ANNUAL REPORT 2018-19

NISE

NATIONAL INSTITUTE OF SOLAR ENERGY

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

www.nise.res.in

NATIONAL INSTITUTE OF SOLAR ENERGY

GOVERNING COUNCIL

1.	Shri Anand Kumar, Secretary, Ministry of New and Renewable Energy (MNRE),	President (Ex- officio)
2.	Ms. Gargi Kaul, AS&FA,MNRE	Member (Ex- officio)
3.	Joint Secretary, Solar, MNRE	Member (Ex- officio)
4.	Managing Director, SECI	Member
5.	Director General, Central Power Research Institute (CPRI)	Member
6.	Director, Gujarat Energy Development Agency (GEDA)	Member
7.	Managing Director, Karnataka Renewable Energy Development Ltd. (KREDL)	Member
8.	Shri Ashish Khanna, Executive Director & Chief Executive Officer, TATA Power Solar System Ltd.	Member
9.	Shri Vineet Mittal, MD, Welspun Energy Ltd.	Member
10.	Dr. Arun K Tripathi, Director General, NISE	Member
11.	Dr. Rajesh Kumar, DDG/ Scientist 'F', NISE	Member
12.	Dr. Anil Kumar Saxena, Additional G.M., BHEL	Member
13.	Prof. Shireesh B. Kedare, IIT Bombay Dept. of Energy Science and Engineering	Member
14.	Dr. T. C. Kandpal, Professor IIT, Delhi	Member
15.	Dr. Pradip Datta, Professor, Department of Mechanical Engg., Indian Institute of Sciences, Bengaluru	Member
16.	Dr. Chandan Banerjee, DDG/Sci-F, NISE	Member, Secretary

Special Invitee

1. Representative nominated by Secretary, Department of Science & Technology (DST), New Delhi

EXECUTIVE COMMITTEE

1.	Dr. Arun K Tripathi, Director General NISE & Member Governing Council	Chairman
2.	Dr. Rajesh Kumar, DDG/ Scientist 'F', NISE& Member Governing Council	Member
3.	Dr. Chandan Banerjee, Scientist 'F', DDG (Fin), NISE & Member Secretary Governing Council	Member
4.	Er. Sanjay Kumar, Scientist 'F', DDG (Admn), NISE	Member

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National Institute of Solar Energy

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

CONTENT

OVERVIEW

Worldwide, India is playing a significant role towards green energy transition initiatives. India has 5th Global position for overall renewable energy capacity. India on its way to improve socio-economic structure has agreed towards decarbonisation. It has assigned a target of 40% of installed power generation capacity from clean energy sources. Considering its initiatives for enhancing its implementation, it was decided to deploy 175 GW of renewable energy installation by 2022. Furthermore, based on the analysis performed on the key indicators such as clean energy policies, power sector initiatives, emissions and installed capacities, etc., according to 2018 climatescope report, world's largest renewables auction market has positioned India as 2nd among other 103 countries around the world.

With such striking boon to electrify the power sector by renewable energy resources, Government of India has provided immense support to utilise its potential to maximum extent. For the past years, Indian Government has taken initiatives to introduce concept of solar parks, solar pump schemes, no interstate transmission charges and losses on renewables power, procurement of waste to energy plants, programme to train people for solar installations, etc. Considering the current scenario of progress for solar augmentation in this country, National Institute of Solar Energy (NISE) has played a crucial role along with Ministry of New and Renewable Energy (MNRE), Government of India. NISE has been assigned with solar photovoltaic technology consultancy projects, skill development programmes, research and development, development of rural community with deployment of solar products developed at NISE, developing and assisting in standard and certification, testing of solar components, etc.

In the Financial Year (FY) 2018-19, NISE has utilised its resources in a well-planned manner for its significant progress in renewable energy sector. NISE has made achievement in deployment of its developed products, the solar photovoltaic module testing lab of NISE is recognised in Bureau of Indian Standard (BIS) for PV Module Testing as Type 2, organised National/ International Training programmes with addition of several new training programmes. NISE has collaborated with various institutions, international agencies and government sectors for developing its expertise in solar energy. Conclusively, with right investments, NISE has persistently put in efforts for harnessing solar energy and has introduced newer technologies for sustainable growth of our country.

GOVERNING COUNCIL

Consequent upon the completion of the tenure of the first Governing Council (GC), the second Governing Council of NISE was constituted in January 2018 with the inclusion of members from industry, research institutions, Government departments and experts from the field of solar energy. In the FY 2018-19, two Governing Council meetings were held on 6th May 2018 (Sixth GC meeting) & 7th Dec 2018 (Seventh GC meeting).

FINANCE COMMITTEE

Two meetings of the Finance Committee (FC) of NISE were held on 26th July 2018 & 16th Oct 2018. The Audited accounts along with audited reports for 2017-18 were approved by the Finance Committee.

EXECUTIVE COMMITTEE

The Executive Committee (EC) takes the decisions related to administration, policy, finance and accounts

related matters and consider for the improvement of the overall functioning of NISE. The four Executive Committee (EC) meetings of NISE were held on the following days i.e. 03rd May 2018, 07th Aug 2018, 31st Dec 2018 and 01st Jan 2019 in the FY 2018-19.

SCIENTIFIC AND OTHER ACTIVITIES OF NISE

NISE acted as a catalyst for the forthcoming solar energy transition in India. The experts of NISE participated in various meetings of MNRE and provided the technical support. Accordingly, for the implementation, coordination, and development, the extensive actions were followed at NISE:

Solar Radiation Resource Assessment (SRRA)

Solar Radiation Calibration Laboratory (SRCL) of NISE has completed the calibration of 30 radiometers from 10 SRRA stations. Under the commercial calibration mode program, calibration of total 6 Pyranometer sensors received at SRCL facility from various private organizations was completed and calibration reports were issued. NISE, has been listed as a member of Baseline Solar Radiation Network (BSRN), a worldwide solar radiation network established under World Climate Research Program (WCRP) by World Meteorological Organisation (WMO). The SRRA station of NISE is listed as Station No. 56, with site specification as Plain terrain, Medium black soil. NISE has initiated a Solar Radiation Forecasting Activity for prediction of radiation data at different zone of India.

Solar Photovoltaic Technologies, Testing, Quality and Certification

During the year, solar photovoltaic laboratory facilities such as solar module testing, inverter, battery, advanced solar lighting, solar water pumping, electroluminescence testing, solar cell lab etc., were properly maintained at NISE. The Solar Module Testing facility is recognised by Bureau of Indian Standard (BIS) for PV Module Testing as Type 2 facility. In this FY 2018-19, the laboratory has upgraded its new facility. A total of 939 module samples were tested by the PVTF at NISE. The Solar Module lab was identified by the Task Working Group 2 (WG2) of IEC TS 82 for testing and data analysis of Light and Elevated Temperature Induced Degradation (LeTID) testing of PV module. The LeTID Test procedure proposed by NISE will be incorporated in IEC 61215 edition (to be published in the year 2019). The Electroluminescence lab tested 70 samples from different types of PV modules, 40 samples were tested for internal research purpose and 30 samples were tested for commercial purpose. The total revenue of Rs.97.15 Lakhs was generated by Solar Module Testing facility.

NISE has established facilities for testing and evaluation of solar inverters/ Power Conditioning Units (PCU) of capacity ranging up to 50 kVA. All types of PCUs, hybrid, standalone, grid-tied inverters (GI) and pump controllers are tested in this laboratory. A total of Rs.36.07 Lakhs revenue was generated by testing 29 power electronics samples.

During the year, the battery testing facility was preparing for NABL Accreditation. The battery testing lab provided a variety of battery testing services from small cell to a large battery pack system including technologies such as lead-acid, Li-ion (all salts), NiMH, NaS, and Ni-Cd. The testing services include performance parameters, reliability and endurance test on secondary battery technology. A total of 14 samples including Lead Acid and Li-ion battery samples were tested, thereby generating a revenue of Rs.10.70 Lakhs in the FY 2018-19.

In the FY 2018-19, a framework of policies and specifications for submersible 1.0 hp solar water pumps were formed by the solar water pumping facility at NISE. The testing rig provisions of solar water pumping facility were upgraded for testing of different types of water pumping systems. A new project entitled "Design and Development of High Efficiency Solar Water Pumping Systems" was sanctioned by MNRE. A total revenue of Rs.29.59 Lakhs was generated by testing 61 different types of pumps.

The Solar Photovoltaic Lighting System Laboratory was engaged in routine testing of solar based lighting system. During this year, this laboratory has inducted a new integrating sphere with temperature controlled system for testing the photometric and colorimetric performances at different temperature range. This lab has also developed a compact, efficient and cost effective MPPT based Solar Induction Controller. A total of 80 samples were tested and certified in this laboratory thereby generating a revenue of Rs. 32.89 Lakhs in the FY 2018-19.

The PVTF has prepared itself for NABL accreditation as per new standard IS/ISO/IEC 17025: 2017, new scope of services were also proposed to be included to the existing services of testing facility at NISE. Meanwhile, the Mobile Testing facility has performed commissioning tests and performance guarantee for the equipment installed in the Mobile laboratory.

