testing and Certification

Figure 4.5 Battery Test Laboratory Setup

Solar Photovoltaic Pump Test Facility

Solar water pumping system test facility at NISE is well-equipped, fully-automated, state-of-the-art testing facility in India. The laboratory conducts tests in strict conformation with MNRE guidelines. The laboratory is equipped to conduct tests on solar water pumps with capacities ranging from 0.5 hp to 10 hp (Figure 4.6). The test facility is equipped with advanced tools such as solar array simulators, automatic data loggers, power analysers, power meters, flow meters, pressure transmitters, automatic gate valves, various sophisticated sensors and a dedicated software. All tests are performed against national and international standards. The facility is also used for carrying out the R&D activities of solar water pumping systems as well as testing, certification, standardisation of pump sets before allowing sales in Indian market. All major pumping technologies such as submersible, surface, AC and DC systems are tested using the facility. With a view to cater to futuristic requirements, the laboratory is being upgraded to include testing of pumps up-to 50 hp as shown in Figure 4.7. NISE is also involved in creating awareness on PM-KUSUM schemes. A training programme was also conducted by NISE for officials from state nodal agencies to brief about the test facilities, standards, policies and R&D in solar water pumps.

Figure 4.6 Solar water pump test facility for up to 10 hp

Figure 4.7 Ongoing construction of solar water pump test facility for up to 50 hp

The following list of standards are adopted in the testing of solar PV water pumps:

a) 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

b) IEC 62253

c) MNRE specification for Solar PV water pumping systems for micro pumping application (2016-2017)

d) MNRE specifications no. 32/645/2017-SPV of KUSUM Programme specifications and testing procedure for solar water pumping systems

e) MNRE specifications no. 32/645/2017-SPV of KUSUM Programme specifications and testing procedure for solar water pumping systems: 2019

f) MNRE test methods for SPV water pumping systems (2014-15); (2015-16) & (2017-18)

g) BIS test methods for IS 17429:2020

h) BIS test methods for IS 17018: Part 1 2018 [RD: IS 9283:2018, IS 3043:1987, IS 9079:2018.

Advanced SPV System & Lighting Laboratory

The Solar Photovoltaic and Lighting Laboratory is well equipped with modern testing equipment like integrating sphere photometer for total luminous flux measurement, digital programmable AC/DC power

supplies, and other digital auxiliary equipment for conformity/ type testing of wide range of products against latest standards and specifications adopted by BIS/MNRE. The laboratory is proficient in testing according to these standards, (i) IESNA LM-78-07 (IESNA approved method for total luminous flux measurement of lamps), (ii) IES LM-79-08/IS 16106: 2012 (method of electrical and photometric measurements of solid state lighting products), (iii) IESNA LM-82-12 (The approved method for determining photometric properties as a function of temperature for LED light engines and integral lamps), (iv) CIE S 025/ E: 2015 (test method for LED lamps, LED luminaries and LED modules), (v) IES TM-30-15 (method for evaluating light source colour rendition), (vi) ANSI C78.377-2017 (electric lamps-specifications for the chromaticity of solid state lighting products), (vii) Flicker test as per IESNA and IEEE recommendations..

Testing is also carried out according to the manufacturer defined technical specifications. The products include all type of lighting in solar photovoltaics, e.g. solar lantern, solar study lamp, solar home lighting system, solar street lighting system, etc. The solar PV based street lighting test facility at NISE is shown in Figure 4.8.

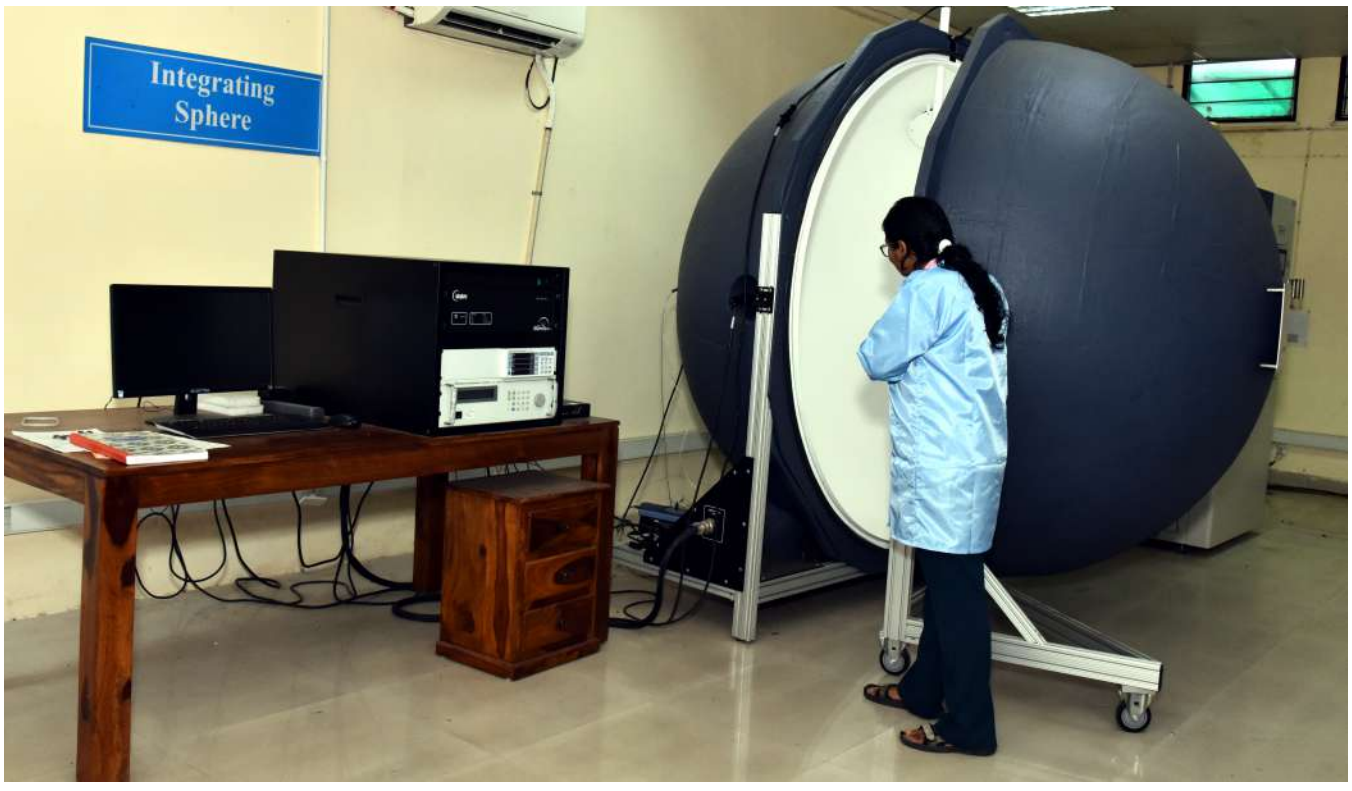

Figure 4.8 Integrating sphere system with temperature control for testing of solar street lights

Field Testing of PV Power Plant

The field testing laboratory for PV power plant has facility for testing of PV modules and inverter in the field conditions. The various tests involved are; visual inspection, I-V testing, insulation testing (dry & wet), earth resistance measurement, IR imaging, EL imaging, and inverter test. Figure 4.9 shows the testing of PV module test bed at NISE campus

Figure 4.9 Testing of PV modules in test bed at NISE

QUALITY MANAGEMENT AT NISE

NISE provides testing, validation, and verification services for various solar photovoltaic technologies. The quality management system has a clear structure for managing laboratory activities as per the provisions of ISO 17025:2017. During the FY 2020-21, the NABL accreditation audit was conducted for examining compliance with the standards. The test facilities were marked up to date with few suggestions for further improvements. The new scope of services were also proposed to be included in the existing services of the testing facility at NISE as per NABL and BIS requirements.

ACHIEVEMENTS

During the year a total of 254 samples were tested and calibrated at NISE. The details of the samples tested are provided in Table 4.2.

Table 4.2 List of samples tested at NISE in the solar PV test facility

S.No	Testing Samples	Quantity (Number of Samples)
1.	Solar Photovoltaic Module	165
2.	Inverter	02
3.	Battery	13
4.	SPV Water Pumps	09
5.	LED Systems	60
6.	Solar Cell Characterization	5
	Total	**254**

FUTURE PROSPECTS AND DEVELOPMENT

NISE has made efforts on testing and R&D on solar PV systems and applications. The division aims to enhance the capacity of testing, increase the number of testing, standard and testing protocol development, imparting training and skill development in the solar PV sector. The following are some of the future prospects envisaged in the PVTF division:

1. Establishment of test facility for IEC 61730-1, 2 photovoltaic module safety qualification, outdoor PID testing, spectral response system for PV module
2. Calibration facility for secondary reference module and solar cell
3. Addition of test facility for testing power converter as per IS 16221 (Part 2):2015/IEC 62109-2:2011 and IEC TS 62910:2015 in PEL
4. NABL accreditation of all laboratories

SOLAR THERMAL TECHNOLOGIES

5

INTRODUCTION

Solar energy in the form of heat also called as solar thermal energy can be used for various thermal applications. Solar thermal technologies collects the Sun's heat by means of a solar thermal collector and transfer the heat to a working fluid, which is either used directly to meet the thermal energy demand or stored for later use. Solar thermal technologies can be classified as low (<100˚C), medium (100-300 ˚C), or high (>300˚C), temperature systems according to the applications. Low temperature applications generally includes space/ room heating, pool heating etc., while medium-temperature applications usually includes hot water/ saturated steam for residential/ commercial applications. High-temperature technologies uses mirrors or lenses to concentrate the Sun's energy to achieve very high temperatures up to 400˚C and is usually used for industries and for power generation applications.

In India, only a handful of institutes and organisations are involved in R&D of solar thermal technologies and majority of such research are limited to proof of concept and/or laboratory scale developments. Scaling up for field demonstration or commercialisation of these technologies is still lacking. Solar thermal division of NISE focuses on R&D, and demonstration of various solar thermal systems and products in an innovative and environmental friendly way, to meet various energy needs of the users. NISE is fully committed at the highest levels to support in commercialisation of these innovations.

R&D IN SOLAR THERMAL TECHNOLOGIES

During 2020-21, NISE continued its R&D activities in solar thermal technologies that were initiated in the previous years. In addition, two new R&D initiatives were taken up during this year.

Solar Dryer-cum-Space Heating System for Ladakh

Crop drying and space heating are two very essential needs for the people of Ladakh to survive the cold and harsh winter conditions. Natives dry and store all kinds of available food items including vegetables, fruits, meat, cheese, etc. for consuming in the winters. Presently drying is done in open sun which is inefficient, unhygienic, and time consuming. Conventionally, for space heating of rooms and houses wood is used in traditional bukhairs which causes indoor air pollution, thereby contributing to adverse health issues. To overcome these issues prevailing in Ladakh, NISE in association with Horticulture Department of Ladakh has taken up a project for design, fabrication and installation of solar drying-cum-space heating systems for Leh and Kargil districts of Ladakh region.

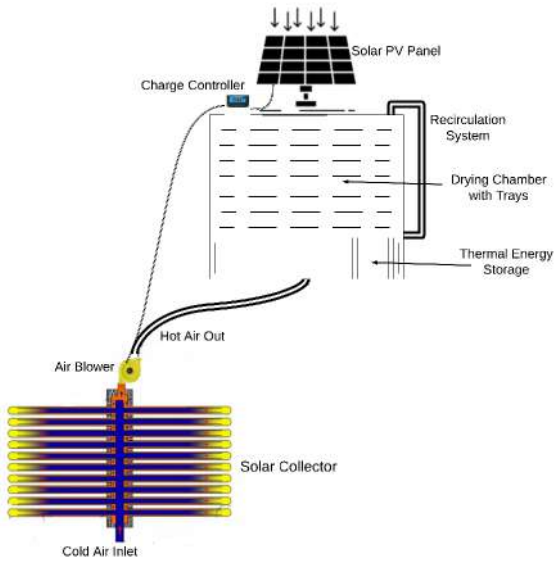

Figure 5.1 Schematics of the solar dryer system

NISE has designed and developed an innovative solar dryer cum space heating system suitable for drying all types of food items (Figure 5.1). The drying chamber has a capacity of 70 – 125 kg depending on the food item with facility to increase capacity depending upon requirement. Evacuated tube solar collectors along

with Phase Change Materials (PCM) based heat storage system is used to generate up to 20 kWh of thermal energy per day. The dryer can heat large volumes of incoming air to achieve temperature of more than 60˚C. Solar PV driven air blowers are installed to circulate the hot air to achieve enhanced and uniform drying. The system is modular can be installed in any size and numbers as per the requirement of drying and space heating.

During 2020-21, a total of 300 such systems have been installed and commissioned at various locations in Ladakh (Figure 5.2). During summer the system is used for drying food items and during winters, it is used for heating of houses. Field testing and performance analysis were carried out of selected systems for further design optimisation and modifications. The project timeline for implementation of Solar Dryer project in Ladakh is shown in Figure 5.4.

Figure 5.2 Solar Dryer-cum-Space Heating systems installed in Ladakh

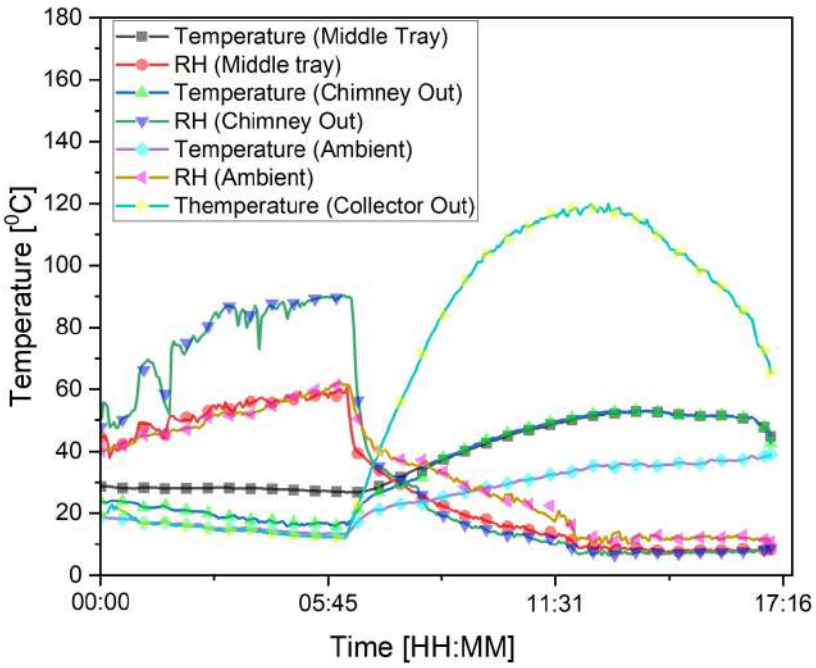

Figure 5.3 Field Testing of Solar Dryer at Ladakh in August 2020

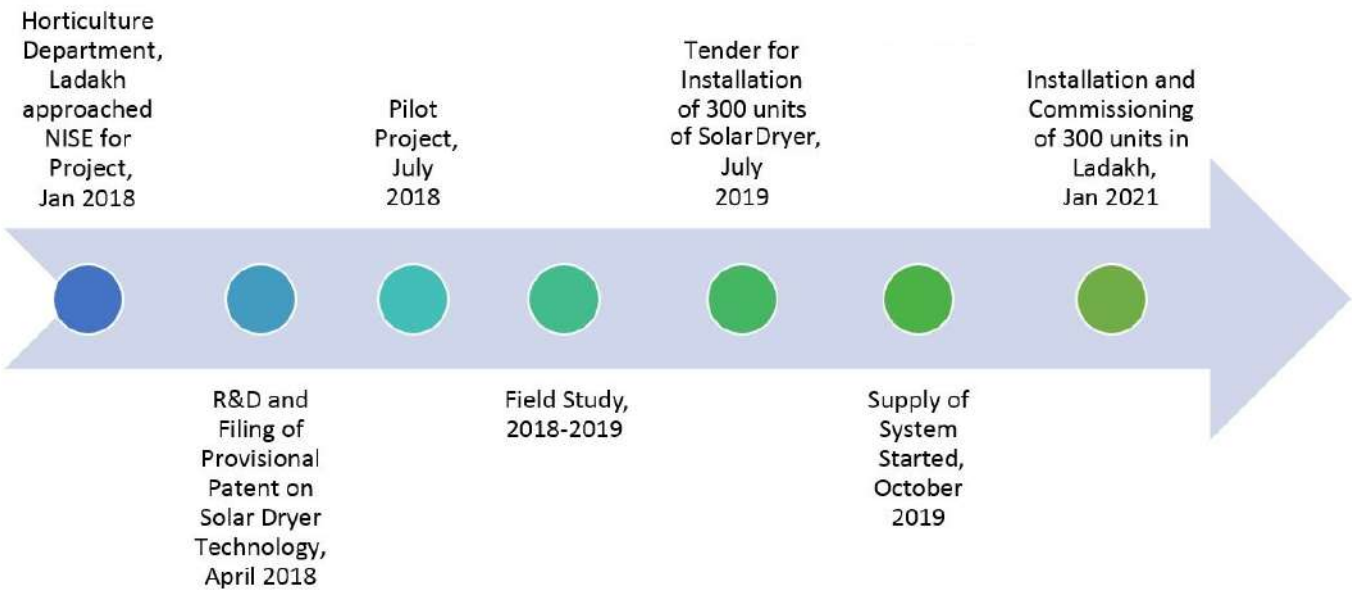

Figure 5.4 Project timeline for implementation of Solar Dryer project in Ladakh

Figure 5.5 NISE team with the Award and Certificate

NISE won the 'Platinum Award' during the '13th QCI – D.L Shah Quality Award 2020' held on 17th December 2020, for the Solar Dryer project implemented in Ladakh (Figure 5.5). The prestigious award is given by Quality Council of India as a recognition for implementing successful projects of an organisation that have resulted in continuous improvement of processes, products and/or services, better/effective operations and increased customers and stake-holder's satisfaction.