Solar Thermal Technologies

During 2018-19, NISE has made serious efforts to revive operation of 1.0 MW Solar Thermal Power Plant. In this regard, a detailed report has been prepared and submitted by the team to MNRE for consideration. In the project 'Central Receiver Facility', an asset analysis was made by undertaking a thorough inspection for repair/ overhauling/refurbishment. The facilities concerning the solar thermal cooling system and the solar thermal desalination system continued to operate during the year with a view to reducing electricity consumption for air-conditioning in some of the rooms at Aditya Bhawan at NISE. The Solar Dish Sterling Engine was made operational in the NISE campus.

Solar Research and Development

NISE has continued its cooperation with IIT Bombay, National Renewable Energy Laboratory (NREL) and PTB Germany to conduct degradation analysis, study the performance and reliability of solar PV modules and quality inspection activities for its contribution in the solar industry in India. In the FY 2018-19, NISE has continued its development in various R&D projects such as PERC solar cells project, SWAJAL, clean drinking water, etc. The R&D Monitoring Committee has conducted a meeting for reviewing of the proposals of various R&D projects. A total of 16 projects were reviewed in this FY 2018-19 at NISE.

Figure 1.1 : Hon'ble Prime Minister of India, Shri Narendra Modi, and H.E. Secretary General of United Nations Mr Antonio Guterres inspecting SolDry unit at Vigyan Bhawan

Figure 1.2: Armed Forces Participants for five days skill development programme on "Renewable Energy Technologies"

The Research & Development activities of NISE were carried out in both solar photovoltaic and solar thermal divisions. In this FY 2018-19, the organisation has been working in research activities concerning to solar photovoltaic cells, water pumping systems, different solar technologies, etc. The developed innovative solar products were deployed in different locations according to the recommendations and requirements received at NISE. The in house installed system were maintained properly. **SolDry** has been successfully demonstrated to Hon'ble Prime Minister of India, Shri Narendra Modi and H.E. Secretary General of United Nations, Mr. Antonio Guterres during the inaugural ceremony of RE-INVEST 2018 at Vigyan Bhawan, New Delhi on 2nd Oct 2018, as shown in Figure 1.1.

Hydrogen Energy and Fuel Cell

Hydrogen Energy is an emerging clean and sustainable energy carrier due to its production from renewable energy resources and therefore recognising its importance as a clean fuel for the transport sector, a hydrogen production, storage and dispensing facility has been installed at NISE by utilizing the electricity generated by the solar photovoltaic system. This facility can be used for providing hydrogen fuel to Hydrogen-Diesel dual fuel vehicles running for the field trials at NISE. In the FY 2018-19, the Fuel Cell Laboratory of the institute were also demonstrated using bottled hydrogen.

Skill Development and Capacity Building

NISE has taken several initiatives towards skill development and capacity building activities. During the financial year 2018-19, 11,912 Suryamitras, 425 Varunmitra and 923 Rooftop Solar Grid Engineers were trained across different states for the development of skilled manpower in the field of solar photovoltaic system. NISE has implemented newly developed trainings programmes and have organised 26 National/ International training programs thereby imparting trainings to 717 number of solar professionals in various fields of Solar Energy. NISE have imparted trainings to wide variety of participants from Government Departments, Schools, Colleges, Armed Forces and Nodal agencies through short term training courses specifically devised according to the need of the participants. The participants of Armed Forces for five day skill development programme on renewable energy are shown in Figure 1.2.

In this FY 2018-19, NISE has also organised 10 International Trainings funded by Ministry of External Affairs (MEA) & International Solar Alliance (ISA), wherein, 255 participants from different countries were imparted trainings. Figure 1.3 shows the International Training

Figure 1.3 International Training participants from NISE visiting the exhibition at RE-INVEST 2018 in Greater Noida

participants from NISE visiting the stall of NISE in the exhibition at RE-INVEST 2018 in Greater Noida.

National/International Cooperation

NISE has signed MoU's with 7 national organisations i.e., Inficold, JMI, AMU etc. to work for the development of solar technologies by collaborating in R&D activities, training and business. During the year, the project work with PTB has entered into Phase- II activities. NISE under the sponsorship of ISA, has initiated a Mid-Career Professionals Programme "Master of Technology on Renewable Energy Technologies and Management" for ISA Member countries. In this programme, eligible professional working in the field of renewable energy are provided Fellowship under Solar Fellowship Scheme of ISA. A total of 22 participants have been nominated to this course being commenced with Centre of Energy Studies, IIT Delhi.

Other Initiatives

NISE has continued its consultancy services and provided consultancy on Detailed Project Report (DPR) preparation, vetting, performance evaluation, training etc. and generated a revenue of Rs.64.75/- (Lakhs). NISE has developed its infrastructure and facilities with the advancement of the library, IT system and automation of customer services and achieved 97.5 % customer satisfaction index during the year.

The library procured 35 books relating to the solar sector. NISE Library possess a very rich collection of 8250 volumes of books, bound volumes of Journals and other reading material, particularly on solar energy. The IT department of NISE has developed National Centralised Monitoring Centre (NCMC) for Data Acquisition Systems for Performance Monitoring of SPV Systems at various locations in India. Additionally, over 10 new web portals were created for NISE.

The scientists of NISE continued its research publications and reports on various sectors of solar energy. During 2018-19, 11 research papers were published in reputed international/national journals by the scientists of NISE. Besides, 3 papers were also published in the proceedings of national/international conferences/workshops. NISE has filed three patent applications for solar powered technologies.

INTRODUCTION

India has extended a robust performance on its changing energy mix, particularly in renewable energy capacity expansion. India's solar power capacity has gone up by five folds in the last three years. The progress of this sector is accredited due to major initiatives and the following monitoring comprehension such as: (i) pivotal role of government in adopting solar expansions, (ii) incentives and policies provided by the Government under National Solar Mission (NSM), (iii) MNRE Solar Park policy for acquiring land certainty, (iv) trained manpower in solar sector, (v) competitive price market, etc.

India's National Climate Action Plan under the Paris agreement has set a major goal to increase the share of non-fossil fuels to 40% of the total electricity generation capacity and to reduce the emission intensity of the economy by 33-35% by 2030 from 2005 level. Solar Energy contributes to a great extent to achieve this goal. The Indian Government with mandate for a fast ramping renewable energy sector, shall offer the advantages essentially, (i) attractive foreign and Indian investments, (ii) reduction in carbon footprints, (iii) increase access to energy especially to rural areas, (iv) cost savings, (v) reduction in coal power fired plant utilisation, etc.

In this phase of breakthrough in renewable energy sector, NISE as an autonomous institute under Ministry of New and Renewable Energy (MNRE), Government of India assists MNRE to achieve to become a low cost renewable power producing nation and accept the series of challenges intervened in amidst of implementation in the National Solar Mission (NSM). NISE is established in the solar energy sector through research and development, solar component testing and certification, capacity building, product development, quality, etc. NISE envisions to accelerate the proliferation of renewable energy sector by intently working together with 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; Research & Development; 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 Research and Development Projects on various aspects of solar energy technologies; and (ii) To act as an Apex Organization for initiating and coordinating the R&D in the field of Solar Energy and related areas such as testing, certification and standards, etc.

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 kms away from the nearest airport, 30 kms away from New Delhi Railway station and 25 kms away from MNRE. The institute has continuous connecting services such as buses, cabs and other convenient commuting facilities outside its premises.

The institute has a 200-acre campus which is registered as a society under 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, 1MW solar thermal power plant, 500 kW SPV power plants, 150kW solar rooftop etc. to harness the solar energy to the maximum extent. The campus area includes the energy efficient building known as Surya Bhawan with conference halls, seminar rooms, committee rooms, guest house, 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 authorization and bookings are made convenient through e-online library portal, easily accessible from 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 Surya Bhawan building in NISE.

The Aditya Bhawan of NISE is exclusively a technical block comprising of testing facilities laboratory, workshops, and R&D activity laboratories. NISE includes world-class, well-equipped testing facilities and R&D rooms spaced at Aditya Bhawan. The solar radiation data centers 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 at both buildings to serve them with delicious food. NISE campus has an SBI ATM at its main gate and offers amenities such as playing field, gyms, indoor games, yoga halls, etc. within the premises.

Figure 2.1: Surya Bhawan Building at NISE, Gurugram

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, Advanced Lighting System and to calibrate 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.

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 of the effectiveness of the Quality Management System as per International Standard ISO/IEC 17025:2005.

ORGANISATION STRUCTURE OF NISE

The affairs of NISE are managed by a Governing Council headed by Secretary, MNRE and an Executive Committee headed by Director General, NISE. An organization chart giving a broad set up of the structure and management of NISE is shown in Figure 2.2. The second Governing Council was constituted by Government of India, MNRE, on 15th January 2018, 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 Governing Council constitutes of members from industry, premier institution, MNRE, NISE and experts from reputed organisations. The Executive Committee has five members headed by DG, NISE to manage the day to day affairs of NISE and to take decisions on matters under the power delegated to it. During the period of report, three Executive Committee meetings were held under the chairmanship of DG, NISE. The Finance Committee of NISE has three members with Additional Secretary & Financial Advisor, MNRE as its chairman as Joint Secretary (Solar) and Director General, NISE as Members.