Low cost portable mini greenhouse based solar dryer

Based on the experience gained from undertaking solar drying-cum-space heating project in Ladakh, NISE is working on design and development of a low cost portable mini greenhouse based solar dryer (Figure 5.6). The aim of this research project is to design and fabricate an easy to handle greenhouse based solar dryer made from locally sourced materials and field test for design optimisation.

A laboratory scale prototype was designed and fabricated using a special polycarbonate sheet which allows all the solar radiation to pass through it except the UV component of radiation. This helps in protecting the fruits and vegetable products from discoloration which is important for farmers as it helps them in fetching higher price of their produce, thereby helping in increasing their income. Also, the polycarbonate sheet has low thermal conductivity which results in lesser heat losses and higher rise in the temperature as compared to conventional natural convection based greenhouse dryers. The polycarbonate sheet is extremely robust, lightweight with glass-like transparency and is impact resistant. It also has a high dimensional stability and is easily moulded and displays excellent heat resistance. The model can accommodate 14 to 21 mesh trays for keeping the food items with a total carrying capacity of 150 kg. Further, blowers are used for circulation of hot air for enhanced drying.

Figure 5.6 Greenhouse Dryer developed by NISE: (a) Lab scale prototype, (b) Lab testing

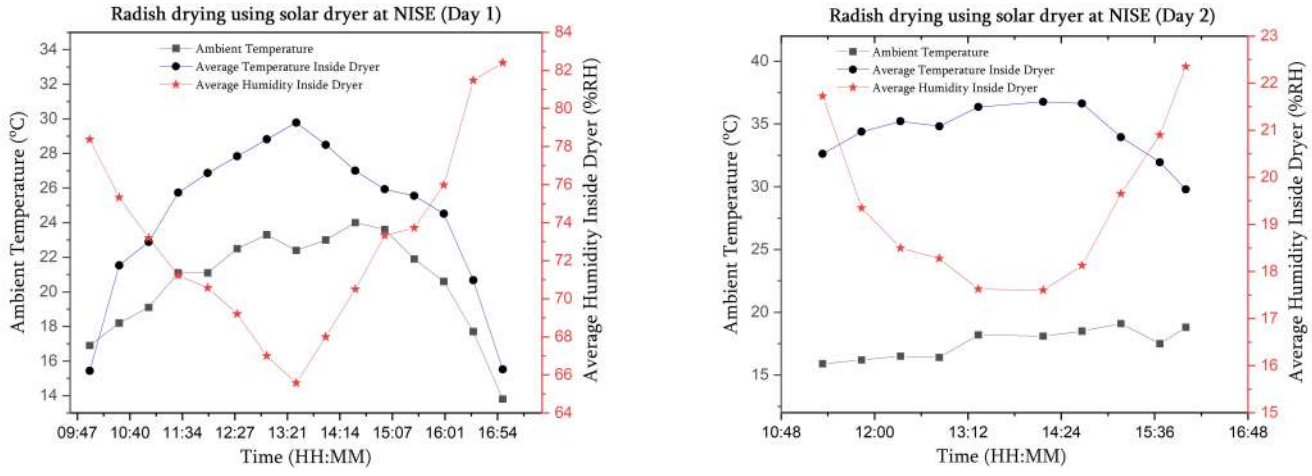

Figure 5.7 Lab testing of new portable Greenhouse dryer at NISE in December 2020

Test results: Lab testing of the developed prototype was carried out (Fig. 5.7) at NISE during the month of December 2020. Food items like radish and some leafy vegetables were loaded in the prototype system for drying. The maximum temperature achieved inside the drying chamber was 40.1 C which was approx. 22 C above ambient. The drying time has been reduced by approximately 40-50% as compared to open sun drying. Also the quality of dried product was better.

Potential advantages of the system

(i) Cost economical: expected to have 70 % lower cost as compared to earlier system.

(ii) Higher capacity as compared to earlier system- approximately 150 kg per batch.

(iii) Portable and mini-size: suitable for individual farmer level drying.

(iv) Hygienic & quality products without contamination will be available.

(v) Faster rate of drying compared to open drying thus minimising product loss.

(vi) Easy transportations and installation

Thermal Energy Storage based Solar Cold Storage and Bulk Milk Cooler

NISE in collaboration with an industrial partner (M/s Inficold India Pvt. Ltd.) had developed a PV based cold storage unit and a PV based bulk milk chiller with thermal storage system for 24x7 operation in off-grid mode. The cold storage unit runs on PV and can store fruits and vegetables at a temperature as low as 3˚C, even for extended duration after sunset. Commercial units have been installed in the states of Assam, Odisha, Uttar Pradesh, Karnataka, and Kerala. Bulk Milk Chillers developed by NISE can cool the milk instantly thereby increasing its shelf life and minimising the risk of any contamination or spoilage. Our R&D efforts have resulted in commercialisation of the Solar Cold Storage and Solar Bulk Milk Cooler, and is under installation at various locations across India.

During FY 2020-21, 12 units of solar cold storage and 2 units of bulk milk cooler were installed in different parts of the country.

Numerical Analysis of Cost-Efficient Parabolic Trough Solar Collector

Parabolic Trough Solar Collector (PTSC) is one of the well-known Concentrated Solar Power (CSP) technologies available to harness the energy from the sun for power generation and process heating applications. But, still the technology is lagging in terms of its acceptance due to high cost associated with the power generation from CSP technologies compared to power generation from conventional power plants and

other renewable technologies. A lot of efforts have been made by researchers to improve the performance and reduce the capital cost of PTSC. It has been reported that the key components with potential to reduce the cost of solar field are support structures, foundations, reflectors and receivers. The solar field cost can be reduced by diminishing the cost of different segments of the solar field utilising a PTSC based power project. The main objective of the research work is to improve the performance of PTSC and to decrease the associated Levelized Cost of Electricity (LCoE) with PTSC based solar plant. Multicriteria design optimisation considering optical, thermal, structure and techno economics will help to provide the design roadmaps for the development of the PTSC. Furthermore, the focus is to consider the constraints of manufacturing capabilities in developing countries, so that the problem of manufacturing can also be addressed.

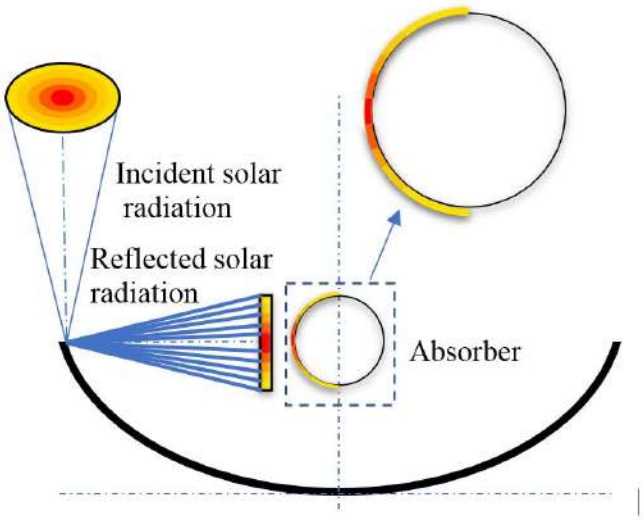

Figure 5.8 Schematic representation of the PTSC

During 2020-21, coupled optical and thermal analysis has been performed to understand the interrelation between the optics and the thermal heat gain from the Euro Trough collector. An attempt has also been made to analyse the effects of the optical errors on the performance of the PTSC. The schematic of the PTSC is shown in Figure 5.8 along with the interaction of the incoming solar radiation. The output of the optical analysis is used as the input for the thermal analysis of the PTSC receiver tube using commercial CFD software i.e. ANSYS. The analysis domain of the receiver tube is shown in Figure 5.9.

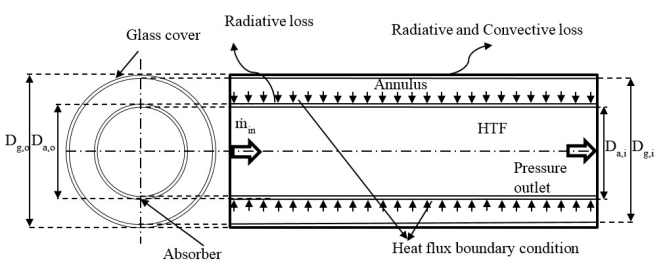

Figure 5.9 Schematic of the receiver tube of PTSC with boundary condition

The thermal analysis was performed to analyse the effect of the vacuum pressure and gases in the annulus region of the receiver tube. The results shows that there is significant effect of the vacuum pressure on the thermal performance of the collector, the heat losses increase from 140 W/m^2 to 2284 W/m^2 with increase of the vacuum pressure from 0.0001 mPa to 1 mPa, as shown in Table 5.1. However, the performance is unaffected with the change of the annulus gas i.e. air, argon and hydrogen. There is only 1˚ C fall in HTF outlet temperature in case of hydrogen gas is present in the annulus.

Table 5.1 Effect of the annulus pressure on heat loss and outlet temperature of the receiver.

Annulus Pressure (mPa)	Heat losses (W/m^2)	Outlet temperature (K)
0.0001	140	409.4
0.001	147	409.3
0.01	220	409.0
0.1	771	408.6
1	2284	406.9

Efforts have also been made to investigate the effect of the DNI on the heat loss and Heat Transfer Fluids (HTF) outlet temperature as shown in Figure 5.10. Analysis was performed for the mass flow rate of 0.5 kg/s at the

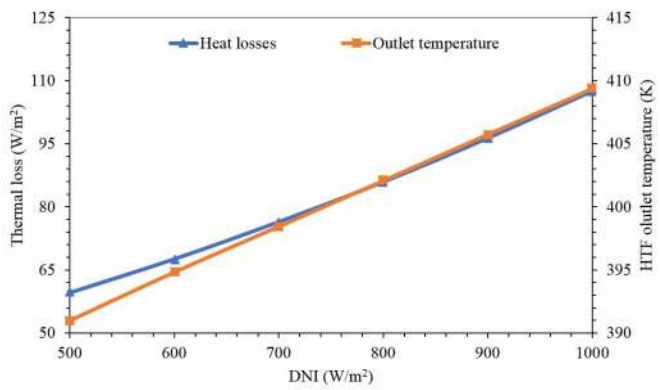

Figure 5.10 Effect of the DNI on heat loss and HTF outlet temperature

fluid inlet temperature of 373 K using Therminol VP-1 as the HTF. Both the heat loss and the outlet temperature increase with increase of the intensity of solar radiation. At the DNI of 500 W/m^2 the outlet temperature of the absorber increases by 18˚C whereas it increases by 136˚C for the DNI of 1000 W/m^2.

Similarly, performance was also investigated for the effect of the various operating parameters such as inlet temperature, mass flow rate etc. The outcomes of the optical and thermal analysis will be used for the structural and techno-economic analysis to covers all the domains required for the performance investigation of the PTSC. This study was an attempt to understand the physics pertaining to the performance investigation of the PTSC and will act as the building block to investigate the performance of the new collector configurations.

Figure 5.11 CST test rig at NISE

CST TEST LABORATORY

NISE has a state-of-art Concentrated Solar Thermal (CST) Test Laboratory for testing and characterization of CST technologies (Figure 5.11). The facility is first of its kind in the country and can analyse thermal and optical performance of all types of CST technologies.

Existing CST testing facilities at NISE:

1. Test facility for hot water/steam based CST systems

a) CST test rig: all CST technologies can be tested, characterised and analysed for its optical and thermal performance as per BIS Standard - IS 16648 (Part 5): 2017 'Concentrated Solar Thermal - Specification Part 5 Test methods'

b) CST system capacity of up to 25 kW$_{th}$ can be tested in this facility

c) Weather station: Dedicated advance weather station for solar radiation measurement

2. Mobile testing for on-site performance evaluation of CST systems

a) Mobile test facility: for testing of all available CST technologies to evaluate their optical and thermal properties in the field as per BIS Standard – IS 16648 (Part 5): 2017 'Concentrated Solar Thermal - Specification Part 5 Test methods'

b) CST system of any capacity can be tested using mobile test facility

c) Portable weather station for radiation measurement

3. Concentrated Solar Thermal component test facility

a) Reflectometer: Reflectivity measurement of concentrator

b) Heat Loss Measurement: For measurement of heat loss coefficients of receiver tube

FUTURE PROSPECTS AND DEVELOPMENT

NISE shall continue its sincere efforts to develop and demonstrate the various ongoing R&D projects and explore its commercial possibilities. Priority is given for product development from R&D, emphasising ease of adaptation/ implementation by the users. Valuable feedbacks from stakeholders are incorporated in the ongoing research to deliver an optimised/customised product.

Emphasis is being made to create awareness and deployment of different products developed by NISE including solar cold storage, solar bulk milk cooler chiller and solar dryer. NISE is in communication with state level nodal agencies for setting up such the products in their respective states, especially at grass root level so that the farmers/villagers can be benefit the maximum by such standalone solar systems. The products are also being promoted through various talks, seminars and trainings which NISE is participating or conducting. Based on feedbacks from farmers and industries, NISE is also proposing new R&D projects that are customised according to climate, geography and end use. This will assist in promoting solar thermal technologies at various levels and as per the need of the respective sectors.

While the division will continue to carry out its ongoing activities in R&D projects, product development & commercialisation, product testing, and consultancy works; R&D projects in thermal energy storage, space heating & cooling, and concentrating collectors are also being envisaged in future prospects.

HYDROGEN ENERGY

6

INTRODUCTION

Hydrogen is not only regarded as an important energy option but also emerging as a clean and sustainable energy vector, if produced from renewable energy resources. It can be used as an energy storage medium for variable renewable energy sources and has the potential to solve the grid stability issues of modern power systems, wherein penetration of variable renewable electricity is increasing from year to year. Industries such as fertiliser and refineries have been using hydrogen for long for different applications. Among other industries, iron and steel plants are likely to make a switch to hydrogen from coke to produce green steel. Hydrogen is also considered as a good option for transport sector for reducing emissions and reducing dependence on fossil fuels. Recognising the importance of hydrogen as a clean energy carrier for transport sector; hydrogen production, storage and dispensing facility operated by electricity generated from solar photovoltaic system was installed and commissioned at NISE in 2014 by the University of Petroleum and Energy Studies under a project supported by the MNRE (Figure 6.1). A 5 Nm^3/h capacity alkaline electrolyser has been installed as a part of this facility. NISE has been maintaining the facility and providing hydrogen fuel to hydrogen-diesel dual fuel vehicles from October 2015 onwards. This facility is equipped to provide clean hydrogen to the vehicles that require it for their operations.

In addition, Hydrogen Energy division at NISE is involved in activities to create knowledge and information base in the country. In this regard, a webinar on "Hydrogen: An emerging energy carrier – Opportunities and challenges for Production and Utilisation in India" was organised by NISE in December, 2020. Various experts from academics, industries and research organisations shared their experiences to the participants from different sectors. NISE is also conducting lectures on hydrogen production cum dispensing facility of NISE in particular and hydrogen energy and fuel cells in general to the participants attending different training programmes at NISE.

Figure 6.1 Hydrogen Production cum Dispensing Facility at NISE

PRESENT ACTIVITIES

To further enhance generation and to meet the growing hydrogen requirement, a new alkaline electrolyser of 10 Nm^3/h capacity is to be installed in the existing plant to augment hydrogen production capacity from 5 Nm^3/h to 15 Nm3/h under a new project entitled "Setting up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Haryana" supported by the MNRE. The facility would be used to provide hydrogen to the existing hydrogen-diesel dual fuel vehicles and any other new hydrogen fuelled vehicles.

During FY 2020-21, NISE carried out detailed studies on two major areas:

(a) Comparison of electric and hydrogen fuelled vehicles, including lithium-ion batteries and hydrogen

The study was completed by constituting a Joint Group with experts from different organisations. The report for the study was prepared by NISE based on inputs received from the different stakeholders. Some findings of the study are given below:

- As energy carrier, electricity and hydrogen are well suited for transport applications in order to reduce GHG emission, enhancing energy security and reduction of local air pollution. Between the two technologies: Electric Vehicles (EVs) and Hydrogen Fuelled Vehicles (HFVs), EVs have the potential for the lowest fuel costs and GHG emissions due to their higher efficiency throughout the fuel supply chain and the vehicle's lower fuel consumption. A comparison of specific power consumption (kWh/km) and range (km) for different electricity and hydrogen technologies for transport sector indicates that electrical propulsion based on presently available EVs has a very efficient fuel cycle but have a limited range. Hydrogen Internal Combustion Engine (HICE) vehicles could increase the range considerably, but at the cost of fuel cycle efficiency. In comparison, Fuel Cell Vehicles (FCVs) would have better efficiency and range. A Comparison of energy utilisation in an EV and an FCV is given in Figure 6.2.

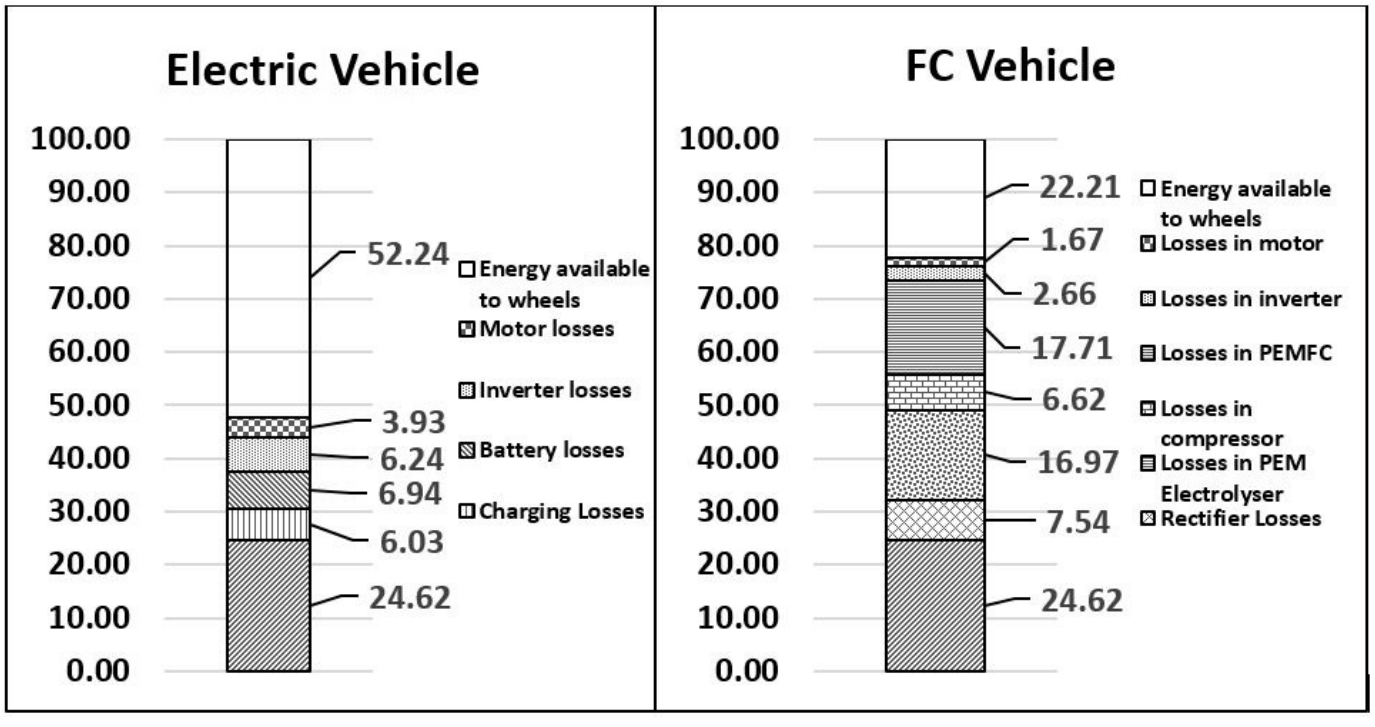

Figure 6.2 Comparison of Energy Utilisation (in percentage) in an EV and a FCV

- Battery based EVs that are currently available in the Indian market have advantage in terms of lower initial cost, lower maintenance cost due to very few moving parts, higher efficiency and lower running cost per km compared to HFVs. However, range of EVs is constrained by battery size and weight and time taken for recharging of Lithium Ion Batteries (LIBs) may take several hours, depending on types of charging (slow or fast). On the other side, HFVs could be refuelled in few minutes like conventional petrol or diesel vehicles and have no range anxiety, except in smaller vehicles such as three wheelers and compact cars, where the amount of on-board stored hydrogen could be limited due to capacity of hydrogen storage tank.

- In terms of lifetime cost of ownership, at present EVs have advantage over their competitors. However, EVs and HFVs are complementary and both of them can co-exist for different category of vehicles and applications.

- On the lines of BEVs and creation of charging infrastructure, HFVs would require financial incentives in India both for acquisition and also for lowering fuel cost to make them attractive in terms of cost of ownership. Incentives are being provided for making initial cost of HFVs affordable to buyers in countries like Japan and South Korea.

(b) Hydrogen production and demand in India

In this study, hydrogen production capacity was estimated in India as 6.34 MTPA as on 1.4.2020. The details are shown in the chart provided in Figure 6.3. In petroleum refineries at 90% of the installed capacity, demand for hydrogen during 2019-20 was estimated at 2.5605 MT. For other industries the demand for hydrogen during 2019-20 was estimated at about 2.84 MT. Hydrogen demand in petroleum refineries in India during 2019-20 could not be estimated due to lack of information.

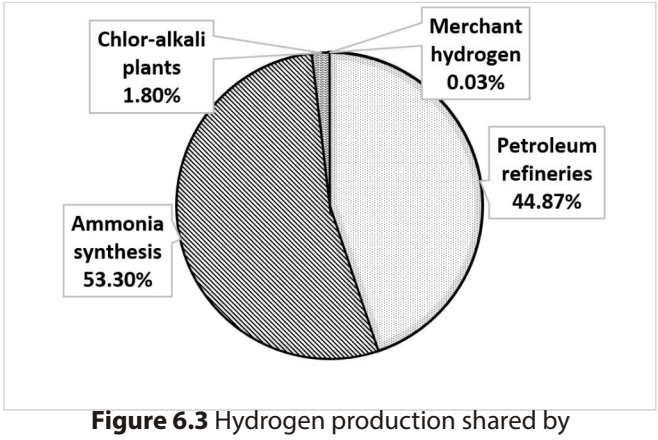

Figure 6.3 Hydrogen production shared by various industrial sectors

FUTURE ACTIVITIES

NISE is continuously working towards creation of a Centre of Excellence on Hydrogen Energy in its campus. NISE is in talk with various industrial organisations to demonstrate/field trials of hydrogen fuelled vehicles with the augmentation of in-house hydrogen production capacity with installation of a new 10 Nm^3/h electrolyser in its existing facility. In addition to the existing hydrogen generation, storage and fuel cell vehicle facilities, NISE will explore the challenges and possibilities of R&D in the area of hydrogen production from solar, its storage and end-use, to make the hydrogen based system cost effective.

RESEARCH AND DEVELOPMENT

7

INTRODUCTION

NISE has a pool of experienced scientific and technical man power from different parts of the country in the area of solar energy. As an autonomous institute of the MNRE, Govt. of India, the primary goal is to perform R&D for the development of the society. Few thrust research areas of NISE are as follows:

Solar PV

a. Performance modelling and characterisation, reliability enhancement of solar PV technology.

b. Research on solar cells

c. Research on polygeneration & desalination.

d. Research on off-grid applications like solar water pump, lighting systems, electric vehicles, etc.

e. Grid modernisation and energy system integration.

f. Feasibility study of technology.

Solar Thermal

a. Performance mapping, Testing protocol, standardisation, and characterisation of solar thermal systems.

b. Research on low & high-temperature applications.

c. Research on Poly generation, desalination.

d. Research on thermal energy storage.

e. Research on space heating applications.

Hydrogen Energy

a. Research on hydrogen production & dispensing

b. Application of hydrogen energy in transportation

As an R&D institute, NISE intends to meet the current and future requirements in the solar energy sector through sustainable development. The R&D is focused on the need of society. Product-based research would be more beneficial and have to ensure economic feasibility, reliability, and efficiency. NISE performs research in the field of solar energy applications to cut down the cost along with enhancing reliability.

ONGOING RESEARCH AND DEVELOPMENT PROJECTS

Details of various research and development projects being carried out during 2020-21 at NISE are given in Table 7.1.

Table 7.1 Details of ongoing R&D projects.

Sl. No.	Project	Funding Agency	Status/achievement
1.	*"Development of high efficiency (21%/ 19%) PERC type of c-Si/mc-Si solar cells".* A joint project between NISE and BHEL for developing PERC type solar cells with benchmark efficiencies in the country.	MNRE	Ongoing. Procurement of equipment is almost completed. The cell development was in progress.
2.	*"Design, development and qualification of large area (156 mm x 156 mm), secondary reference solar cells".*	DST	Ongoing.

Sl. No.	Project	Funding Agency	Status/achievement
3.	*"High-Efficiency Solar Water Pumping Systems"* NISE has collaborated with different stakeholders to develop new and improved models of solar water pumping Systems under this project.	MNRE	Ongoing. Tender process completed. Installation of Test rig is in progress.
4.	*"Supply of Clean Drinking Water through IoT based solar-powered station at a large village in Haryana through automated dispensing while improving the water table: Pilot – Faridpur"* A joint project between NISE and Saurya Ener Tech Pvt Limited for the developing and installing of clean water purification set up using solar PV modules.	DST	Completed
5.	*Fabrication, Supply, Installation, Commissioning and AMC of Solar Drying cum Space Heating Systems for Leh and Kargil Districts of Ladakh region*	Horticulture Department of Ladakh	Completed installation and commissioning of 300 units in Ladakh in January 2021
6.	Settling up of a Centre of Excellence on Hydrogen Energy at NISE	MNRE	On-going

Project on PERC Solar Cell Development

In continuation of MNRE sponsored R & D project on PERC cells titled "Development of high efficiency (21%/ 19%) PERC type of c-Si/mc-Si solar cells" jointly with BHEL ASSCP, Gurugram NISE is in the process of establishing an Advanced PV Characterization Laboratory in the Aditya Bhawan for housing the testing and characterisation equipment under a single roof. As part of the project, NISE established a laboratory space of 140 sq. m, ISO Class 8 clean room to install all the testing and characterisation euipments. NISE has procured and commissioned Spectroscopic Ellipsometer, Optical Microscope, Semi-Automatic Four Probe Resistivity Meter, Surface Profilometer and Spectral Response Measurement System (QE-SRMS) under this project (Figure 7.1). These equipments have been used to characterise samples fabricated by BHEL-ASSP on time-to-time basis. Other two equipments FESEM with EDAX facility and Electrochemical Capacitance Voltage (ECV) Profiler proposed through this project are going to be commissioned soon.

Figure 7.1 Equipment commissioned in clean room under PERC solar cell project

Project on Secondary Reference Solar Cell Development

In the last quarter of FY 2020-21, NISE has been awarded another R&D project sponsored by DST titled "Design, development and qualification of large area (156 mm x 156 mm), secondary reference solar cells". This large area reference solar cell will replace conventional small area (50 cm x 50 cm) reference solar cell and influence of the inhomogeneity of solar simulators will be reduced. As a result, the accuracy of measurement output will increase. The activity in 2020-2021 in secondary reference solar cell project was to establish the course of action for procurement of equipments proposed through this project.

Design and Development of High Efficiency Solar Water Pump Project

MNRE sanctioned this project on 28th Feb 2019 for a duration of three years. The main objective of the High efficiency solar water pumping system 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%), creation of state of the art testing facility for solar water pumping systems, preparation of 'Best Practices' guidelines 'Document & standardisation procedure of each component.

In this regard, NISE has signed MoU with three organizations to develop the high efficiency solar PV pumping system, and the collaborative research work is in progress. 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. Under this project, NISE team also visited villages in Haryana to conduct site survey and discussed with farmers on their welfares and experiences after adopting solar water pumping system for irrigation.

Solar Powered Clean Drinking Water Project

Focus of this project is to design a solar driven drinking water plant for the villages or cities with population of about 10,000 or more where ground water has become contaminated and shows presence of heavy metals/toxins and water-borne diseases are rampant due to open sewage systems and bad quality of septic tanks. The approach is for complete turnkey solution which uses solar energy for water filtration while keeping the TDS of water low through extensive rain water harvesting. The following were the project outcome:

- A community size solar powered water purification system with 6000 LPH purified water dispensing capacity has been designed fabricated and installed in village Faridpur and is already serving people (Figure 7.2).
- Three rainwater harvesting pits have been installed in the vicinity. Impact of rainwater harvesting is already being felt by the village community as the community well and ponds are getting recharged.
- Rainwater harvesting systems have been operational before the last monsoons (during COVID period) have recharged the well.
- The information and outreach activities are ongoing and water consumption data was being continuously monitored.

Figure 7.2 Solar powered clean drinking pilot project implemented by NISE at Village Faridpur.

IN-HOUSE R&D WORKS

Performance and economic viability of the PV system in different climatic zones of Nigeria (Completed)

This study analysed the effect of climatic variation on PV systems' performance and economic viability in four climatic zones of Nigeria (warm desert, warm semi-arid, tropical savanna, and monsoon climate). Performance ratio (Figure 7.3) was found to be high in monsoon and tropical savanna climate due to the influence of cool-moist air from the ocean, low temperature, and increased cloud cover in the region. Meanwhile, the least performance ratio was noticed in the warm desert and warm semi-arid climate due to the dusty wind from the Sahara desert, relatively high temperature, and low precipitation in the region. In order to assess the cost-effectiveness and profitability of the solar project in Nigeria, the Levelized Cost of Electricity (LCOE), Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP) were employed. The average LCOE across the climatic zones is 0.21 $/kWh, which is lower compared to the 0.25 $/kWh grid tariff. The average NPV and IRR are found to be $31,164 and 22%, respectively, making the project economically feasible. However, the payback period was found to be ranging from 3.7 to 5.2 years. Finally, the analysis has proven that solar PV technology is economically viable and profitable in Nigeria.

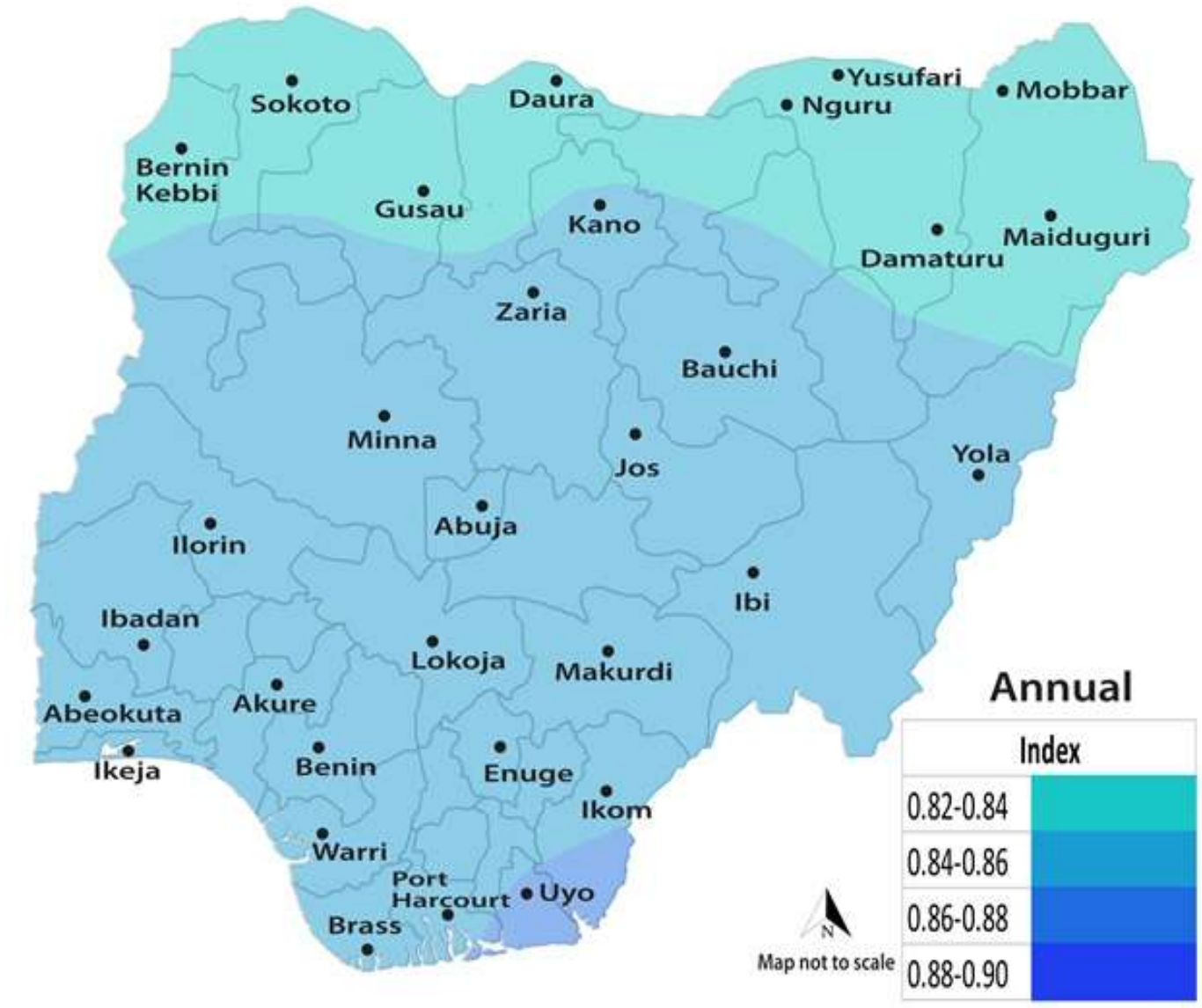

Figure 7.3 Estimated Annual AC Performance ratio of PV power plant of Nigeria

Experimental investigations of fault tolerance due to shading in photovoltaic modules with different interconnected solar cell networks (Ongoing)