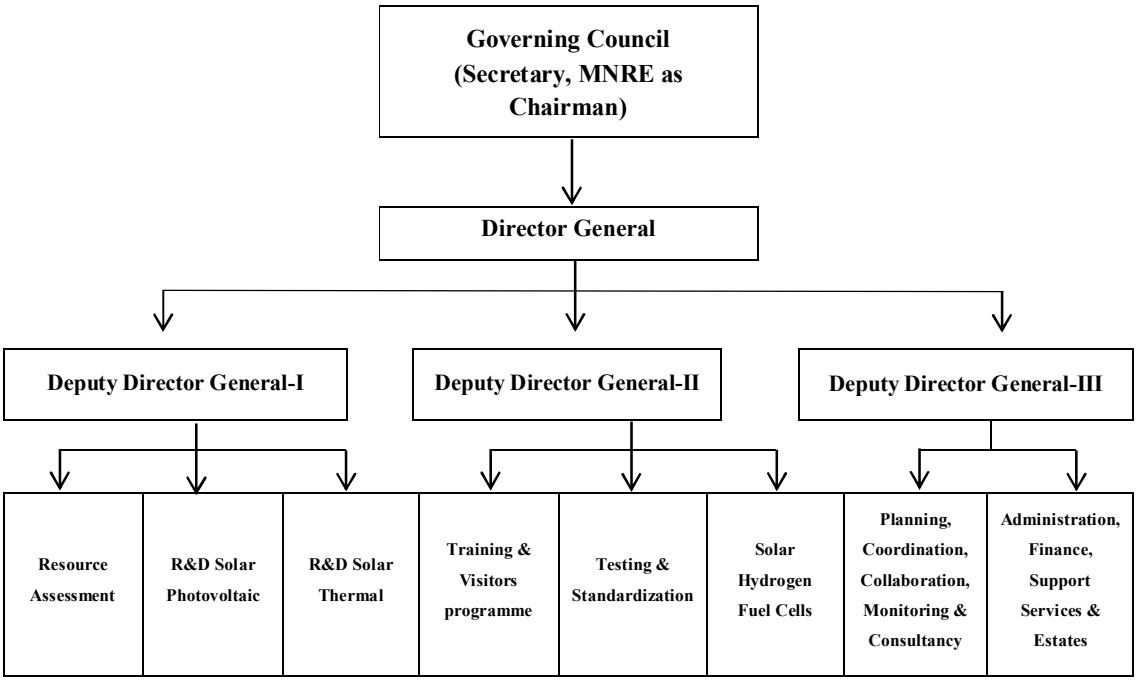

Figure 2.2: Organization Structure of NISE

THRUST AREAS

The basic function of NISE is to admittedly serve as a Technical Focal Point in Solar Energy related areas. NISE is committed to perform at its best in all spheres of its areas relating to Solar Energy and continually provide assistance and guidance in the solar energy related areas and maintain 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 of Solar Photovoltaic and Solar thermal
- 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 and
- Collaborations, Monitoring and Consultancy Services
- Development of Solar Energy Products & Hybrid System
- Solar 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.

MAJOR FUNCTIONS

The main functions of the Institute include:

i. Assisting the Ministry in implementing the Mission 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 of projects. The Institute will also consider the sector-specific R&D needs to commercialize 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/standardization 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 organizations to further R&D and related capacity building in the areas of solar energy and the related activities 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 fore sighting relating to solar energy and related technologies including storage techniques and provides inputs to the Ministry and the Mission Steering Group for the accelerated development of the indigenous solar energy technologies and industry in the country.

xi. The Institute also provides technical support to other R&D and testing organizations, 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, other Ministries/organizations 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 organizations for this purpose.

xvi. Any other tasks assigned by the Government from time to time.

NISE is conceived as a technical solar hub for all solar linked activities, standardization, designing, consultancy, and skill development programs. The institution is engaged in a focused manner to establish itself as one of the premier institutions in solar energy technology. The institution aims to address the gaps and work towards the National Solar Mission in the most significant procedure.

SOLAR RADIATION RESOURCE ASSESSMENT

India is a tropical country blessed with abundant solar energy, received throughout the year. The country has wide range of climatic conditions and varied topography, thus the mapping of the solar radiation data with accurate spatial resolution is an essential and stringent demand for establishment of an efficient and reliable solar energy system. The availability of high -quality ground solar radiation data determines the optimal design, characterization, performance analysis and financing of solar projects in India.

NISE as a part of Solar Radiation Resource Assessment initiative of MNRE has established one Advanced Monitoring Station (AMS) and one Solar Radiation Resource Assessment (SRRA) station for generation of high quality (1 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, Infrared radiation. The institute has ongoing R&D projects for research in solar radiation such as Calibration of solar radiometer of SRRA program of MNRE and forecasting of solar radiation. NISE has created its own data base and mapping of solar radiation and metrological data.

As a contribution to the Global initiative of Earth's climatic study programme, the SRRA Facility at NISE, has been listed as a member of Baseline Solar Radiation Network (BSRN), a worldwide solar radiation network established under World Climate Research Program (WCRP) by World Meteorological Organisation (WMO). The SRRA station of NISE is listed as Station No. 56, with site specification as Plain terrain, Medium black soil. The BSRN network establishment was aimed at detecting the important changes in the Earth's solar radiation field at the Earth's surface which may be related to climate changes and currently maintains 64 stations in contrasting climatic zones of the world. In the FY 2018-19, data from SRRA facility at NISE is continuously added to BSRN Database.

PERFROMANCE ASSESEMENT OF SOLAR RADIATION STATION DATA AT NISE

The SRRA Facility at NISE, measures and monitors all the components of solar radiation and metrological data at every 1 minute. The Table 3.1 shows the parameters measured via different sensors and its measurement type and resolution respectively.

Table 3.1: Status of Parameter Assessment at Solar Radiation Station in NISE

S. No.	Parameter Name	Sensor	Measurement Type	Measurement Resolution
1	Global Horizontal Solar Irradiance-GHI (W/m^2)	Pyranometer	Basic Solar Radiation Components	1 Min
2	Diffuse Horizontal Solar Irradiance- DHI (W/m^2)	Pyranometer		1 Min
3	Direct Normal Solar Irradiance- DNI (W/m^2)	Pyrheliometer		1 Min
4	Ambient Temperature (°C)	Ambient Temp & RH Sensor	Meteorological Measurement	1 Min
5	Relative Humidity (%)			1 Min
6	Wind Speed (m/s)	Anemometer		1 Min
7	Wind Direction (°)			1 Min
8	Spectral DNI (10 Discrete Wavelength) ($W/m^2/nm$)	Sunphotometer	Advanced Solar Radiation Measurement	1 Min
9	Longwave Radiation (Infrared Radiation) (W/m^2)	Pyrgeometer		1 Min
10	Ground Reflected Radiation (W/m^2)	Albedometer		1 Min
11	Atmospheric Visibility (Km)	Scatterometer		1 Min

The quality of Solar Radiation Data recorded at NISE are shown in Figures 3.1 & 3.2. The Monthly and Hourly Solar Radiation Distribution received during the year is depicted as variation in the Global, Direct and Diffuse Radiation for the various months in the year.