In a photovoltaic module, solar cells are generally connected in series. The series connection of the constituent cells makes the module most susceptible to power loss due to mismatch in their electrical characteristics. In this study PV modules of 50 Wp each, have been designed and developed by changing the conventional series architecture of network of 36 cells into series-parallel 9x4 architecture with different schemes of interconnection of cells. Simple series–parallel, bridge linked (BL) and total cross tied (TCT) are the three schemes of interconnection of cells used in this study along with the standard series configuration of cell network. Rigorous experimental investigations have been carried out in real operating conditions to find the configuration of cell network that is least susceptible to environmental stresses such as partial shading and hot spot issues. Fifteen diverse cell level partial shading scenarios were created artificially

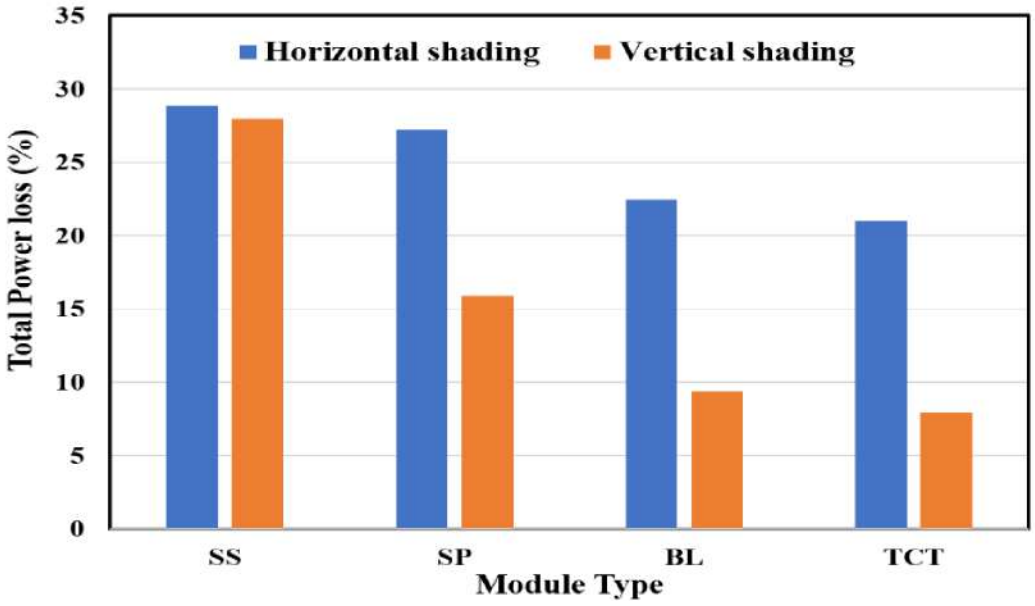

Figure 7.4 Power loss in module with different cell configurations with different distribution of 2 cells shaded with 60% intensity

using sheets of paper of different transmissivity. Comparative performance assessment for these cell networks is done with respect to maximum power point, voltage and current at maximum power point, shading loss, mismatch loss and presence of secondary power peaks on the output characteristics (Figure 7.4). Additionally, important parameters such as series resistance, shunt resistance, fill factor, temperature coefficient of current, voltage and power were determined for each cell network at standard test conditions and were compared. It is found that the performance of series paralleled 9x4 configuration with TCT/BL cell interconnection excels over conventional series configuration under partial shading conditions producing power enhancement ranging from 63% to 2%. The problem of appearance of secondary power peaks due to bypass diodes in standard series configuration was also circumvented by using series-parallel 9x4 configuration of cell network.

Failure Mode Analysis of PV Modules in Different Climatic Conditions (Completed)

Understanding the reliability of photovoltaic (PV) modules under field conditions is one of the primary areas to ensure prolonged operation. NISE reported a study on assessing PV modules' reliability under different outdoor environments, using procedures available in the literature. Research study identified dominant failure modes of PV modules under different climatic conditions of India. Risk Priority Number (RPN) of different failure modes were estimated by analysing the consequences of defects in performance and safety. Modules deployed under cold and sunny, hot and dry, warm and humid, and composite climates of India have more varieties of failure modes than those in cold and cloudy and moderate climatic conditions. The frequency of occurrences of benign or cosmetic defects of PV modules varies under different climatic zones. The biggest concerns in old PV systems were hot spots, internal circuitry discoloration, backsheet problems, and grounding wires' corrosion. In the hot zones, primary safety issues were frame grounding corrosion, backsheet problems, hot spots, and nonhot zones were backsheet burn marks, backsheet peeling, and grounding wire corrosion. The defects observed in different climatic zones (Figure 7.5) were analysed in terms of its possible defect generation route also.

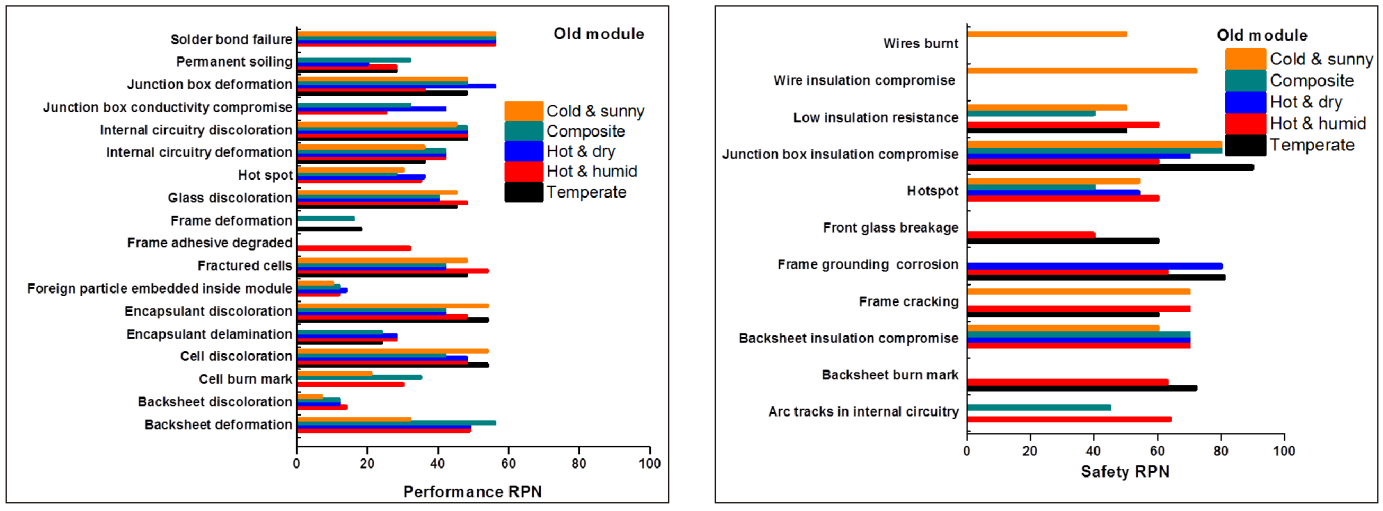

Figure 7.5 RPN of different failure modes of PV module in different climatic zones of India

Performance and Degradation Analysis of High-Efficiency SPV Modules under Composite Climatic Condition (Ongoing)

High-efficiency commercial solar panels have an appreciable solar energy to electrical energy conversion efficiency as compared to other SPV modules. It generates 36% more efficient power in panel over 25 years as compared to other modules and shows module wise highest efficiency of over 20%. The performance of an SPV module depends on environmental conditions and it degrades with the time of exposure. In this work the degradation study of 100 kW high-efficiency SPV power plant installed in NISE Campus, has been carried out after 2 years of installation in (Indian) composite climatic conditions. The annual degradation rate of the high-efficiency technology was calculated from I-V measurement data of the individual modules of the power plant after subjecting them to visual inspection, thermal imaging and insulation resistance testing. The annual degradation rate of maximum power was found to lie in the range of 2.8% to 4.3% per year with a median of 3.9% for 2 years.

Assessment of Photovoltaic Fed Universal Power Converter for Agriculture Applications

Standalone Solar Photovoltaic Water Pumping Systems (SPWPS) have established a massive demand in the Asian countries due to ease of installation, operational flexibility, no need for the distribution network, and economic viability. Based on long-term field data, this study investigates the factors leading to underutilisation of existing SPWPS and proposes the method to optimise the performance using the configuration of power converters, such that photovoltaic power is used in the operation of additional agriculture loads. A typical common DC bus converter configuration is employed, which is universal to feed power to single and three-phase loads, assisted with minimal battery storage. This study contributed the best possible control strategies for enhancing overall performance through optimum utilisation of power by the systematic approach of modeling and control design of the entire system. This study distinguished the gaps in energy utilisation and recommends a Renewable Fed Drive for Agriculture Applications (RDAA). Various modes of operation of RDAA were are presented to prove the superiority of the RDAA based systems in terms of energy utilization and reliability and are verified using experimentation.

SKILL DEVELOPMENT & CAPACITY BUILDING

8

INTRODUCTION

NISE extends capacity building opportunity for skilling up young minds across the world. The organisation empowers people by conducting skill development programmes, training, short term courses, client specific courses on solar photovoltaic technology. The proposed mandate enables to meet the challenges, maintain quality and upgrade itself in this competitive environment.

NISE has organised various technical training programmes for both national and international participants. The training curriculum launched for various training programmes were developed, scrutinised and duly improved by industry experts, renowned professors and professional experts. NISE considers this as an opportunity to contribute to the world's pressing needs and link its potential individuals to prospective employer.

During the year 2020-21, NISE imparted trainings (both online and offline mode) to the participants from a 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 needs of the participants. Additionally, international training programmes were also organised for active growing solar environment and sustainability. In the FY 2020-21, newly developed training courses were conducted for enhancement of knowledge sharing in an online mode through Webex platform. A total of 12 numbers of national and international level training courses were conducted in which 453 participants were imparted training. The photograph of the participants of induction training program for newly recruited scientists from MNRE is shown in Figure 8.1. The details of the Training Programme conducted at NISE during the FY 2020-21 is given in Table 8.1.

Figure 8.1 Participants of Induction Training Programme for newly recruited scientists from MNRE (March 2021)

Table 8.1 Details of Training Programme conducted at NISE during FY 2020-21

S. No.	Training/ Program	Number of Programs	Duration of Program (Days)	Date	Number of Participants
1	Workshop on Start-up India Skill Development Programme	3	3	28th-30th September 2020 23th -25th November 2020 8th -10th February 2021	48 61 65
2	3 Days Online Training Programme for Design, installation & Commissioning of Solar Water Pumping System	2	3	22nd -24th December, 2020	21
3	Solar Analytics	1	5	14th -18th December, 2020	28
4	3 Day Design of Solar PV Systems using simulation software	1	3	15th -17th December 2020 2nd- 4th February, 2021	33 15
5	Solar Thermal Technologies Performances Evaluation and Their Applications	1	2	7th -8th January, 2021	21
6	2 day online training programme on solar PV Pump technologies, policies and application for nodal state agencies areas	1	2	18th - 19th January 2021	100
7	5 Days Induction Training Program for Scientist B of MNRE	1	5	15th - 20th March 2021	14
8	2 Day online Training Program for MES Officials	1	2	13th - 14th August, 2020	32
9	3 Day online Training Program for ONGC	1	3	21st - 23rd September, 2020	15
	TOTAL	**12**			**453**

SURYAMITRA SKILL DEVELOPMENT PROGRAMME PAN INDIA BASIS

The Suryamitra Skill Development Programme was designed with an objective to develop skilled and employable workforce (Suryamitras) for catering the needs of Solar PV industries. These participants are trained to perform the work related to installation, commissioning and operation & maintenance of a solar PV system. Further, on completion of the training programme, Suryamitras are offered positions such as technician, supervisor, and managers in Solar PV organisations and also an opportunity to emerge as an entrepreneur in the Solar PV Industry. A total of 175 Suryamitra centres were allocated batches with a target to train 5250 Suraymitra candidates during FY 2020-21 as shown in Table 8.2. Some glimpses of Suryamitra training programme at various affiliated institutes in India are shown in Figure 8.2.

(i) MITCON Consultancy and Engineering Services Ltd.

(ii) AISECT, Bhopal

(iii) Center of Excellence, Lucknow University

(iv) Ultimate Energy Resource Pvt. Ltd

Figure 8.2 Suryamitra Training Programme conducted at various affiliated institutes in India

Table 8.2 State-wise allocation of Suryamitra Skill Development Programme for FY 2020-21

S. No.	State/UTs	No. of Batches allocated	Suryamitra Target Set
1	Andhra Pradesh	10	300
2	Arunachal Pradesh	1	30
3	Assam	6	180
4	Bihar	6	180
5	Chandigarh (UT)	0	0
6	Chhattisgarh	7	210
7	Delhi (UT)	3	90
8	Goa	1	30
9	Gujarat	10	300
10	Haryana	3	90
11	Himachal Pradesh	2	60
12	Jammu & Kashmir (UT)	6	180
13	Jharkhand	3	90

14	Karnataka	4	120
15	Kerala	4	120
16	Ladakh (UT)	1	30
17	Lakshadweep (UT)	0	0
18	Madhya Pradesh	20	600
19	Maharashtra	8	240
20	Manipur	0	0
21	Meghalaya	2	60
21	Nagaland	0	0
22	Odisha	6	180
23	Puducherry (UT)	0	0
24	Punjab	1	30
25	Rajasthan	12	360
26	Tamil Nadu	13	390
27	Telangana	15	450
28	Tripura	1	30
29	Uttar Pradesh	21	630
30	Uttarakhand	3	90
31	West Bengal	6	180
	Total	**175**	**5250**

VARUNMITRA SKILL DEVELOPMENT PROGRAMME

Solar Water Pumping System is anticipated to attain an impressive growth in global market by observing to its allied activities in irrigation, farming, drip irrigation, drinking, cooking etc. NISE intends to impart skill based training on solar water pumping system. With the support of MNRE, NISE is implementing Varunmitra Skill Development Programme. The main objective of the programme is to impart knowledge in understanding of site feasibility, water table, efficiency and different types of heads, solar water pumping components such as controller, battery, motors, pump – motor set, sensors, actuators etc. This course provides a hands on practice on Solar PV water pumping system. During the FY 2020-21, a total of 767 participants were trained in the Varunmitra training programme. This course follows SGJ/Q0112 (SGJ/N0134) qualification pack of SCGJ. Table 8.3 shows the state wise participants for solar water pumping programme conducted in various states across the country. A glimpse of Varunmitra training programme at various affiliated institutes in India is shown in Figure 8.3.

(i) ADS Foundation Skill Centre (JCARC), Gandhinagar, Gujarat

(ii) CPIT Skill Education, Ganganagar.

(iii) CPIT Skill Education, Ganganagar

(iv) ADS Foundation Skill Centre (JCARC), Gandhinagar, Gujarat.

Figure 8.3 Varunmitra Training Programme conducted at various affiliated institutes in India

Table 8.3 State-wise detail of Varunmitra candidates trained for FY 2020-21

Sr. No	State/UTs	No. of Participants
1	Andhra Pradesh	30
2	Assam	30
3	Bihar	30
4	Chhattisgarh	26
5	Gujarat	60
6	Haryana	60
7	Himachal Pradesh	30
8	Jharkhand	59
9	Karnataka	57
10	Madhya Pradesh	25

Sr. No	State/UTs	No. of Participants
11	Odisha	30
12	Puducherry (UT)	30
13	Punjab	30
14	Rajasthan	60
15	Tamil Nadu	60
16	Telangana	30
17	Uttar Pradesh	60
18	West Bengal	60
	Grand Total	**767**

WORKSHOP ON PROSPECTS FOR START-UP IN SOLAR ENERGY TECHNOLOGIES

NISE has been organising training programme on start up in solar energy technologies. The target participants are entrepreneurs, EPC contractors, Engineers, etc. This course provides implementation methodologies, latest market strategies, new trends and technology concept, etc related to establishment of solar PV power plant. NISE conducted 3 numbers of three days online Start-Up programme on prospects of solar energy technologies and has trained 174 participants during the FY 2020-21.

SOLAR ANALYTICS PROGRAMME

NISE has been conducting a skill development training program on solar analytics. This programme demonstrates solar plant data analysis applying descriptive analytics, diagnostic analysis, predictive analysis assessing the plant condition, real time analysis of data applying machine learning principles. The Solar Analytics programme aims to developing Centre of Excellence (CoE) on analytics for organisation as well as developing skills for managing the same. A five days skill development programme was organised in December 2020 at NISE, through online mode, in which 28 participants participated.

TRAINING PROGRAMME FOR INDUSTRY & PUBLIC SECTOR UNITS

NISE has designed & conducted training programmes for industry and organisation according to their field job knowledge and prospective requirements. These customised programmes are developed for an organisation for development of skills, knowledge of solar technologies and market, and update information of present technology in solar field. This training program covered various sectors of solar energy i.e. start-up India scheme, solar photovoltaic applications, business model for solar in Industry, opportunities for entrepreneurs in solar sector etc. During the FY 2020 - 21, NISE conducted online training programmes for ONGC, and Military Engineering Services (MES). A total of 15 participants from ONGC and 32 participants from MES participated in these programmes.

TRAINING PROGRAM FOR NEWLY RECRUITED SCIENTISTS OF MNRE

NISE has designed & conducted an induction training programme on solar energy technologies for the newly recruited scientists of MNRE. The training programme discussed about technologies, and also aspects on various policy and planning of RE Technologies. A total of 14 scientists from MNRE participated in this programme. This programme was conducted from 15th to 20th March 2021 in physical mode at NISE campus, complying to all the COVID related protocols.

ONLINE INTERNATIONAL TRAINING PROGRAMME OF SOLAR ENERGY TECHNOLOGIES AND APPLICATIONS UNDER INDIAN TECHNICAL ECONOMIC CO-OPERATION (E-ITEC)

Every year NISE organises three weeks Indian Technical and Economic Co-operation (ITEC) programs fully funded by Ministry of External Affairs, Govt. of India. During the FY 2020-21, NISE conducted e-ITEC programme from 15th March 2021 to 19th March 2021 through online platform and trained 58 participants from 24 developing countries around the world. The programme also provided a platform for mutual knowledge sharing in the field of solar energy around the world. The details of country-wise participation of the delegates in e-ITEC Training programme is given in Table 8.4.

Table 8.4 Country-wise participation of delegates in e-ITEC International Skill Development Programmes conducted during FY 2020 – 21

S.No.	Country Name	No. of Participants
1	Afghanistan	2
2	Azerbaijan	2
3	Benin	2
4	Bhutan	1
5	Bolivia	1
6	Cambodia	2
7	Costa Rica	1
8	Ethiopia	1
9	Fiji	3
10	Guatemala	1
11	Guyana	1
12	Kenya	3
13	Kingdom of Eswatini (Formerly Swaziland)	1
14	Maldives	2
15	Morocco	2
16	Palestine	1
17	Peru	1
18	South Sudan	8
19	Sri Lanka	1
20	St. Kitts & Nevis	1
21	Tanzania	1
22	Trinidad & Tobago	3
23	Zambia	14
24	Zimbabwe	3
	Total	**58**

CENTRE OF EXCELLENCE IN THE FIELD OF SOLAR ENERGY AND HIGHER LEARNING

NISE has set up a Centre of Excellence (CoE) in collaboration with Power Sector Skill Council (PSSC), Schneider Electric Foundation India (SEFI) and National Skill Development Corporation (NSDC) for the high end learning in the area of power and solar sector. The centre aims to provide state-of-the-art equipment and facilities with a focus to provide training in the area of electricity, automation and solar energy related aspects. The centre shall design and deliver Training of Trainers, Instructors and Training of Assessors and high end programmes in the area mentioned above. In this regard, as per the MoU signed between NISE, PSSC, SEFI and NSDC on 24th October 2019, CoE will operate from the NISE premises for which NISE has provided 4000 sq. ft area. The space needed is to accommodate class rooms, laboratories, Director and Co-Director's office and conference rooms etc. The facilities so developed will also be available for NISE to utilise as per their program and requirement. Figures 8.4 and 8.5 shows the inauguration of CoE in the field of solar energy high-end learning and laboratory facility at NISE.

Figure 8.4 Inauguration Programme conducted for Centre of Excellence in the field of solar energy for high-end learning

Figure 8.5 Centre of Excellence Laboratory Facility at NISE

FUTURE PROSPECTS AND DEVELOPMENT

NISE intends to introduce new structured courses on electric vehicles, data analytics, design and development of power electronics converters and training programmes in solar energy using machine learning and artificial intelligence. NISE shall organise international training programmes with enhanced practical training and structured modules. Furthermore, in the forthcoming year, NISE has planned extensive courses on solar thermal technologies. NISE also plans to continue organising on-line trainings in future. The training calendar to organise online training programmes for the FY 2021-22 is given in Table 8.5.

Table 8.5 NISE Training Calendar for different Training Programmes for the FY 2021-22

S. No.	Training Id No.	Program Title	Duration	Number of programs	Tentative Schedule
1	NISE/SDD/01/2021-22	Prospects for Start-ups in Solar Energy Technologies	3 days	3	July 2021, November 2021, February 2022
2	NISE/SDD/02/2021-22	Hydrogen Energy : Production, Storage and Utilisation	1 day	2	October 2021, February 2022
3	NISE/SDD/03/2021-22	Training Programme on Solar Thermal Technologies-Performance Evaluation and their Applications	3 days	2	August 2021, January 2022
4	NISE/SDD/04/2021-22	Performance evaluation of low, medium and high temperature solar thermal system using SAM	5 days	1	November 2021
5	NISE/SDD/05/2021-22	Three days Skill Development Program on Design of Solar PV systems using simulation software	3 days	4	October 2021, December 2021, January 2021, February 2022
6	NISE/SDD/06/2021-22	Design, Development and Application of Solar Photovoltaic Water Pumping Systems	3 days	2	August 2021, November 2021
7	NISE/SDD/07/2021-22	Electric Vehicle Technology	3 days	2	November 2021, February 2022

OUTREACH ACTIVITIES

9

CUSTOMER SERVICE CELL

Customer Service Cell (CSC) division is centrally responsible for management of testing, calibration and developmental testing in NISE. CSC enables its customers to avail testing services from online portal available at NISE website. This testing portal allows easy access for selection of testing services, online payment and process the testing request. NISE offers comprehensive range of testing services (IEC, BIS, MNRE specifications etc.) to facilitate testing as per national /international standards for various solar energy products and components. NISE has dedicated team in CSC to guide the customers seeking support for testing services.

NISE has started developmental testing for new R&D products and few testing protocols are under formulation. To maintain high Customer Satisfaction Index (CSI), CSC division follows industry standards & processes, and periodically collect feedback to continuously improve and set higher standards of service. CSC has also proactively taken various quality interventions in its operations and to improve services of various labs.

During FY 2020-21, Customer Service Cell received 292 samples for testing services. The details are in Table 9.1.

ALMM Project (Approved List for Module Manufacturers)

MNRE has issued ALMM order (Approved Models and Manufacturers of Solar Photovoltaic Modules) (Requirements for Compulsory Registration) dated 2nd January, 2019.

NISE has been designated as Implementation Support Agency, entrusted with processing of applications, carrying out inspections, verifications and quality checks on behalf of MNRE. All manufacturing units of Solar Photovoltaic are required to have ALMM enlistment for further participation in any government tender.

Table 9.1 Details of sample received by CSC during FY 2020-21

S. No.	Particulars	Quantity
1	Solar PV Module Testing Lab	165
2	Solar Light /LED *(HLS,SLN,SLS) Testing Lab	60
3	Solar Inverter Testing Lab	02
4	Battery Testing Lab	13
5	Radiation Sensor Calibration Lab	38
6	Solar Water Pump Testing Lab	09
7	Solar Cell Testing Lab	05
	Total	**292**

*HLS=Home Light System, SLN=Solar Lantern, SLS=Solar Street Light.

Table 9.2 ALMM application status during FY 2020-21

Total Applied Capacity in MW		Total Indian Manufacturers in MW	Total Foreign Manufacturers in MW	Recommended for Enlistment to MNRE
Modules	29454	10010	19444	8367
Cells	15500	2000	13500	2000

Total No. of ALMM Applications		Site Inspections Completed	Recommended for Enlistment to MNRE
Modules	51	26	26
Cells	10	4	4

CONSULTANCY SERVICES

NISE offers various consultancy services to projects in Solar Photovoltaic & Solar Thermal Technologies. The consultancy division provides specialised services to its clients in designing and offers solutions to various stakeholders i.e. facility owners, Investors, Financial Institutions, Armed forces, Banks, EPC Contractors, Independent Power Producers (IPP), Project Developers, Service Providers and Insurance Firms interested in assessing the performance of Solar PV Power Plants. Following are the services offered by NISE:

Service Based Consultancy

a. Vetting of Technical specifications/ documents and Tender
b. Yield assessment
c. Field/Plant testing of MW scale SPV Power Plants
d. Power plant Final Acceptance Test
e. Pre-Commissioning and Post- Commissioning checks
f. Quality Checks through Visual Inspection, EL and Thermography and Workmanship check
g. Performance Trouble shooting

Solution Based Consultancy

a. Preparation of Tender.
b. DPR preparations of the Solar Power Plants
c. Feasibility Study of the Solar Power Plants
d. Project planning
e. Solar Resource assessment
f. Design of Customised solutions
g. PV system Design (PVSYST and PVSOL)
h. Technical Consultation on Solar based demonstration facilities

To carry out, various field measurement studies and analysis, NISE owns necessary portable instruments, like I-V tracer, EL image tester, IR measurement tester, etc. NISE has started on site testing of large scale Solar Photovoltaic Projects for quality and performance assessment of solar PV plants. Technical experts from NISE were involved in the testing and quality inspection of Solar PV power plants installed by Ministry of Defence (Figure 9.1). The team of technical experts renders advice to their clients on various technical parameters found during on site testing, this enables the clients to take the appropriate measures to improve the plants performance. During the FY 2020-21, NISE has carried out various consultancy projects involving vetting of technical documents, technical support for establishment of RE laboratories, and also as a consultant in implementing Solar PV Port training programmes. Major clients included, departments from state Government, and Solar industry.

Figure 9.1 Field inspection by NISE officials of 1 MW Solar Power plant at Mahajan, Rajasthan

COORDINATION & INTERNATIONAL COOPERATION

10

One of core functions of NISE is to develop and coordinate national and international collaborations. This facilitates for mobilising partnerships and galvanising efforts of different institutes/ organisations to work towards national and global research challenges. NISE partners with government, academia, entrepreneurs and non-profit organisations for partnering and accelerate the growth of renewable energy technologies. NISE seeks to provide highly specialised services for developments and agreements. The partnering provides access to new innovations, technical expertise and support for projects. It acknowledges the large-scale implementation of projects while maintaining its quality and enhancement.

NISE has worked with various organizations for training, business and product development. The partnership has accelerated into new agreements and assignments. These opportunities have licensed for execution of various products in the market and further fostering for the expansion of renewable energy technologies.

MoUs SIGNED BY NISE

In the FY 2020-21, NISE has established its partnerships with esteemed organisations by signing 17 MoUs. These include, 1 MoU was signed with an international organisations and 16 MoUs with various national organisations (Table 10.1).

Table 10.1 List of MoUs Signed during 2020-21

Sl. No.	MoUs Signed with National Organizations/Agencies
1	NISE & Netprophets Cyberworks Private Limited, New Delhi
2	IDAM Infrastructure Advisory Pvt. Ltd., Mumbai
3	NISE & Energy Management Centre (EMC), Kerala
4	NISE & CSIR-CMERI, West Bengal
5	NISE & ASTU (Assam Science and Technology University), Guwahati
6	NISE & GLA University, Mathura
7	NISE & NITCON Limited, Chandigarh
8	NISE & MSME-TDC (PPDC), Meerut
9	NISE & Sukoon Solutions Pvt Ltd
10	NISE & Ecosense Sustainable Solutions Pvt Ltd, New Delhi
11	NISE & UPES, Uttarakhand
12	NISE & MNRE (Ministry of New & Renewable Energy)
13	NISE & SSS-NIBE, Kapurthala (Sardar Swaran Singh National Institute of Bio-Energy)
14	NISE & Jaipur National University, Jaipur
15	NISE & Shakti Pumps India Ltd.
16	NISE & RR Soura Shakti Pvt Ltd, Hyderabad
	MoUs Signed with International Organisations /Agencies
1	NISE & International Solar Energy Institute, Uzbekistan

PV Port & Store Project with German Cooperation GIZ

NISE is working along with German Development Cooperation (GIZ) to launch the first portable residential Solar Rooftop Photovoltaic System in India termed as "PV Port & Store". The key objectives of this project are to manage procurement, field test, research and evaluate different versions of PV Port. This pilot phase intends to validate the technical concept and further upscale and commercialise PV Port & Store Systems in India. This project will envisage activities to improve the quality of product, to provide easy transport and assembling, selection of suitable consumer, development of PV Port portal and Mobile

app, and training of qualified Suryamitra for installation of solar rooftop system.

PV Port & Store System is available in five versions with a 2 kW_P DC capacity (solar) with battery storage (Lead Acid & Li-ion) designed for 100% self-consumption with no power being fed back to the Grid. So far, 6 PV Port systems have been deployed in different locations in Delhi. NISE has conducted Quality Testing of five different PV Port versions along with the field testing of 3 different versions of PV Port in Delhi.

The project has developed the criteria for consumer selection, site selection for these systems together with the required forms, pamphlets, interest forms, O&M practises for consumers, consumer feedback form, etc. for operationalising of PV Port website & PV Port app. The performance of the systems installed and commissioned at different locations in Delhi are being monitored by NISE. Figure 10.1 shows the photographs of PV Port & Store System installed at two different locations in Delhi.

Figure 10.1 PV Port & Store System installed at two locations in Delhi

GENERAL FACILITIES AND ACTIVITIES 11

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

LIBRARY

The Institute's library (Figure 11.1) was established in September, 2013. The library is fully automated since February, 2017. The library uses e–Granthalaya software for circulation of books. During the FY 2020-21, 99 books and 04 Standards were purchased. Facilities and services of library are availed by visitors and many trainees of different departments. The NISE library possesses a very rich collection of 6860 volumes of books, bound volumes of Journals and other reading material, to cater to the requirements of its users. Apart from books and journals, the library also has a large collection of national and international standards. The library subscribes to in number of Hindi and English journal and newspapers. In addition, a number of electronic academic and scientific journals are subscribed for use, apart from annual report and project reports. The library is being modernised by strengthening of internet services with the addition of 6 computers, computerisation of library catalogue, automation of check-out check in functions, barcoding of collection, data entry of entire collection, automation of stock verification, creation of digital library and establishment of multimedia library. 69 nos. of technical books & 30 nos. of administrative books were purchased for NISE Library during 2020-21. 46 nos. of books have been gifted by Central Council for Research in Ayurvedic Sciences (CCRAS), Ministry of AYUSH, Govt. of India. Lifetime membership is offered to all retired employees of NISE at a one-time nominal fee of Rs. 5000.

Figure 11.1 Library facility at NISE

SPORTS FACILITIES

The sports facility developed at NISE (Figure 11.2 (a)) ensures the quality facility and opportunity for its employees to participate in sports and physical activities. The access to the facility of gym, yoga, indoor activities are imparted by a coach within the institute (Figure 11.2 (b)). The equipment and facilities are well maintained by the instructor. As sports is the integral part in discipline and stress management, quality programme schedules, diet and yoga sessions are organised for the staff and trainees at NISE.

Figure 11.2 (a) Sports facility at NISE

Figure 11.2 (b) Gym facility at NISE

INFORMATION TECHNOLOGY (IT) DIVISION

The IT division (Figure 11.3) implemented several important projects to make NISE technically competing and progressive. NISE IT division implemented advance software backup solution in NISE, as recommended by the quality management system, during the internal audit conducted in NISE. This enables that, all raw data and test reports generated by testing laboratories can be stored on server for maintaining the electronic record, data protection and for back up of records. The testing machines are now directly interfaced with the server and the raw data is directly stored on server. NISE has a local data centre with high end server and 10 TB storage capacity. The local data centre stored NISE data for security and data backup purpose. NISE IT division is closely working with MNRE and provides support in various projects like renewable energy job portal and investment and grievance portal. During the year 2020-21, the Government e- Market place procurement was fully used by IT Division. Human resource manpower tender and cleaning services tender allotment were also performed through Government e- Market place. The candidate report verification functionality of Suryamitra programme was supported by IT division, by developing suitable IT platform. NISE is now using online Tender wizard portal solution to publish, evaluate and award the tenders online for transparency. IT division plays an important role in any Institute's growth and development. IT division of NISE provides support to other divisions in day-to-day activity to make their work simple and smooth. IT division has implemented many important projects this year. In this year the division organised two training programs on power plant performance monitoring using AI/ML. IT division developed an inventory portal for proper asset maintenance and management. Division also implements a bar code asset management system for testing equipments and IT equipments.