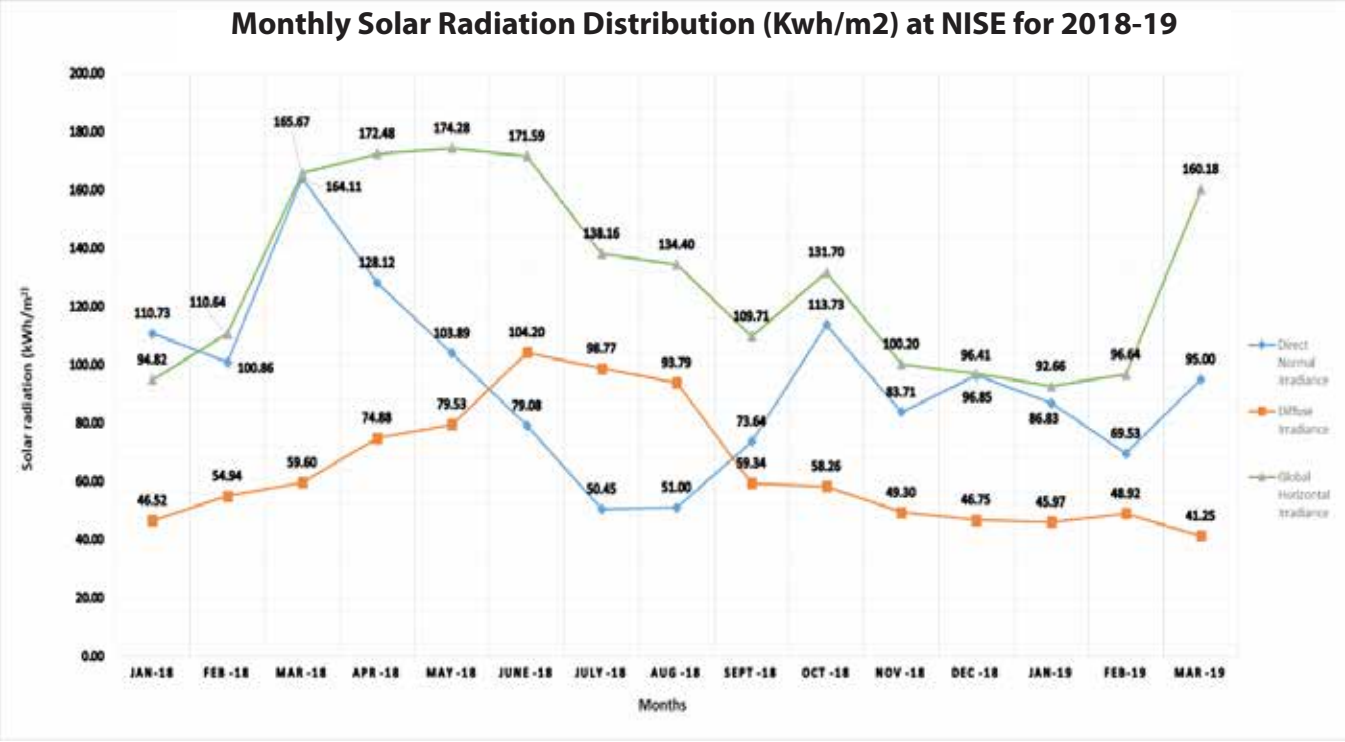

Figure 3.1: Monthly Solar Radiation Distribution at NISE

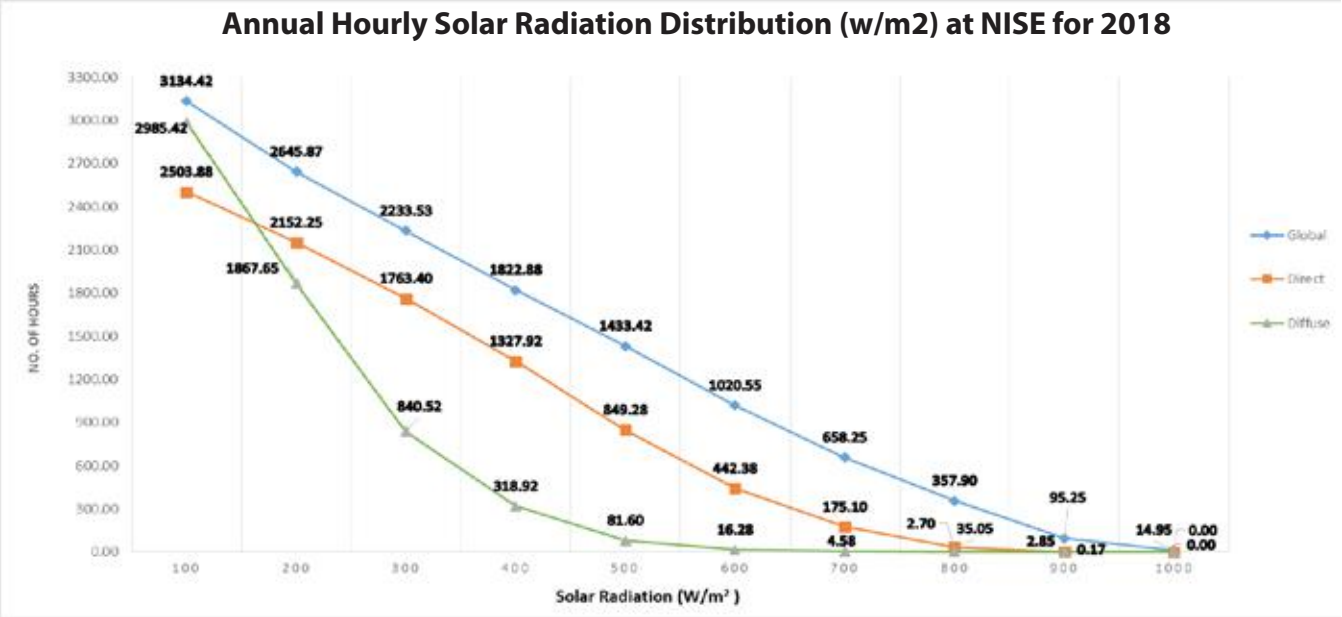

Figure 3.2: Hourly Solar Radiation Distribution at NISE

In addition, it also measures the Metrological parameter distribution available at NISE station such as Ambient Temperature, Relative Humidity and Wind Speed. Figure 3.3, 3.4 and 3.5 shows the metrological parameters recorded during sunshine period at NISE SRRA station.