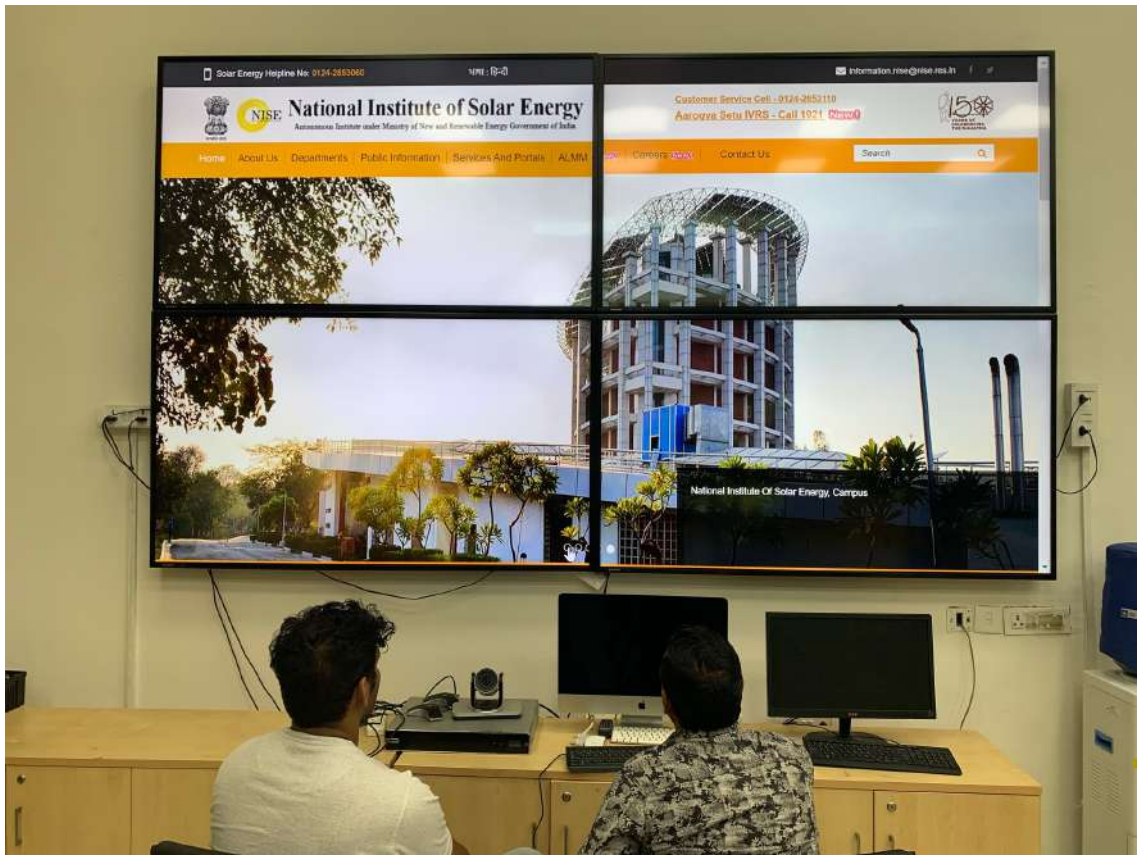

Figure 11.3 IT Division at NISE

PROMOTION OF OFFICIAL LANGUAGE

With a view to implement the Official Language Policy of the Government of India, an official language section has been established. 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 of the provisions of Official Language Act - 1963 and Rules were framed thereunder. For promotion of official language policy and to create 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 Official Languages 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 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 convenience of officers/staff, (vi) The Annual Report 2019-20 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.

To review the progress made in the implementation of Official Language policy, quarterly meetings of Official Language Implementation Committee were held. The divisions were advised to achieve the targets specified by the Department of Official Language. During the year, various measures were taken for effective implementation of Official Language Policy in the Institute. Special emphasis was laid on increasing originating correspondence in Hindi. 'Hindi Pakhwada' was organised during 14th to 28th September, 2020 (Figure 11.4 (a)) 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, mementos, certificates and cash prizes were awarded to the participants by the DG, NISE (Figure 11.4 (b)).

Figure 11.4 (a) Closing Ceremony of Hindi Pakhwada

Figure 11.4 (b) Prize Distribution ceremony by Dr. Arun K Tripathi, DG NISE

Inspection of NISE was done on 9th November, 2020 by Regional Implementation Office, Rajbhasha Vibhag, Ministry of Home Affairs, Govt. of India.

INDEPENDENCE DAY CELEBRATION

Independence Day is one of the national festivals of India, which was celebrated on 15th August, 2020 with great zeal and respect throughout the country. Like every year, Independence Day was celebrated with great enthusiasm in NISE. Photographs from Independence Day celebrations organised at NISE are shown in Figures 11.5 (a) & (b).

Figure 11.5 (a) Independence Day celebrations at NISE

Figure 11.5 (b) Speech by DG, NISE during Independence Day celebrations

REPUBLIC DAY CELEBRATION

Like every year, Republic Day (Figure 11.6) was celebrated with great enthusiasm in NISE on 26th January, 2021. The flag was hoisted in the courtyard of Aditya Bhawan of the institute by Dr. Arun Kumar Tripathi, DG and a small parade was also organised by the security personnel of the institute on this ocassion.

Figure 11.6 Republic Day celebrations

VIGILANCE AWARENESS WEEK

The Central Vigilance Commission observes the Vigilance Awareness Week (VAW) every year. The VAW is being celebrated every year and coincides with the birthday of Sardar Vallabhbhai Patel. This year it was observed during 27th October – 2nd November 2020. The theme of the Vigilance Awareness Week-2020 was 'Satark Bharat Samriddh Bharat'. NISE followed this endeavour actively. A pledge was also taken by all the employees of the institution for being a part of the drive against corruption.

All the officers and employees of the institute pledged to continue to strive towards the corruption-free nation by taking the "Satyanishtha Pledge" (Figure 11.7 (a) & (b)). During this period, an essay competition and slogan writing competition was organised in NISE (Figure 11.8). Prizes were distributed by NISE to the winning participants in the competition.

Figure 11.7 (a) Satyanishtha Pledge by Employees during Vigilance Awareness Week at NISE

Figure 11.7 (b) Address by DG NISE during Vigilance Awareness Week at NISE

Figure 11.8 Essay competition organized during Vigilance Awareness Week at NISE

COMMITTEE FOR PREVENTION OF SEXUAL HARASSMENT OF WOMEN AT WORKPLACE

In accordance with Government instructions, a complaints committee for women for redressal of complaints concerning sexual harassment in the workplace has been constituted at NISE. No complaints were received during the year 2020-21.

RIGHT TO INFORMATION ACT

The Institute is implementing the Right to Information (RTI) Act, 2005 as per the guidelines issued by 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 in accordance with subjects assigned to them. A list of CPIOs and first Appellate authorities is given in Table 11.1. 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 applications/First Appeals received, disposed-off, as well as pendency during the year (from 01.04.2020 to 31.03.2021), is given in Table 11.2.

Table 11.1 Name and Designation of the CPIOs and Appellate Authorities in NISE under Right to Information Act, 2005

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. Chandan Banerjee Scientist 'F' (Deputy Director General)	Dr. Arun K Tripathi Director General
2	All matters concerning Finance	Shri Ankeshwar Mishra Deputy Director Administration	
3	All Administrative Matters (Except Financial Matters)	Ms. Aakanksha Sharma Administrative Officer	
4	Public Grievance Officer	Shri Ankeshwar Mishra Deputy Director Administration	

Table 11.2 Status of RTI Applications received during 2020-21

Item	Received	Replied	Pending as on 31.03.2021
RTI Applications*	49	49	NIL
First Appeals*	16	16	NIL

* As per Quarterly report submitted on RTI Portal.

ADMINISTRATION & STAFF

NISE is an autonomous institute of the MNRE. The institute is set up for assisting the Government of India in the NSM under the official and authoritative decisions made by MNRE. The organisation is administered by the head of the institution, Director General, NISE. The scientific staff, senior consultants, consultants, executive assistants, multi-tasking staff and other staff provide support in the smooth functioning of the organisation.

The Government of India has sanctioned 41 regular posts including the post of Director General. The Institute has framed Recruitment Rules for sanctioned 41 regular scientific, technical and administrative posts. The Rules were approved by the GC in its 3rd meeting held on 6th April 2015. Efforts were made to fill up these posts through written test/interviews. Out of 41 posts, the sanction has been made for posts of which regular Officers/Staff were in place as on 31-03-2021. Rests are at various stages of joining. The status of filling up of the posts is given in Table 11.3.

Table 11.3 Recruitment posts at NISE

S. No.	Name of the post	PB+GP	No. of Post			Status
			Tech.	Admn.	Total	
1.	Director General	PB-4+10000	1	0	1	Filled
2.	Deputy Director General	PB-4+8900	3	0	3	• 01 post filled • 02 posts to be re-advertised
3.	Director	PB-3+7600	2	1	3	• 01 Technical post filled • Recruitment under process (01 Admn. post) • 01 Technical post to be re-advertised
4.	Deputy Director	PB-3+6600	6	2	8	• 01 Admn. post filled • 05 Technical posts filled • 02 posts to be re-advertised (01 Admn., 01 Technical)
5.	Administrative Officer	PB-3+6600	0	1	1	Filled
6.	Assistant Director	PB-3+5400	7	2	9	• 02 Admn. posts filled • 07 Technical posts filled
7.	Office Secretary	PB-2+5400	0	1	1	Posts to be re-advertised
8.	Office Secretary -I	PB-2+4800	0	3	3	Posts to be re-advertised
9.	Executive Officer	PB-2+4800	4	0	4	Posts to be re-advertised
10.	Executive Assistant-I	PB-2+4600	8	0	8	08 Technical posts filled
	Total		**31**	**10**	**41**	**27 posts filled**

PUBLICATIONS & PATENTS

12

During the FY 2020-21, various divisions of NISE published 9 research papers/book chapters in various journals & conference proceedings, and filed two patents. The details are as follows:

Research Papers / Book Chapters

1. Bora, B., Mondal, S., Prasad, B., Sastry, O.S., Bangar, M., Tripathi, A.K., & Banerjee, C. (2021). Accelerated stress testing of potential induced degradation susceptibility of PV modules under different climatic conditions, Solar Energy, 223, 158-167, ISSN 0038-092X

2. Ray, S., Pal, B., Ghosh, H., Mitra, S., Mondal, A.K., Banerjee, C., Saha, H., & Gangopadhyay, U. (2020). Effect of Induced Charges on the Performance of Different Dielectric Layers of c-Si Solar Cell by Experimental and Theoretical Approach, Silicon, 12, 1-4.

3. Ray, S., Mitra, S., Ghosh, H., Mondal, A., Banerjee, C., Gangopadhyay, U. (2021). Novel Technique for Large Area n-type Black Silicon Solar Cell by Formation of Silicon Nanograss after Diffusion Process, Journal of Materials Science: Materials in Electronics, 32(2), 1-11.

4. Rana, M., Banerjee, C., Chowdhury, P. (2021). Studies on optical signal due to oxygen effect on hydrogenated amorphous/crystalline silicon thin films, Appl. Phys. A, 127, 192.

5. Umar, N.H., Bora, B., Banerjee, C., Gupta, P., & Anjum, N. (2021). Performance and economic viability of the PV system in different climatic zones of Nigeria, Sustainable Energy Technologies and Assessments, 43, 100987.

6. Singh, R., Sharma, M., Kumar, R., Rawat, R., & Banerjee, C. (2020). Effect of thermal stress over high-efficiency solar photovoltaic modules in real operating condition, Advances in Energy Research, 1, 69-79.

7. Malan, A., & Kumar, K. R. (2021). A comprehensive review on optical analysis of parabolic trough solar collector. Sustainable Energy Technologies and Assessments, 46, 101305.

8. Malan, A., & Kumar, K. R. (2021). Coupled optical and thermal analysis of large aperture parabolic trough solar collector. International Journal of Energy Research, 45(3), 4630-4651.

9. Sahoo, K., Yadav, V., Singh, Y., Sahoo, U., Tripathi, A.K., Banerjee, C., Mukhopadhyay, S., Goyal, N., & Kumar, S. (2021). Experimental Investigation of Solar Photovoltaic Cold Storage with Thermal Energy Storage, Hybrid Renewable Energy Systems, John Wiley & Sons, 135-167.

Patent Applications Filed

1. A Low-Cost Innovative Flat Plate Solar Air Heating System: Indian Patent Application No: 202111008027.

2. Ultra-capacitor assisted photovoltaic and grid hybrid superfast battery charger: Indian Patent Application No. 202111023691.

FINANCE AND ACCOUNTS

13

NISE has both Internal Finance Division (IFD) and Finance & Accounts Division (F&A) which look after the concurrence and preparation of accounts respectively. IFD scrutinises and concurs to all financial proposals for payments whereas, the Finance and Accounts Division deals with budget preparation, maintenance of accounts and audit functions.

NISE is registered with Income Tax as well GST and complies with all the statutory provisions of both the Act. The statutory Auditor of NISE is appointed out of the panel of auditors provided by CAG. The annual accounts of the NISE for the FY 2020-21, duly audited by the Statutory Auditor, is being presented herewith.

S.M.SAINI & ASSOCIATES
Chartered Accountants

120, Mohyal Colony
B/H MMI School Sector-40, Gurgaon-122001
Ph.09310832563, 09868275687,01244276532
Email: info@smsaindia.in

Independent Auditor's report

Report on the Financial Statement

We have audited the accompanying financial statements of **NATIONAL INSTITUTE OF SOLAR ENERGY** ("The Institute"), which comprise the Balance Sheet as at 31st March 2021 and the statement of Income & Expenditure for the year then ended and a summary of significant policies and other explanatory information.

Management's responsibilities for the Financial Statement

The Management is responsible for the preparation of these financial statement 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. The responsibility also includes the maintenance of adequate accounting records in accordance with the provision of the act for safeguarding of the assets of the Institute and for preventing and detecting the frauds and other irregularities; selection and application of appropriates accounting policies; making judgment and estimates that are reasonable and prudent; and design, implementation and maintenance of internal financial control, 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 free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with the Standards on Auditing issued by ICAI. Those Standards require that we comply with ethical requirement and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedure to obtain audit evidence about the amount and disclosure in the financial statement. The procedures selected depend on the auditor's judgment, including the assessment of the risk of material misstatement of the financial statement, whether due to fraud or error. In making those risk assessments, the auditor considers internal financial control relevant to the Institute's preparation of the financial statements that give true and fair view in order to design audit procedure that are appropriates in the circumstance. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by Institute Director's as well as evaluating presentation of the financial statement.

We believe that the audit evidence we have obtained is sufficient and appropriates to provide a basis for our audit opinion on the financial statement.

S M SAINI & ASSOCIATES

PARTNER

S.M.SAINI & ASSOCIATES
Chartered Accountants

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B/H MMI School Sector-40, Gurgaon-122001
Ph.09310832563, 09868275687,01244276532
Email: info@smsaindia.in

Report on the 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 from. The details of such observation were provided to the management separately which they have noted for 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 accounts as required by law have been kept by the Institute so far as appears from our examination of those books.
   c) The Balance sheet and the Statement of Income & Expenditure dealt with by this Report agreement with the books of accounts.
   d) In our opinion, the 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 our 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 31,2021;
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 SM SAINI & ASSOCIATES
Chartered Accountants
FRN: - 014267N

S M SAINI & ASSOCIATES

(Laxmikant Saini) PARTNER
(Partner)
Membership No. 512056
Place : Gurugram
UDIN : 21512056AAAAAM8986
Dated: 07th October 2021

S.M.SAINI & ASSOCIATES
Chartered Accountants

120, Mohyal Colony
B/H MMI School Sector-40, Gurgaon-122001
Ph.09310832563, 09868275687,01244276532
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Annexure - A

Annexure to the Independent Audit Report on the financial statement of National Institute of Solar Energy for the FY 2020-21 as referred in the said report.

1. The following advance was found outstanding for more than three years.

Party Name	2019-20	2020-21
C- DAC	2,07,31,550.00	2,07,31,550.00

Management Remark:

i. The advance to C-DAC was given by the erstwhile Solar Energy Centre (MNRE) for works to be executed at Bangalore, Kolkata and NISE for different agencies. The Utilization Certificate is still awaited.
ii. No other capital advance is outstanding for more than 1 year except the above.

2. Grant not received: We found in some cases where total grant has not been received from concerned Ministry and UC has been submitted for the same.

S.No.	Name of Ministry	2019-20	2020-21	Reason of Outstanding	Related Period
1.	Ministry of External Affairs	12,56,895	--	--	--
2.	Ministry of New & Renewable Energy	85,20,940	82,85,606	Programmes conducted earlier and UC submitted. Balance grant is awaited	2017-18 & 2018-19

Management Remark:

Out of Rs. 82,85,606/- outstanding from MNRE, Rs. 22,68,000/- has been adjusted during the FY 2021-22. Matter is being taken up for balance Rs. 60,17,606/- which is expected to be adjusted during current financial year.

3. The Utilization Certificate in respect of advances released in earlier years to different State Nodal Agencies amounting Rs. 25,41,660/- has not been received. These advances are 2 to 3 years old.

Management Remarks:

The matter has been taken up with the State Nodal Agencies of Rajasthan, Punjab, Jharkhand & Odisa for full adjustment or refund of the amount. The adjustment from Jharkhand & Punjab amounting Rs. 12,70,500/- has been received during current year.

4. Advances to Staff: An amount of Rs.34,478/- is outstanding against advance to staff since 2016-17.

Management Remark:

Since this is an old case, the matter will be taken up for disposal/write off as per the delegation of power in the current financial year.

S M SAINI & ASSOCIATES

We are also at: Delhi, Jaipur & Rewari

PARTNER

S.M.SAINI & ASSOCIATES
Chartered Accountants

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5. No corresponding credit has been found in the form 26AS in respect of TDS deducted from the customers. The financial implication is of Rs. 4,24,437/-

Management Remark:

Rs. 3,81,519/- out of the above amount pertains to the deduction made by State Bank of India and balance from different customers. SBI is in the process of rectifying the same. The balance cases are also under process.

6. The Internal Audit has not been conducted for the year 2020-21. The same should be conducted by Management every year.

Management Remark:

Due to extended lockdown and Covid-19 condition, Internal Audit could not be conducted for the FY 2020-21. However the same will be conducted positively during FY 2021-22.

7. Advance of Rs. 20,54,52,547/- is appearing under ALMM scheme for which no revenue has been recognized during the Year.

Management Remark: Since majority of advance under ALMM scheme pertains to the parties located in foreign country, the inspection of their facilities could not be completed due to Covid restrictions on travelling. Hence the revenue has not been recognized.

For SM Saini & Associates
Chartered Accountants
FRN: 014267N

S M SAINI & ASSOCIATES
PARTNER

(Laxmikant Saini)
(Partner)
Membership No.512056
Place: Gurugram
UDIN : 21512056AAAAAM8986
Dated: 07th October 2021

NISE

NATIONAL INSTITUTE OF SOLAR ENERGY

(An Autonomus Institute of Ministry of New & Renewable Energy ,Govt.of India)
Gurgoan-Faridabad Road, Gwalpahari, Gurgaon, Haryana-122003

BALANCE SHEET AS AT 31ST MARCH 2021

CORPUS/CAPITAL FUND AND LIABILITIES	SCHEDULE	AS AT MARCH 31, 2021		AS AT MARCH 31, 2020	
		TOTAL		TOTAL	
Corpus/Capital Fund	1				
Gross Corpus/ Capital Fund		1,318,001,817		1,140,847,870	
Less : Accumulated Depreciation		337,260,763		250,343,184	
Net Corpus/ Capital Fund			980,741,054		890,504,686
Current Liabilities & Provisions	2	703,293,011	703,293,011	1,354,090,693	1,354,090,693
Total			**1,684,034,066**		**2,244,595,380**
ASSETS	SCHEDULE	AS AT MARCH 31, 2021		AS AT MARCH 31, 2020	
		TOTAL		TOTAL	
Fixed Assets	3				
Gross Block		1,014,915,552		920,832,895	
Less : Accumulated Depreciation		337,260,761		250,343,184	
Net Block			677,654,791		670,489,711
Current Assets, Loans & Advances	4	1006379274	1,006,379,274	1,574,105,667	1,574,105,667
Total			**1,684,034,066**		**2,244,595,380**
SIGNIFICANT ACCOUNTING POLICIES AND NOTES TO ACCOUNTS	11				

As per our Audit Report of even date
For SM SAINI & ASSOCIATES
Chartered Accountants
(FRN:014287N)

S M SAINI & ASSOCIATES

(Laxmikant Saini)
(Partner)
M. No.512056

PARTNER

Place: Gurugram
Dated:

National Institute of Solar Energy ★ Gurugram

For NATIONAL INSTITUTE OF SOLAR ENERGY

Dr. Chandan Banerjee
(Dy. Director General)

Sh. G Upadhyay
(Director General - IC)

NISE

NATIONAL INSTITUTE OF SOLAR ENERGY

(An Autonomus Institute of Ministry of New & Renewable Energy ,Govt.of India)
Gurgoan-Faridabad Road, Gwalpahari, Gurgaon, Haryana-122003

Amount in ₹

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH 2021

PARTICULARS	Schedule	2020-21	2019-20
		TOTAL	TOTAL
INCOME			
Receipts from Testing & Operations	5	116,700,699	60,897,189
Grants/Subsidies utilised for Revenue Expenditure	6	818,886,544	533,643,406
Interest Earned	7	7,595,793	3,765,166
Other Income		7,872,035	4,934,974
Interest Earned on Grant Account(Contra)		53,793,016	46,965,554
Depreciation (As per Contra)	3	86,917,578	83,352,080
Provison Written back (F.Y. 2019-20)		7,306,384	-
Total (A)		***1,099,072,048***	***733,558,369***
EXPENDITURE			
Establishment Expenses	8	43,228,674	33,859,901
Other Administrative Expenses	9	68,938,466	83,217,470
Operational Expenses	10	733,813,036	469,258,081
Interest Payable on Grant Accout (Contra)		53,793,016	46,965,554
Depreciation (As per Contra)	3	86,917,578	83,352,080
Total (B)		***986,690,770***	***716,653,086***
Net Surplus/(Deficit) for the year		112,381,278	16,905,283
Provision for Taxation (A.Y.2020-21)		8,256,606	-
Balance being Surplus/(Deficit) for the year transferred to General Reserve (A-B)		***104,124,672***	***16,905,283***
SIGNIFICANT ACCOUNTING POLICIES AND NOTES TO ACCOUNTS	11		

As per our Audit Report of even date
For SM SAINI & ASSOCIATES
Chartered Accountants
(FRN-014267N)

S M SAINI & ASSOCIATES

(Laxmikant Saini)
(Partner)
M. No.512056

Place: Gurugram
Dated:

PARTNER

National Institute of Solar Energy ★ Gurugram

For NATIONAL INSTITUTE OF SOLAR ENERGY

Dr. Chandan Banerjee
(Dy. Director General)

Sh. G Upadhyay
(Director General -IC)

NISE

NATIONAL INSTITUTE OF SOLAR ENERGY

(An Autonomus Institute of Ministry of New & Renewable Energy ,Govt.of India)
Gurgoan-Faridabad Road, Gwalpahari, Gurgaon, Haryana-122003

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2021

SCHEDULE 1- CORPUS/ CAPITAL FUND	AS AT MARCH 31, 2021	Total	AS AT MARCH 31, 2020	Total
General Reserve				
Balance as at the beginning of the year	118,839,070		101,933,787	
Add : Excess of income over expenditure during the year	104,124,672	222,963,742	16,905,283	118,839,070
Corpus Fund				
Balance of Grant Received from Govt. Non-Refundable				
Opening Balance(Refer Grant Sheet)	10,000,000		10,000,000	
Add: Amount received during the Year	-		-	
Closing Balance		10,000,000		10,000,000
Capital Reserve				
Grants adjusted against purchase of assets				
Opening Balance	505,415,071		390,740,796	
Add : Addition during the period	105,322,979		114,674,275	
Closing Balance		610,738,050		505,415,071
Capital Reserve for Building (SEC)	392,966,000	392,966,000	392,966,000	392,966,000
Grant utilised for advances given during the year				
Opening Balance	113,627,729		162,150,997	
Less : Net Adjusted during the Year	32,293,705		48,523,268	
Closing Balance		81,334,024		113,627,729
Total		**1,318,001,817**		**1,140,847,870**

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SCHEDULE 2- CURRENT LIABILITIES AND PROVISIONS	AS AT MARCH 31, 2021	Total	AS AT MARCH 31, 2020	Total
Current Liabilities				
Sundry Creditors				
- For goods and services	459,559		408,947	
- Creditors For Capital Goods	28,701,854		26,825,874	
- Creditors For Suryamitra Training Participants	3,694,194	32,855,607	-	27,234,820
Deposits				
- Earnest Money Deposit	1,975,700		3,925,896	
- Security Deposits	331,415		370,575	
- Deposit (SECI)	-		11,624,295	
- Deposit (Others)	1,306,577		133,454	
- Advance Received from Customers- ALMM	205,452,547		153,473,139	
- Advance Received from Customers	7,778,026	216,844,264	64,045,955	233,573,314
Statutory Liabilities				
- TDS Payable under Income Tax	9,663,973		2,021,540	
- GST Payable (Incl TDS under GST)	412,869	10,076,842	143,479	2,165,019
Other Current Liabilities				
- Salary & Remuneration Payable (Incl. National Pension Fund)	225,462		399,570	
- Interest refundable to Ministry	65,024,016		84,142,659	
- Advances received against trainning (ISA)	24,950,745		19,673,968	
- Advances received against GIZ Project	-		4,451,550	
- Other misc. liabilities	1,133,453	91,333,676	1,207,335	109,875,082
Balance of Grants Payable to Government of India	339,002,179	339,002,179	964,184,328	964,184,328
Provisions				
Provision for Expenses	1,701,106		13,835,397	
Provision for Income Tax	11,479,336	13,180,442	3,222,730	17,058,127
Total		**703,293,011**		**1,354,090,691**

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NATIONAL INSTITUTE OF SOLAR ENERGY

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Gurgoan-Faridabad Road, Gwalpahari, Gurgaon, Haryana-122003

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2021

SCHEDULE 3- FIXED ASSETS & DEPRECIATION — Amount in ₹

PARTICULARS	GROSS BLOCK					DEPRECIATION					NET BLOCK	
	As at 01.04.2020	Addition before 30.09.2020	Addition After 01.10.2020	Sales/ Adjustment during the year	As at 31.03.2021	As at 01.04.2020	Current Depreciation on K+C	Current Depreciation on D	Total Current Year Depreciation	Total Depreciation (G+H)	WDV as on 31.03.2021 (F-I)	WDV as on 31.03.2020
A	B	C	D	E	F		G	H		I	J	K
NATIONAL INSTITUTE OF SOLAR ENERGY												
Building-NISE	587,453,410	270,986	10,069,251	-	597,793,647	157,693,614	43,003,078	503,463	43,506,541	201,200,155	396,593,492	429,759,796
Desktop Computers	5,782,672	-	1,860,000	-	7,642,672	4,379,479	561,277	372,000	933,277	5,312,756	2,329,916	1,403,193
Printers and other IT Peripherals	33,233,908	1,303,680	681,960	-	35,219,548	8,206,210	3,949,707	51,147	4,000,854	12,207,064	23,012,484	25,027,698
Air Conditioner	2,253,436	-	241,556	-	2,494,992	1,069,248	177,628	18,117	195,745	1,264,993	1,229,999	1,184,188
Misc. Assets Guest House/ Office	22,432,187	58,000	-	-	22,490,187	9,843,569	1,896,993	-	1,896,993	11,740,562	10,749,625	12,588,618
Scientific & Laboratory Equipments	179,483,276	-	56,604,488	294,159	235,793,605	54,286,556	18,779,508	4,245,337	23,024,845	77,311,401	158,482,204	125,196,720
Vehicles	590,361	-	-	-	590,361	348,061	36,345	-	36,345	384,406	205,955	242,300
Furniture & Fixtures	5,292,073	-	9,491,069	-	14,783,142	1,310,076	398,200	474,553	872,753	2,182,829	12,600,313	3,981,997
Laptops	803,541	-	-	-	803,541	672,669	52,349	-	52,349	725,018	78,523	130,872
Other Assets (Training)	7,928,390	-	-	-	7,928,390	3,611,626	647,515	-	647,515	4,259,141	3,669,249	4,316,764
Softwares	3,957,846	269,698	2,222,942	-	6,450,486	3,556,200	268,537	444,588	713,126	4,269,326	2,181,160	401,646
500 KW Power Plant	69,761,662	-	-	-	69,761,662	5,232,125	9,679,431	-	9,679,431	14,911,555	54,850,107	64,529,537
Transformer	1,629,733	-	-	-	1,629,733	122,230	226,125	-	226,125	348,355	1,281,378	1,507,503
Assets under Solar Tower	-	-	9,621,150	-	9,621,150	-	-	721,586	721,586	721,586	8,899,564	-
Books/Standards and Periodicals	-	204,274	1,477,762	-	1,682,036	-	81,710	295,552	377,262	377,262	1,304,774	-
RO System	230,400	-		-	230,400	11,520	32,832	-	32,832	44,352	186,048	218,880
Total	920,832,895	2,106,638	92,270,178	294,159	1,014,915,552	250,343,183	79,791,234	7,126,343	86,917,578	337,260,761	677,654,791	670,489,712

Note: Adjustment (Rs. 294159/-) includes panelty deducted while releasing the balance payment in respect of Power Analyser and Tempreture controlled water bath system & Sun simulator.

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National Institute of Solar Energy Gurugram

SCHEDULE 4- CURRENT ASSETS, LOANS & ADVANCES	AS AT MARCH 31, 2021		AS AT MARCH 31, 2020	
		Total		Total
Current Assets				
Balance with Bank :				
-Saving & Current Accounts	26,867,399		149,469,888	
-Auto Sweep Account	405,713,718	432,581,116	1,058,080,848	1,207,550,735
Fixed Deposit:				
Fixed Deposits -Core & Project Grant)	67,806,582		89,513,288	
Fixed Deposits - Project Grant	28,486,458		12,127,046	
Fixed Deposits - Revenue	25,500,000		42,470,883	
Fixed Deposits - ALMM	258,000,000		-	144,111,217
Fixed Deposit- Corpus Fund	27,511,153	407,304,193	20,741,192	20,741,192
Sundry Debtors:				
Sundry Debtors	35,571,344	35,571,344	13,289,128	13,289,128
Inventory	-	-	6,783,030	6,783,030
Loan & Advances & other assets				
Advances and other amounts recoverable in cash or in kind or for value to be received				
- Advances for capital assets	77,306,763		108,270,935	
- Advances for trainning programs	17,017,293		17,853,742	
- Advance to Vendors	2,324,280		4,939,098	
- Balances with Staff (Incl Imprest Accounts)	149,497	96,797,833	412,002	131,475,777
Deposits				
- Security Deposits	278,485		310,965	
- GST (Input Credit and GST Paid on Advance)	12,483,066		15,296,144	
- TDS Recoverable	17,584,402		26,909,702	
- Advance Tax/Income Tax Refundable (F.Y. 2014-15 & 2015-16)	3,778,834	34,124,787	7,637,776	50,154,588
Total		**1,006,379,274**		**1,574,105,667**

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National Institute of Solar Energy ★ Gurugram

SHEDULES FORMING PART OF INCOME AND EXPENDITURE ACCOUNT AS AT 31ST MARCH 2021				
SHEDULE 5- RECEIPTS FROM TESTING AND OPERATIONS	2020-21		2019-20	
		Total		Total
Receipts from Testing				
- Testing of Solar Components	6,454,410	6,454,410	9,838,426	9,838,426
Receipts under ALMM				
- Application Fees	42,677,875		10,903,000	
- Inspection Fees	23,250,000	65,927,875	6,000,000	16,903,000
Other Operational Receipts				
- Receipts from Trainings and Seminars- For Domestic Participants	2,320,660		4,335,100	
-for International Participants	5,950,800		6,435,900	
- Administrative Charges	30,981,954		18,834,763	
- Consultancy Charges	5,065,000	44,318,414	4,550,000	34,155,763
Total		**116,700,699**		**60,897,189**

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SCHEDULE 6- GRANTS/SUBSIDIES (Irrevocable Grants & Subsidies Received)	2020-21		2019-20	
		Total		Total
Grants Received during the year-NISE(Core Grants)	130,000,000		130,000,000	
Less : Grant Refunded	3,000,000	127,000,000	-	130,000,000
Grants Received during the Year-NISE(Project Grants)	218,221,429		610,456,153	
Less : Grant Refunded	76,608,267		4,176,645	
Grant Unutilised brought forward from Previous Year-NISE	964,184,330	1,105,797,492	839,456,729	1,445,736,237
Grant Adjusted towards Revenue Expenditure :				
Current Year Expenditure-NISE	845,980,176		586,335,452	
Less : Expenses adjusted towards current year Revenue-NISE	25,392,526		38,856,649	
Less: Provision made against Revenue Expenditure	1,701,106		13,835,397	
	818,886,544		533,643,406	
Less: Expenses Adjusted against Previous Advances-NISE	21,610,705	797,275,839	29,454,081	504,189,325
Less : Grants utilised for purchase of Fixed Assets-NISE	59,787,139		39,001,313	
Less : Grants utilised for Advances against Capital Expenses	14,700,000		55,187,790	
Less : Grants utilised for Advances against projects	11,428,936		12,152,206	
Less: Grant Utilised for Advance agaist General Exp.-NISE	10,603,400	96,519,475	1,021,275	107,362,584
Grants Payable to Government of India		**339,002,179**		**964,184,328**

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National Institute of Solar Energy ★ Gurugram

SCHEDULE 7- OTHER INCOME	2020-21		2019-20	
Bank Interest	Credited in Revenue	Total	Credited in Revenue	Total
- Interest earned on Savings account-NISE	1,347,102		750,188	
- Interest earned on Auto Sweep account	2,024,860		119,529	
- Interest earned on F.D	1,959,944		2,738,568	
- Interest earned on Corpus Fund	1,372,931	6,704,837	156,881	3,765,166
Interest on Income Tax Refund	890,956	890,956	-	-
Miscellaneous Income				
- Guest House Charges	492,000		1,960,900	
- Other Income	1,039,337	1,531,337	2,589,654	4,550,554
Others (Solar Dryer Project)				
Supply of Solar Dryer Cum Space Heating System	74,350,998		4,800,000	
Add: Inventory of Solar Dryer System	-		6,783,030	
Less: Inventory of Solar Dryer System	6,783,030		-	
Less: Purchases of Solar Dryer Cum Space Heating System	61,227,270	6,340,698	11,198,610	384,420
Total		**15,467,828**		**8,700,140**

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SHEDULES FORMING PART OF INCOME AND EXPENDITURE ACCOUNT AS AT 31ST MARCH 2021

SCHEDULE 8- ESTABLISHMENT EXPENSES	2020-21					2019-20			
	Adjusted with grant	Adjusted against Advances	Provision for Expenses	Charged to Revenue	Total	Adjusted with Grant	Provision for Expenses	Charged to Revenue	Total
Consultancy Charges	1,520,000	-	224,840	10,386,106	12,130,946	3,139,568	-	16,560,661	19,700,229
Remuneration	30,935,728	-	-	162,000	31,097,728	14,159,672	-	-	14,159,672
Total	32,455,728	-	224,840	10,548,106	43,228,674	17,299,240	-	16,560,661	33,859,901