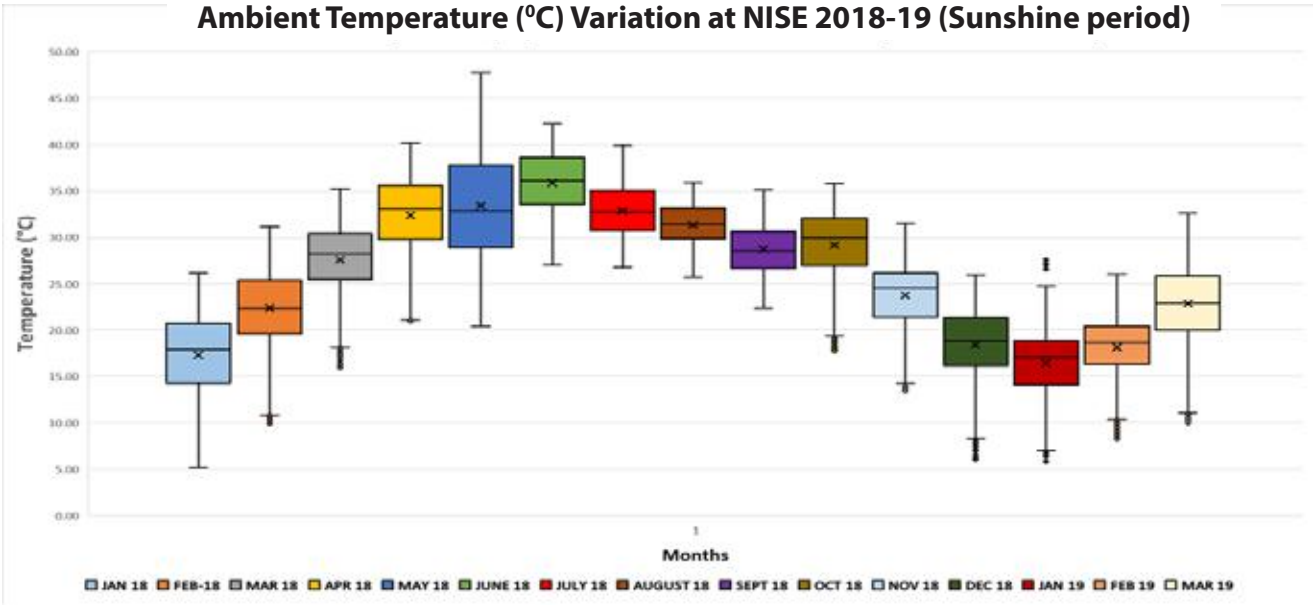

Figure 3.3: Ambient Temperature Variation recorded at NISE SRRA Station

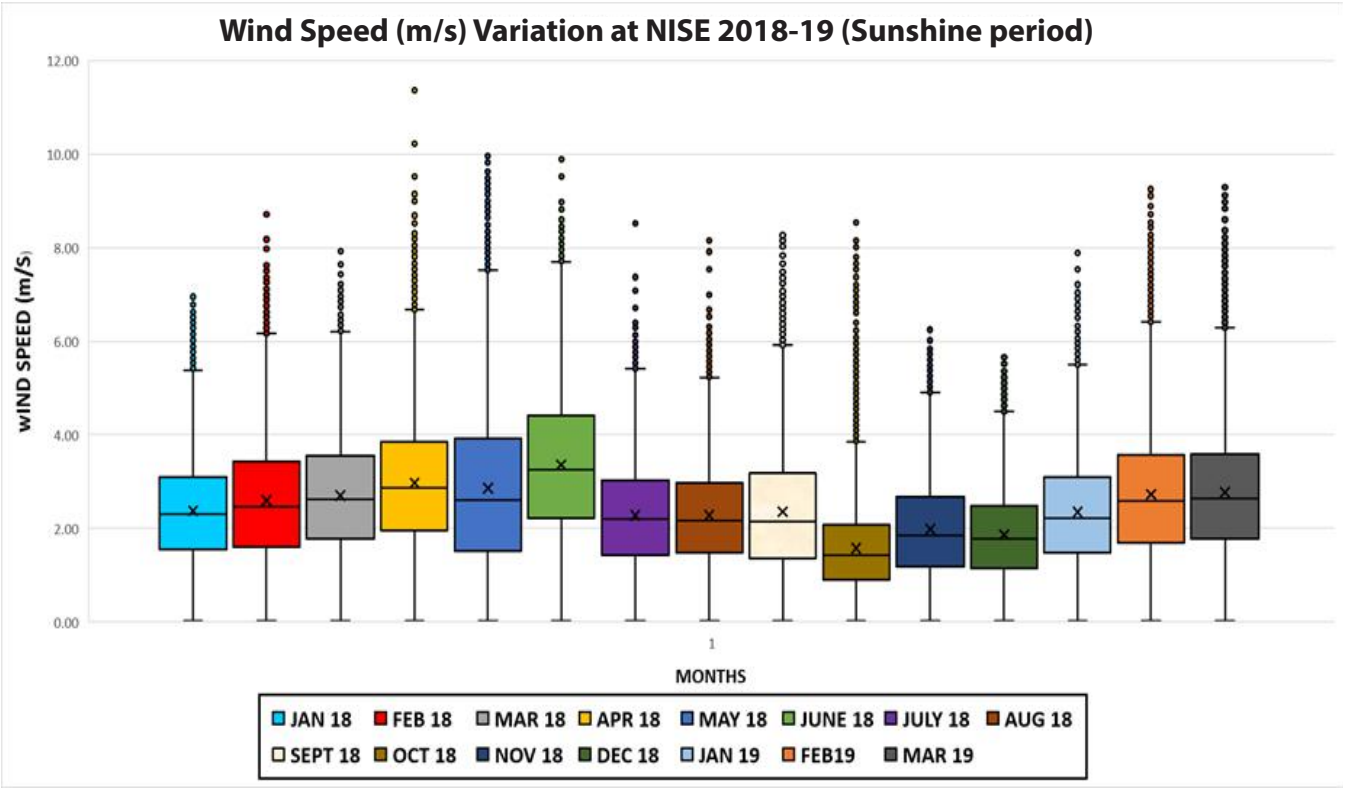

Figure 3.4: Wind Speed Variation recorded at NISE SRRA Station

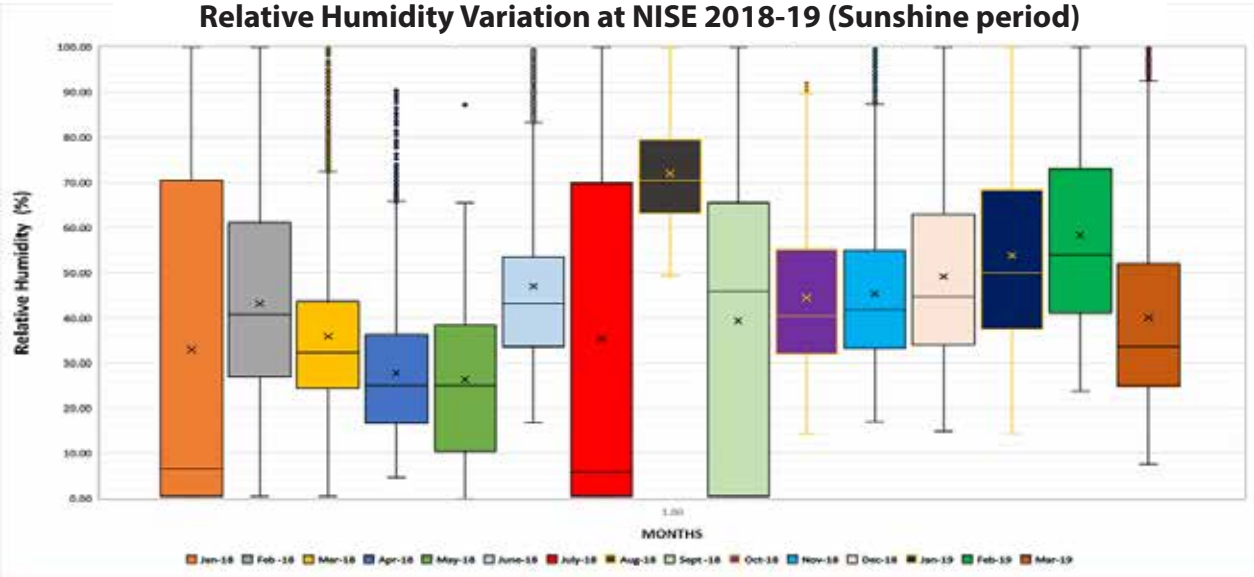

Figure 3.5: Relative Humidity Variation recorded at NISE SRRA Station

SOLAR RADIATION CALIBRATION LABORATORY

NISE has successfully implemented the MNRE sanctioned R&D project for Calibration of Solar radiometers to ensure the reliable and quality data generation from Solar Radiation Resource Assessment (SRRA) of MNRE. The Solar Radiation Calibration Laboratory (SRCL) is established following the WMO guidelines where calibration is performed as per the International standards (ISO). SRCL has Primary Standard sensor/Absolute Cavity Radiometer (Highest solar radiation standard) and number of Secondary standard reference sensors for achieving precise radiometric calibration are traceable to World Radiometric Reference (WRR) scale. In addition, the facility also caters the calibration need of private organizations in the country under its commercial mode program.

Calibration Status of SRRA Stations

The Solar Radiation Calibration Laboratory (SRCL) has completed the calibration of 30 sensors from 10 SRRA station at the established calibration facility at NISE. The details of different SRRA stations and calibration status is given in Table 3.2.

Table 3.2: Calibration Status of SRRA Stations

S.No	SRRA Station	State	Pyranometer	Pyrheliometer	Total
1	Pasighat	Arunachal Pradesh	02	01	03
2	Itanagar	Arunachal Pradesh	02	01	03
3	Gorakhpur	Uttar Pradesh	02	01	03
4	Sultanpur	Uttar Pradesh	02	01	03
5	Kanpur	Uttar Pradesh	02	01	03
6	Banda	Uttar Pradesh	02	01	03
7	Moradabad	Uttar Pradesh	02	01	03
8	Nainital	Himachal Pradesh	02	01	03
9	Aurangabad	Bihar	02	01	03
10	Ambikapur	Chhattisgarh	02	01	03
11	Imphal	Manipur	Under Calibration		
12	Kohima	Nagaland			
		Total	**20**	**10**	**30**

Calibration of Radiometers under Commercial Mode

NISE extends the calibration services to any Organization /Institute in the country at applicable calibration charges. A total of 6 Pyranometer were calibrated during 2018 -2019.

SOLAR RADIATION FORECASTING ACTIVITIES

Solar Radiation Forecasting is a challenge caused by intermittent solar radiation, but for the acquisition of reliable solar system performance and utilization of solar energy, prediction of radiation data is an essential requirement of the country. During the year, NISE has initiated the Solar Irradiance Forecasting. The facility has established a parallel computing cluster arrangement for prediction of radiation data. The forecasting model has been developed at NISE and it is further tested and validated with 9 SRRA stations in India. These SRRA station are distributed and selected in such a way that the different region mapping may be predicted and validated. Figure 3.6 shows the region selected for forecasting.

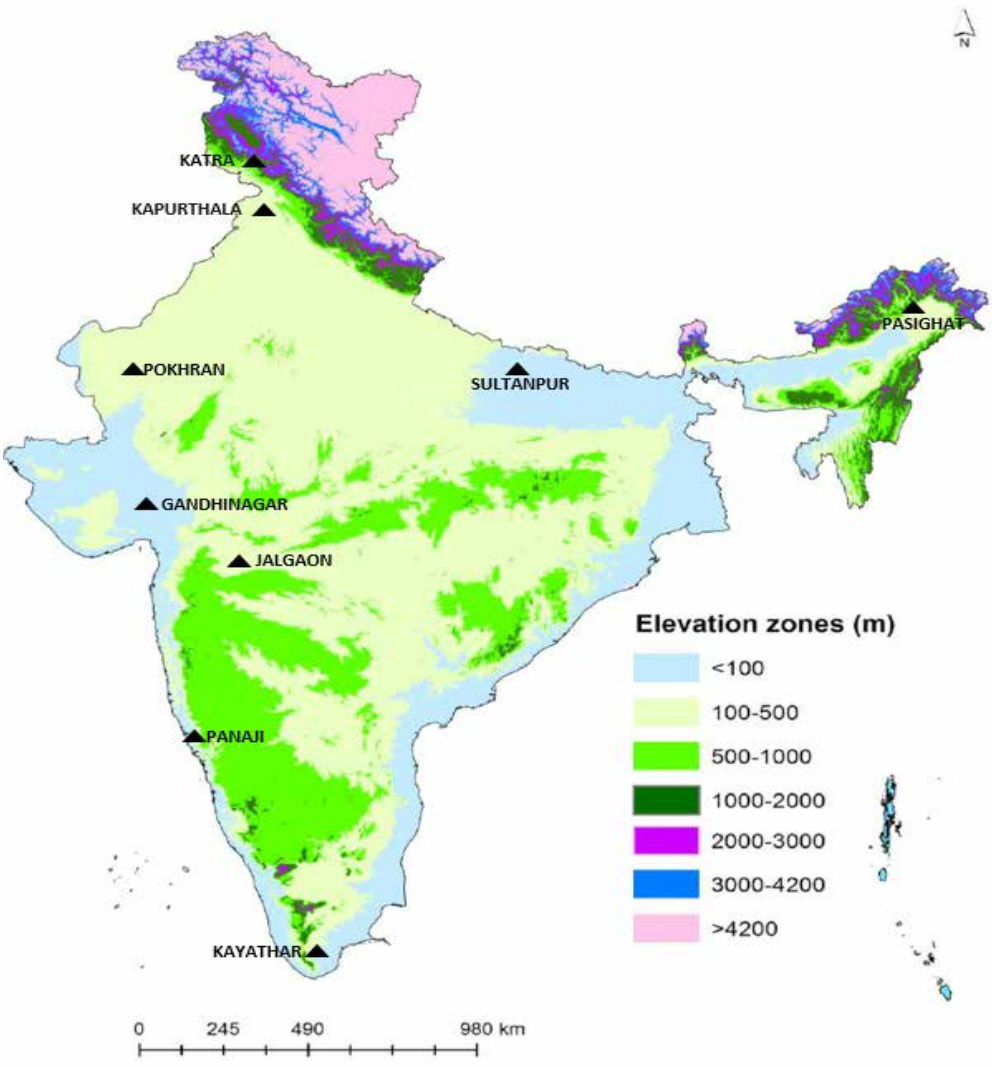

Figure 3.6: Region Selected for Forecasting

The study has shown that the results are promising. The prediction data obtained from the model matches with ground data and hence validate the forecasting. The GHI Mapping under forecasting experiment is shown in Figure 3.7. The forecasting of one of the station (Jalgaon Station) is shown in Figure 3.8. The analysis shows that the GHI Model data is related and almost similar with the GHI ground Data of Jalgaon Station.

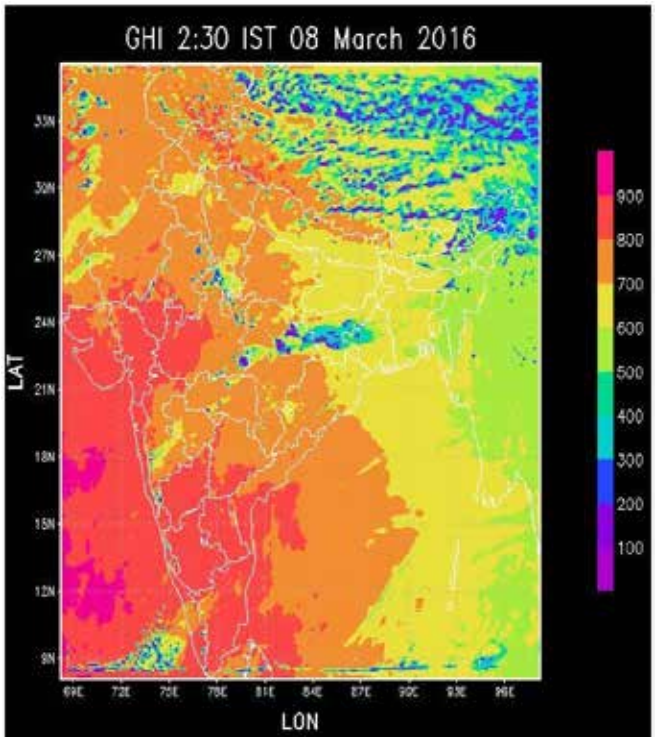

Figure 3.7: GHI Map prepared under Forecasting Experiment

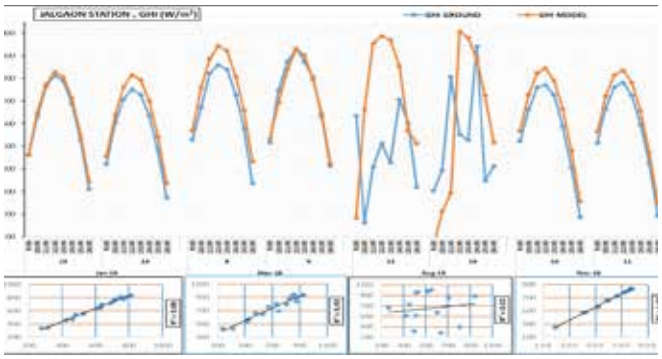

Figure 3.8: Jalgaon Station Forecasting Results

The improvements and developments are made to optimise the forecasting model. The SRRA team is engaged in upgradation of parallel computing facility so as to see the feasibility of accessing the real time data more accurately.

UPCOMING ACTIVITIES

NISE is initiating a proposal for the establishment of Indoor Calibration and Characterization facility for Solar Radiometers in collation with PTB, Germany. NISE will prepare for the integration of SRRA facility at Aditya Bhawan and Solar Radiometer calibration facility at Surya Bhawan and its relocation. It is proposed for the Calibration of Solar Radiometers from SRRA stations at Eastern, North Eastern Regions of the country at the calibration laboratory facility. NISE is in the process of setting up an operational solar power forecasting facility. The team shall look forward for working on real time data assimilation techniques, which will be very helpful for Now-casting purpose.

SOLAR PHOTOVOLTAIC TECHNOLOGIES, TESTING, QUALITY & CERTIFICATION

INTRODUCTION

Around the globe, the quality and performance of standards, demonstrating the robust long term yield of systems under an abreast changes of climate is a perquisite for the reliability of the system and in order to flourish in the competitive solar sector, it is equally important that the performance characterisation according to the set parameters are delivered to the customers as per the required parameter yield. NISE, with an ISO 17025 accredited laboratory, performs testing and certification of solar PV systems following the National/International Standards. NISE ensures that the manufacturers and retailers products are established with quality and performance standards. NISE has an ISO certified laboratory with proper testing protocols (National/International standards) for clarity of procedures and methodology. Also, it has a comprehensive network of testing of solar PV systems along with NABL accredited laboratories for developing standards and up gradation of testing facilities with new developments in the market. NISE is looking ahead to maintain laboratory management and information system. During the year, NISE has tested and certified, 1133 samples comprising of different solar PV technologies.

PHOTOVOLTAIC TESTING FACILITY (PVTF)

The Photovoltaic Module Testing Facility at NISE has National Accreditation Board for Testing & Calibration Laboratories (NABL) accredited laboratory as per ISO/IEC 17025:2005 standard for Qualification Testing and Customised Testing as per customer requirements. This facility is recognised by Bureau of Indian Standard (BIS) for PV Module Testing as Type 2 category facility. The laboratory is well equipped with facilities for testing as per IEC/IS standards as given below:

1. IEC 61215: 2016/ BIS 14286: Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1: Test requirements; Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 2: Test procedures.
2. IEC 61701: 2011: Salt mist corrosion testing of photovoltaic (PV) modules
3. IEC 61730-1, 61730-2: 2016 (partial, accreditation process going on): Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction; Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing
4. IEC 61853-part I: 2011/IS 16170: Part 1 (accreditation process going on): Photovoltaic (PV) module performance testing and energy rating - Part 1: Irradiance and temperature performance measurements and power rating
5. IEC TS 62804: 2015/MNRE specifications (accreditation process going on): Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation - Part 1: Crystalline silicon

In this FY 2018-19, the laboratory has upgraded its facilities with addition of following equipment and system, i.e. (i) UV Chamber, (ii) Leakage current measurement setup for Potential Induced Degradation (PID) testing, (iii) Torque screw driver, (iv)

Nominal Module Operating Temperature (NMOT) set up. A total of 939 module samples were tested by the PVTF at NISE.

The in-house activities of PV facility at NISE, has always extended its efforts for maintaining the quality management system of laboratory testing services. Considering to this attempt put forth by the management system, the lab was identified by the Task Working Group 2 (WG2) of IEC TS 82 for testing and data analysis of Light and elevated temperature induced degradation (LeTID) testing of PV module. This study was conducted to evaluate the LeTID Test procedure and was proposed to be incorporated in IEC 61215 edition (to be published in the year 2019). Currently, this IEC 61215:2019 is in Committee Draft (CD) stage and it will go for CDV (Committee draft for vote) after evaluation of the procedure.

Forthcoming, the PV facility at NISE has the following activities for further enhancement of laboratory as given below:

1. Full testing set up for IEC 61730-1,61730-2 (including fire tests): Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction; Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing
2. IEC 62716: 2013: Photovoltaic (PV) modules - Ammonia corrosion testing
3. IEC 61853-2: Photovoltaic (PV) module performance testing and energy rating - Part 2: Spectral Responsivity, incidence angle and module operating temperature measurements
4. IEC TS 62782:2016: Photovoltaic (PV) modules - Cyclic (dynamic) mechanical load testing
5. A new salt mist testing chamber

ELECTROLUMINESCENCE (EL) TESTING & CHARACTERIZATION

The lifetime performance of a module is an extremely important criterion for predicting the cause of degradation of a solar photovoltaic modules. The Electroluminescence (EL) imaging at NISE is a non-destructive technique for conducting such analysis on degradation of PV Modules. The EL facility at NISE follows DIN IEC 60904-13:2016 standard. It enables in identifying the defects which are sensitive to the Solar PV Modules. The characterisation of PV Modules are conducted while applying a current to a modules and collecting the emitted radiation from the module. The EL image shows inhomogeneities, microcracks, defects on electrical interconnections and even Potential Induced Degradation (PID) effects on the cells. The EL image of defects on CIGS Module is shown in Figure 4.1.

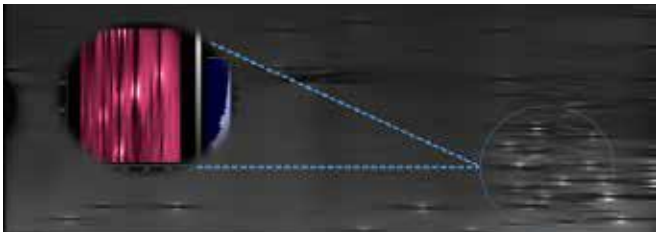

Figure 4.1: EL image of CIGS Module

During the financial year 2018-19, EL lab tested 70 samples from different types of PV modules. Additionally, 40 samples were tested for internal users and 30 samples were tested for commercial purpose.

POWER ELECTRONICS LABORATORY

Figure 4.2: Power Electronics Laboratory setup

The Power Electronics Laboratory at NISE conducts testing of Solar Inverters as per Indian conditions. It provides testing and certifications for all types of PCUs, hybrid, standalone, Grid-tied inverters (GI) and pump controllers. During the year, NISE has up graded its facilities for testing and evaluation of Solar Inverters/ power conditioning Units (PCU) for a capacity ranging up to 100 kVA. Figure 4.2 shows the testing facility of power electronics laboratory at NISE. In the FY, a total of 29 samples were tested as per International standards and MNRE specifications.