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SCHEDULE 9- OTHER ADMINISTRATIVE EXPENSES	2020-21					2019-20				
	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
Electricity / Fuel Expenses	5,702,858	-	520,070	-	6,222,928	4,505,133	-	2,000,000	1,536,945	8,042,078
Outsourcing Services	18,768,765	-	627,490	4,394,900	23,791,155	22,675,327	-	3,402,457	6,381,797	32,459,581
Security Services	9,329,555	-	-	2,422,057	11,751,612	14,933,641	-	-	-	14,933,641
Bad Debts	-	-	-	88,938	88,938	-	-	-	-	-
Miscellaneous Exp.	451,170	-	-	77,817	528,987	-	-	-	414,874	414,874
Office Expenses	375,590	-	4,012	520,238	899,840	769,833	24,748	-	-	794,581
Refreshment/Hospitality/Meetings	112,445	-	-	-	112,445	1,385,946	-	-	-	1,385,946
Legal & Professional Charges	1,040,732	-	218,271	113,745	1,372,748	2,139,364	2,235	176,405	4,000	2,322,004
Recruitment Expenses	-	-	-	-	-	-	-	-	2,424,193	2,424,193
Bank Charges	-	-	-	296,317	296,317	31,053	-	-	64,793	95,846
Gateway charges	-	-	-	129,915	129,915	-	-	-	188,090	188,090
Horticulture Expenses	-	-	-	778,530	778,530	87,254	-	-	-	87,254
Advertisement Expenses	-	1,254,047	-	-	1,254,047	-	-	-	-	-
Guest House Expenses	-	-	-	79,080	79,080	-	-	-	611,336	611,336
IT Expenses (Facilitation Charges)	473,372	2,468,915	-	-	2,942,287	1,852,750	-	1,765,100	-	3,617,850
Software Expenses	5,779,961	-	-	-	5,779,961	-	-	-	-	-
Testing/Accredation Charges	-	-	-	-	-	-	-	-	31,971	31,971
Seminars/Conferences/Training Programmes	13,200	-	-	1,172,187	1,185,387	-	-	-	941,276	941,276
Consumables/ Laboratory/Workshop Exp.	266,378	-	-	1,057,757	1,324,135	-	-	-	3,350,332	3,350,332
Electrical Consumables	127,934	-	-	-	127,934	-	-	-	-	-
Library Books & Periodicals	13,617	-	-	-	13,617	80,665	-	-	-	80,665
Postage , courier, Printing and Stationery	1,479,911	-	-	11,108	1,491,019	1,081,372	-	215,948	103,065	1,400,385
Interest & Penalty	7,351	-	-	53,163	60,514	4,070	-	-	226,494	230,564
Repairs & Maintenance Expenses (Building, Machinary & Computers)	686,115	-	49,549	382,161	1,117,825	1,161,576	-	270,986	330,669	1,763,231
Telephone & Lease line Expenses	3,638,491	-	28,590	1,442,779	5,109,860	1,806,387	-	179,666	176,265	2,162,318
Vehicle Running & Maintenance	75,094	-	-	-	75,094	225,395	-	-	-	225,395
Hiring of Vehicles Expenses	1,050,730	-	-	20,105	1,070,835	-	-	-	-	-
Tour / Travel & Transport	52,366	-	28,284	432,007	512,657	1,765,408	-	1,105,847	2,782,804	5,654,059
Tour / Travel & Transport-ALMM	-	-	-	742,069	742,069	-	-	-	-	-
Foreign Currency Fluctuations Expenses	78,731	-	-	-	78,731	-	-	-	-	-
Total	**49,524,366**	**3,722,962**	**1,476,266**	**14,214,872**	**68,938,466**	**54,505,174**	**26,983**	**9,116,409**	**19,568,904**	**83,217,470**

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SCHEDULE 10- OPERATIONAL EXPENSES	2020-21					2019-20				
	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
SERIIUS Project Expenses	-	-	-	-	-	-	30,355	-	-	30,355
Released to State Nodal Agencies for Skill Development	690,628,181	9,293,334	-	-	699,921,515	359,316,131	22,244,703	-	-	381,560,834
ITEC/SCAAP/TCS Columbo Training Programe (P11-TP MEA- ITEC)	1,934,944	-	-	-	1,934,944	21,962,473	-	4,718,988	2,727,085	29,408,546
Hydrogen Project Exp. (P02- Hydrogen)	8,091,747	-	-	-	8,091,747	1,030,567	-	-	-	1,030,567
MNRE-USAID T.A Program (P08- TP DISCOM ER)	-	-	-	-	-	10,957,089	2,913,840	-	-	13,870,929
Solar Powered Clean Drinking Project (P03-SDWP)	39,249	-	-	-	39,249	717,419	-	-	-	717,419
BHEL R&D Project (P01- PERC)	3,686,304	-	-	-	3,686,304	4,731,165	-	-	-	4,731,165
R & D Concentrated Solar Sunborn Project (P04-CONC. SOLAR)	-	-	-	-	-	4,607,759	-	-	-	4,607,759
Solar Radiation Calibration Lab (SRCL) (P05-SRRA)	2352584	-	-	-	2,352,584	3,730,638	100,000	-	-	3,830,638
Department of Science and Technology Project (P06- WPDST)	3908065	8,592,337	-	-	12,500,402	1,909,026	-	-	-	1,909,026
Department of Science and Technology Project (P06- WPDST-2)	500000	-	-	-	500,000					-
Solar Water Pumping System Project (P07-SWP)	4150596	-	-	-	4,150,596	1,695,131	-	-	-	1,695,131
Rooftop Grid Engineer Skill Development Project (P09 TP ROOFTOP)	-	2,072	-	-	2,072	9,310,342	3,958,200	-	-	13,268,542
GIZ Project Expenses	-	-	-	629,548	629,548	-	-	-	-	-
Varunmitra Skill Development Programme (P10- TP VARUNMITRA)	4,075	-	-	-	4,075	12,417,170	180,000	-	-	12,597,170
Total	**715,295,745**	**17,887,743**	**-**	**629,548**	**733,813,036**	**432,384,910**	**29,427,098**	**4,718,988**	**2,727,085**	**469,258,081**

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STATEMENT OF GRANTS FOR THE FINANCIAL YEAR 2020-21

PARTICULARS	Opening Balance 01.04.2020	Refund/Transfer during the year 2020-21		Receipt/Transfer during the year 2020-21		Utilization against advances 20-21	Utilization against Fixed Assets 20-21	Utilization against Revenue Expenses 20-21	Utilization against Admin Charges 20-21	Total Utilization 20-21	Closing Balance 20-21
National Institute of Solar Energy		Refund to Ministry	Transfer	Received in Bank	Received Through Transfer						
Grant for Creation of Capital Assets	1433337	-	-	45,000,000	-	14,700,000	29,993,381	-	-	44,693,381	1,739,956
Grant in aid- General	1701345	-	-	60,000,000	-	10,603,400	-	51,044,365	-	61,647,765	53,579
Grant in aid- Salaries	8952957	3,000,000	-	25,000,000	-	-	-	30,935,728	-	30,935,728	17,229
Grant for BHEL R&D Projects (P01- PERC)	26896304	-	-	25,000,000	-	1,748,751	20,991,347	3,686,304	-	26,426,402	25,469,902
Grant for Project Hydrogen (P02- Hydrogen)	76046829	-	-	-	-	-	-	2,896,122	5,195,625	8,091,747	67,955,082
Grant- Skill Development Programme	771009877	52,058,895	-	167,015,343	-	8,488,585	-	670,317,687	20,310,494	699,116,766	186,849,559
Grant for SERIIUS (Indo US Project)	469504	429,838	-	-	-	-	-	-	-	-	39,666
Grant- World Renewal Energy Muesum	26655548	-	-	-	-	-	-	-	-	-	26,655,548
Grant- Solar Powered clean drinking water project (P03-SDWP)	-317801	-	-	-	-	-	-	-	39,249	39,249	-357,050
Grant- Project Rooftop Grid Engineering (P09- TP ROOFTOP)	219000	219,000	-	-	-	-	-	-	-	-	-
Grant- R&D Concentrated Solar Project (P04- Conc. Solar)	23664414	23,664,414	-	-	-	-	-	-	-	-	-
Grant - Solar Radiaton Sensor Project (P05- SRRA)	1806754	-	-	-	-	-	-	2,174,931	177,653	2,352,584	-545,830
Grant - Varunmitra Skill Development Programme (P10- TP Varunmitra)	-2211507	-	-	2,003,653	211,929	-	-	-	4,075	4,075	-
Grant - Varunmitra Skill Development Programme (P10- TP Varunmitra-2)	-	-	-	5,981,004	-	-	-	-	-	-	5,981,004
Grant- International Training Programme (P11- TP MEA- ITEC)	2171064	-	236,120	-	-	-	-	1,934,944	-	1,934,944	-
Grant - Solar Pumpting Project (P07- SWPUMP)	21404869	-	-	-	-	-	8,802,411	3,150,596	1,000,000	12,953,007	8,451,862
Grant - Department of Science & Technology (P06- WPDST)	4281837	-	-	4,478,700	-	1,191,600	-	3,908,065	-	5,099,665	3,660,872
Grant - Department of Science & Technology (P06- WPDST-2)	-	-	-	13,530,800	-	-	-	-	500,000	500,000	13,030,800
Total Grant (Balance of Grant payable to Govt. of India)	964,184,330	79,372,147	236,120	348,009,500	211,929	36,732,336	59,787,139	770,048,742	27,227,096	893,795,313	339,002,179
Contributions for Corpus Fund											
NISE											
Contribution by IREDA	10,000,000	-	-	-		-	-	-		-	10,000,000
Total Grant Received from Govt. Non-Refundable	10,000,000	-	-	-		-	-	-		-	10,000,000

S M SAINI & ASSOCIATES

PARTNER

National Institute of Solar Energy ★ Gurugram

NATIONAL INSTITUTE OF SOLAR ENERGY

(An autonomous Institute of Ministry of New & Renewable Energy, Govt. of India)
Faridabad-Gurugram Road, Gwal Pahari, Gurgaon, Haryana-122003

SCHEDULE 11

SIGNIFICANT ACCOUNTING POLICIES AND NOTES TO ACCOUNTS FORMING INTEGRAL PART OF THE FINANCIAL STATEMENTS FOR THE F.Y. 2020-21.

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 and training 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 Grant in Aid (Capital) and hence, the charge of deprecation over the same is being recognized 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.

National Institute of Solar Energy ★ Gurugram

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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 Corus Fund as on 31.03.2021 is Rs. 275.11 lakhs (Previous year Rs.207.41 lakhs).

2. The guidelines for enlistment under "Approved Models and Manufactures of Solar Photovoltaic 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. 337260761/- (Current Year Rs. 86917578/-) 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 recognized in the Income & Expenditure account as a contra item.

4. The amount of interest earned on grants and payable to MNRE is Rs. 53793016/-(Previous Year Rs. 46965554/-) 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. Additions made during the F.Y. 2020-21 in Capital Reserve (Purchase of Assets) amounting to Rs. 105322979/- (Previous Year Rs.11,46,74,275/-).

7. The Income Tax Assessment for AY 2020-21 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.1701106/-(previous year Rs. 1,38,35,397/-).

9. An amount of Rs. 73,06,384/- 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. A letter of credit has been opened by SBI as under: -

Party Name	LC Value
M/s. JOEL ASIA PTE LTD., SINGAPORE	USD 351,000

11. The balances of sundry creditors and debtors are subject to confirmation.

12. Previous year figures have been regrouped and rearranged to make them comparable with those of current year.

National Institute of Solar Energy Gurugram

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NATIONAL INSTITUTE OF SOLAR ENERGY

(An Autonomus Institute of Ministry of New & Renewable Energy ,Govt.of India)
Gurgoan-Faridabad Road, Gwalpahari, Gurgaon, Haryana-122003

Amount in ₹

RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED ON 31ST MARCH 2021

RECEIPT	2020-21		PAYMENT	2020-21	
Opening Balance with Bank:		1,207,550,735	**Amount Refunded to MNRE**		163,666,535
Saving & Current Accounts	149,469,888		Grant in aid- Salaries	3,000,000	
Sweep Accounts	1,058,080,848		Grant- Project Rooftop Grid Engineering (P09- TP ROOFTOP)	219,000	
Grant Received		348,009,500	Grant- Skill Development Programme	52,058,895	
Core Grant	130,000,000		Grant- R&D Concentrated Solar Project (P04- Conc Solar)	23,664,414	
Projects Grants	218,009,500		Grant for SERIIUS (Indo US Project)	429,838	
Fixed Deposit Matured During the Year (Note- 1)		81,861,134	Interest on Grants Refunded	72,060,576	
Fixed Deposit (Core Grant)	5,907,496		Deposit- SECI	12,233,812	
Fixed Deposit (Project Grant)	20,248,715		**Salary of Regular Employee**		28,875,623
Fixed Deposit (Revenue)	43,471,111		Employee Provident Fund	12,214	
Fixed Deposit (SECI)	12,233,812		National Pension Fund	4,283,969	
Bank Interest Received (Note-2)		52,257,895	Directorate of Estate General Pool- Accomodation	503,842	
Interest on Revenue- Saving & Sweep	3,371,962		Donation to PM Cares Fund	106,595	
Interest on Grant- Saving	353,022		Salary Exps	23,969,003	
Interest on Grant- Sweep	48,532,911		**Duties & Taxes**		55,131,274
Guest House Charges		512,700	Goods and Service Tax	7,645,790	
Guest House Charges Booked	453,900		TDS	44,942,539	
Advance against Guest House charges	5,000		TDS Under GST	2,091,775	
Received against previous year Guest House charges	53,800		TDS liability of SEC	451,170	
Processing Fees		1,230,600	**Fixed Deposit made during the year**		317,486,458
Prosessing Fees Booked	1,225,000		Fixed Deposit (ALMM)	258,000,000	
Advance against Processing Fees	5,600		Fixed Deposit (Project Grant)	28,486,458	
Consultancy Fees		2,645,243	Fixed Deposit (Corpus Fund)	5,500,000	
Consultancy Fees Booked	1,486,658		Fixed Deposit (Revenue)	25,500,000	
Advance against Consultancy Fees	1,158,585		Earnest Money Deposit		2,160,196
Training Fees		2,377,033	Security Deposit		42,880
Training Fees Booked	2,306,853		**Payment to contractural Manpower**		22,054,231
Advance against Training Fees	70,180		**Projects Expenses**		656,377,322
ALMM		124,924,042	DST Project	3,693,154	
Inspection & Application Fees Booked	24,144,727		Suryamitra Skill Development	628,444,329	
Advance against Inspection & Application Fees	100,779,315		ISA Fellowship Programme	24,239,839	
Testing Fees		7,830,762	**Advance Against Projects**		1,191,600
Testing Fees Booked	7,532,450		DST Project	1,191,600	
Advance against testing fees	298,312		**Payment for Purchases of Capital Assets**		65,871,302
Refund From Income Tax		22,315,121	Capital Grant	18,181,853	
F Y 2016-17	3,869,857		BHEL R&D Project	21,968,108	
F Y 2017-18	10,164,120		Solar Water Pumping System Project (P07-SWP)	8,833,841	
F Y 2018-19	6,728,728		Payment to Tata Power	16,887,500	
Interest Received on TDS	1,552,416		**Advance Against Capital Assets**		
ISA Fellowship Programe		29,958,104	Executive Engineer CPWD		22,715,000
Assessment & Admin charges booked	3,754,858		**Payment to ISA**		3,199,323
Advance against fellowship program	26,203,246		GST Input Credit	1,608,409	
Ministry of External Affairs		14,516,971	Tax Deducted at Source (TDS)	1,372,006	
Income From International Training Fees	5,950,800		Refund of NFP Conclave Programe	218,908	
Advance against Training Fees	2,518,019		Refund of Testing Fees		659,916
Reimbursement of Training programme	6,048,152		Refund of Training Fees		380,750
Adjustments received from staff		254,030	Advances with Staff		2,728,502
Other Reciept		19,428	TDS Deducted by Bank		3,316,906
Earnest Money Deposit		170,000	Administrative Expenses		47,069,498
Security Deposit		36,200	Project Expenses		6,368,080
			Revenue Expenses		18,188,353
			Honorarium paid to external expert		861,336
			Purchases of Solar Dryer System		45,543,296
			Opening Balance with Bank:		
			Saving & Current Accounts	26,867,399	
			Sweep Accounts	405,713,718	432,581,117
Total		**1,896,469,498**			**1,896,469,498**

As per our Audit Report of even date
For SM SAINI & ASSOCIATES
Chartered Accountants
(FRN-014267N)

S M SAINI & ASSOCIATES

(Laxmikant Saini)
(Partner)
M. No.512056

PARTNER

National Institute of Solar Energy ★ Gurugram

For NATIONAL INSTITUTE OF SOLAR ENERGY

Dr. Chandan Banerjee
(Dy. Director General)

Sh. G Upadhyay
(Director General - IC)


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NATIONAL INSTITUTE OF SOLAR ENERGY

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

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