BATTERY TEST & CHARACTERIZATION

The Battery Test and Characterization Laboratory at NISE is recognized by Bureau of Indian Standards (BIS), for IS 16270:2014- Secondary Cells and Batteries for Solar Photovoltaic Application General - Requirements and Methods of Test services. This laboratory tests the battery technologies as given in Figure 4.3.

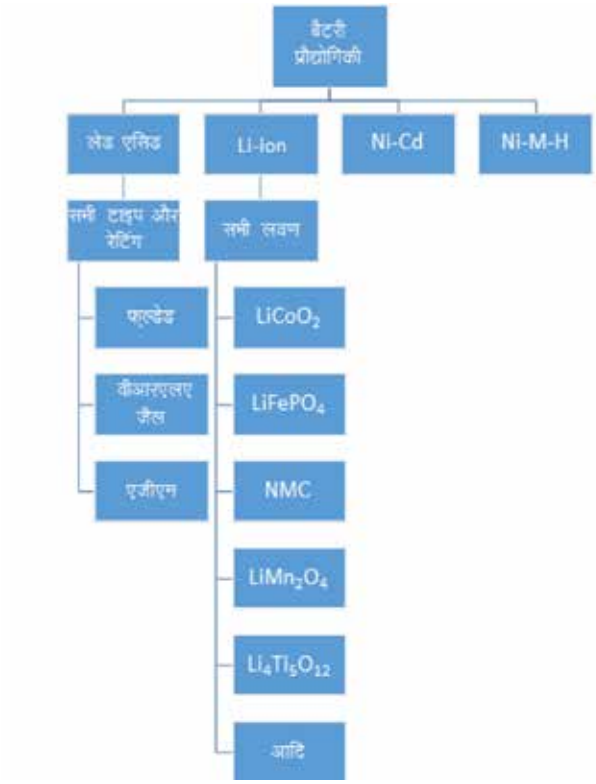

Figure 4.3: Different types of Secondary batteries serviced for Testing and Certification

The laboratory also follows different National/ International Standards for variety of secondary batteries, these batteries are operated with broad range of climatic chambers and water thermal bath for a broader range of temperature control and detailed parameter analysis. During the FY, the laboratory was preparing for NABL accreditation. A total of 14 battery samples were tested and certified at NISE during the year.

SOLAR WATER PUMPING TEST FACILITY

The Solar Water Pump Testing Set-up in NISE has the facility for testing of 0.5 hp to 10 hp solar water pumps. The test rig have 8 slots (6 slots for submersible AC pumps, 1 slot for submersible DC pump and 1 slot for surface AC/DC pump) for testing as per MNRE specification. During the year, the testing rig provisions were enhanced for increasing the testing facility. In the FY 2018-19, 61 samples for different types of pumps were tested. In addition to the routine testing, the solar pump testing laboratory have initiated its work on a project entitled "Design and Development of High Efficiency Solar Water Pumping Systems" and has devised a framework of policies and specifications for submersible 1.0 hp solar water pumps.

ADVANCED SPV SYSTEM & LIGHTINING LABORATORY

TheSolarPhotovoltaic(SPV)LightingSystemLaboratory is engaged in performance testing and reliability of off-grid system. The laboratory follows the following standards and comply with the system performance parameters, (i) IESNA LM-78-07 (IESNA Approved Method for Total Luminous Flux Measurement of Lamps Using an Integrating Sphere Photometer), (ii) IES LM-79-08/ IS 16106:2012 (Method of Electrical and Photometric Measurements of Solid State Lighting (LED) 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 Luminaires and LED Modules), (v) IES TM-30-15 (Method for Evaluating Light Source Color Rendition), (vi) ANSI C78.377-2017 (Electric Lamps—Specifications for the Chromaticity of Solid State Lighting (SSL) Products), (vii) Flicker test as per IESNA and IEEE recommendations, (viii) Horticultural lighting performance reporting computing PPF, PRF, and Photon Efficiency.

In the year 2018-19, lighting system laboratory has inducted new Integrating Sphere with temperature controlled system. This system is designed specifically to test photometric and colorimetric performance over a broad dynamic range of temperatures per IES LM-82 and LM-79 recommended practices. The performance characteristics of a luminaire or fixture at various temperatures, can be modelled with the expected light output. Figure 4.4 shows the Integrating Sphere with Temperature Controlled System. During the year, 80 samples were tested comprising of different system such as home light system, solar power packs, charge controllers, etc.

Figure 4.4: Integrating Sphere with Temperature Controlled System

SPV Lighting System Laboratory of NISE in collaboration with the company M/s. Ruchi Telecom Pvt Ltd developed a compact, efficient and cost effective MPPT based Solar Induction Controller (Figure 4.5) to run standard induction cooker for normal house of having 4 – 5 family members. The Solar Induction Controller has been developed with vision to convert the conventional AC Induction cooking system with solar energy, to empower women in rural area by providing cost effective, zero emission cooking technology, and to reduce the injuries from open flames of cooking fire.

Figure 4.5: Solar Induction Controller

The Solar Cooking system consists of solar induction controller which is connected with Solar battery, solar PV module and conventional induction stove. Figure 4.6 shows the block diagram of Induction Cooker components. Presently, SPV Lighting System Laboratory is involved in developing the testing methods for solar PV based cooking systems according to International standards (Figure 4.7)

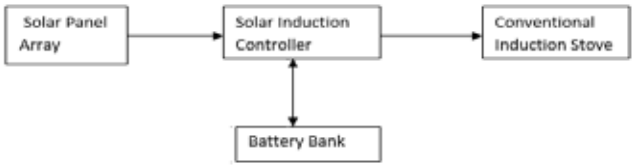

Figure 4.6: Block diagram of Induction Cooker

The solar induction IOT based controller can be made to monitor system performance and artificial intelligence for managing different available power and utilization of resources with self-learning.

Figure 4.7: Testing of Solar Induction Controller

SOLAR CELL CHARACTERIZATION AND OUTDOOR MODULE TESTING FACILITY

The Solar Cell Characterisation laboratory has an ORIEL's class AAA "SUN Simulator", which provides a continuous steady state source and an electronic load for testing of different types of solar cells. During the year, this facility has accomplished its proficiency in calculating the Quantum Efficiency of solar cell and has improved the characterisation for the spectral content of light for different wavelength.

Quantum efficiency for calculating the MMF (Mismatch factor of solar cell)

Figure 4.8: Test set up for EQE Measurement

The External Quantum Efficiency (EQE) measurement is one important method implemented to observe solar cell behaviour in a specific range of wavelength. The EQE are different for various type of solar cells such as silicon, dye-sensitised solar cell (DSSC), and perovskite solar cell. The objectives of this study was to analyse the correct EQE measurement method and to estimate the factors that affect EQE result on the three types of measured solar cells. The experimental set up comprises of a dedicated illuminator, monochromatic light source, and lock-in amplifier. The Figure 4.8 shows the experimental set up for EQE measurement. The test methodology were followed as per the latest version of the standard (ASTM E1021-15) for doing EQE measurement. In this method, the spectral Responsivity (SR) has to be measured first before calculating the EQE value. This value was then validated using current density value obtained from current-voltage measurement. Figure 4.9 shows the EQE, IQE and Reflectance in percentage measurement for different wavelength range (nm) for multicrystalline solar cell.

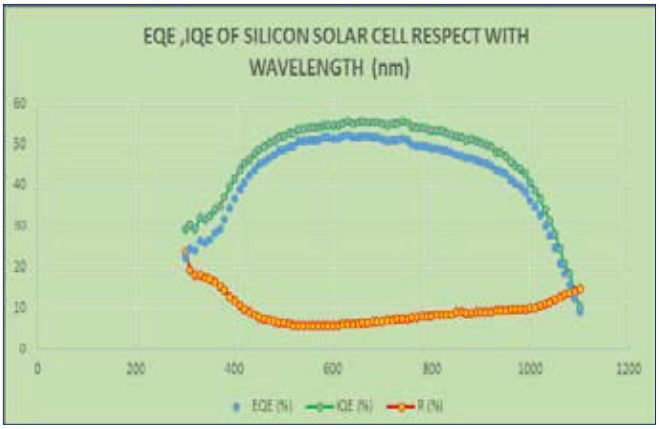

Figure 4.9: EQE, IQE and Reflectance in percentage measurement for different wavelength range (nm) for multicrystalline solar cell.

MOBILE TESTING SET UP

In the FY 2018-19, the Mobile Photovoltaic testing facility has further enhanced its facility with up gradation and testing of system in the field. The commissioning tests and performance guarantee tests performed are given in the Table 4.1 & Table 4.2 respectively.

Table 4.1: Commissioning tests

Item	Type of test
Document verifications	1. Information about Project 2. Inspection of plant layout 3. BOQ, standards, DPR) as per tender specifications 4. Tender document
Design/ physical verification	1. PV Module Mounting Structure & Civil foundation 2. DC Junction Box or String Monitoring Box 3. Earthling & Lightning Arrestor 4. PV Module 5. Inverter 6. AC Distribution Box 7. Cable identification and cable routing inspection 8. Weather monitoring station and monitoring system

Item	Type of test
Testing	1. String fuse continuity and string open circuit voltage test 2. String DC short circuit current test 3. Isolation device functional test 4. Inverter functional test 5. Acceptance test 6. Inspection of plant layout

Table 4.2: Performance Guarantee test

Description of Measurement	No. of Samples to be Tested
Visual inspection	Total power plant
String I-V Test	Total power plant
I-V Test of module	Statistically Selected modules (good, worst and mid-range string)
Insulation and wet leakage testing of modules	Statistically Selected modules (good, worst and mid-range string)
Thermal imaging	Total power plant
EL imaging	Statistically Selected modules (good, worst and mid-range string)
Inverter test	Total inverter

QUALITY MANAGEMENT AT NISE

NISE provides testing, validation and verification services for various Solar Photovoltaic Technology. The quality management system has a clear structure for managing lab activities as per the provisions of IS/ISO/IEC 17025: 2005. During the year, NABL accreditation audit was conducted for examining the compliance with the standard. The test facilities were marked up to date with suggestions for further improvements. In addition, the PVTF has prepared itself for NABL accreditation as per new standard IS/ISO/IEC 17025: 2017 and new scope of services are also proposed to be included to the existing services of Testing facility at NISE.

ACHIEVEMENTS

During the year a total of 1133 samples were tested and calibrated, that generated a total revenue of Rs. 208.70 Lakhs. The details of samples and revenue generated from testing and certification at solar photovoltaic facility at NISE are shown in Table 4.3.

Table 4.3: Samples tested, calibrated and the revenue generation

S. No.	Testing Samples	Quantity (Number of Samples)	Revenue (Rs. In Lakhs)
1	Solar Photovoltaic Module	939	97.16
2	Inverter	29	36.07
3	Battery	14	10.70
4	SPV Water Pumps	61	29.59
5	Led (Including different system)	80	32.89
6	Solar Thermal	4	1.47
7	Calibration	6	0.81
	Total	**1,133**	**208.70**

SOLAR THERMAL TECHNOLOGIES

Development, demonstration and testing of solar thermal systems and products is very important activity of NISE. R&D project supported by MNRE and other development activities with internal funding have been undertaken during the year. These activities were focused on solar thermal power/energy generation using parabolic trough, linear Fresnel reflector and central receiver technologies, use of Concentrating Solar Thermal (CST) technologies for applications related to supply of process heat, drying, cooking, space cooling and heating, water desalination and also development of hybrid system based on CST and biomass gasifier system for power generation and cooling. Development and use of thermal energy storage materials and systems is another important activity at NISE. In addition, NISE also undertook testing of different CST technologies. In the area of solar thermal energy utilization, NISE has undertaken the following activities during 2018-19.

1.0 MW SOLAR THERMAL POWER PLANT

To facilitate the development and deployment of solar thermal power projects in India and achieve the objectives of National Solar Mission, a Solar Thermal Power Plant (STPP) of gross capacity of 1.0 MW_e was installed and commissioned in the campus of NISE by IIT Bombay as a part of the MNRE funded project entitled "Development of a Megawatt-scale Solar Thermal Power Testing, Simulation and Research Facility" in September, 2013 with the following objectives: (i) Establishment of a national research facility on solar thermal power (1 MW_e grid interactive), (ii) Establishment of test facility for component and system characterization and (iii) Development of simulation facility for future scale-up of plant capacity.

The 1.0 MW_e STPP uses two different solar fields: Parabolic Trough Collectors (PTC) and Linear Fresnel Reflectors (LFR), without a fossil fuel backup. The integration of these two technologies into one project makes it India's first power plant to run on two different solar thermal technologies. The plant intermixes the thermal energy obtained from thermic oil from PTC field and direct steam generation of LFR field. PTC and LFR based solar fields of STPP are shown in Figure 5.1. The plant also uses a small amount of thermal energy storage (for about 20 min) as transient back-up during passing cloud cover.

Figure 5.1: PTC and LFR Solar fields of the 1MWe STPP at NISE

During 2018-19, NISE made serious efforts to revive operation of the STPP from its own resources and taking help from the external experts in this field. The operation of various sub-systems of STPP was impacted adversely due to its inoperative conditions for about two years. NISE discussed the mechanism to be adopted for revival of STPP with outside experts and they were of the view that most of the sub-systems would require servicing/overhauling along with replacement of some damaged components. For this purpose, NISE engaged some external technical experts. They carried out the servicing/overhauling of major sub-systems such as Turbine, Generator, Alternator, Condenser etc. The power plant was made operational for a very brief period during 2018-19. But all the technical issues especially those relating to software of major sub-systems could not be resolved along with synchronization of the STPP with the grid. It was not possible to resolve these issues in view of the financial constraints. For this purpose, a project proposal was prepared by NISE and submitted to the MNRE.

NISE also explored the possibility of engaging a competent third party for repair, operation and maintenance of STPP by inviting 'Expression of Interest' two times during 2018-19. In December 2018, United National Industrial Development Organization (UNIDO) approached NISE with a proposal to carry out the assessment work (Technical and Financial) for refurbishing 1.0 MWe STPP by assessing the present condition of various sub-systems and components of the STPP and with the ultimate objective of bringing the plant back into full operational condition. In the first phase of the assessment work undertaken during 7th to 18th January, 2019, the engineering components of STPP were thoroughly examined for their present condition. During the second phase (7th to 15th March, 2019), financial implication of bringing STPP to full operational condition was estimated. The cost/time for repairing/replacing/overhauling of all the equipment have been identified. A detailed report has been prepared by the team engaged by UNIDO and submitted to UNIDO and NISE. The outcome of UNIDO report were discussed in MNRE and it was decided that NISE would prepare a proposal for revival of the STPP based on UNIDO report and submit it to MNRE for consideration.

MODULAR CENTRAL RECEIVER CONCENTRATED SOLAR POWER PLANT FOR DECENTRALIZED POWER GENERATION

NISE is implementing an R & D project entitled "Modular Central Receiver Concentrated Solar Power Plant for Decentralized Power Generation" sanctioned by MNRE with the objectives i.e.:

(i)Installation of remaining three Heliostats in the Solar Field, (ii) Flux characterization of the heliostats and testing and optimization of their control system, (iii) Reliability test for Solar field commercialization, (iv) Design finalization of 1 MW_{th} receiver, (v) Designing and construction of a storage element, including vessel manufacturing, fill material filling, site preparation and assembling, (vi) 1 MW_{th} Pilot plant testing and performance evaluation: The testing of the receiver & storage subsystems, including the development of a testing plan, testing for sufficient duration at different solar conditions and performance evaluation, (vii) Overall testing and performance evaluation of Heliostat, receiver and thermal storage including control strategy during startup, shutdown and transient period, (viii) Design and simulation of commercial plant, (ix) Use of above test results to provide a conceptual pre-engineering design of a scaled-up power tower with an electrical output of 5 MWe which will include design parameters and performance simulation on hourly-annual basis and detailed cost estimation of both solar and power blocks.

Brief progress of the project during 2018-19: (i) Though the project was sanctioned in the last week of March, 2018; the formal handing over of the assets and stores of the project was completed in

end October, 2018, (ii) A brainstorming meeting of the experts from the academia and the erstwhile team of the engineers from M/s Sunborne Energy Pvt. Ltd. to discuss various technical issues of implementing the project was held in the first week of January, 2019. NISE was not at all involved earlier in implementation of the project and therefore required such discussions, (iii) An engineer of the earlier team has been engaged by NISE along with deputation of some existing scientists from NISE for implementation of the project, (iv) The assets of the project that were installed by the previous project implementing agency have been inspected thoroughly for repair/overhauling/refurbishment as the assets were not in use for about 3 years, (v) A project Monitoring Committee appointed by MNRE reviewed the progress of the project in March, 2019, (vi) Actions have been initiated by NISE for repair/ overhauling/refurbishment of the existing assets of the project.

PARABOLIC TROUGH COLLECTOR BASED 100KW SYSTEM USING TRIPLE EFFECT VAPOUR ABSORPTION SYSTEM

During the year, Eleven FCUs were currently connected with the system. In Summer, when system is running on full load it is consuming 65-70 units of electricity during whole day's operation, and as one FCU each of 2-ton cooling capacity are running using solar energy, 115-120 units of electricity is saved per day. In winter, system runs for providing space heating to connected rooms and for operation of the system, it consumes only 38-40 units of electricity per day for operation, and it replaces room heater in eleven rooms including labs of capacity 2-5 kW each, which saves approx. 190 to 200 units of electricity per day. Figure 5.2 shows the plant configuration. The detailed configuration of the system is given below:

- Chilled water In/Out : 12–7 °C
- Hot Water In/Out : 210–200 °C
- COP : 1.7
- Collector Area : 288 sq. m.

Figure 5.2: 100 kW triple effect vapour absorption system

PARABOLIC TROUGH COLLECTOR BASED 15KW SYSTEM USING AIR COOLED DOUBLE EFFECT VAPOUR ABSORPTION SYSTEM

A 15 kW LiBr- H_2O water double effect absorption prototype system with air cooling was operated and maintained at the NISE campus. The system configuration along with the data showing the performance of this plant is given in the Table 5.1. The system is shown in Figure 5.3. Configuration of the system is given below:

- Chilled water In/Out : 15–10 °C
- Hot Water In/Out : 180–170 °C
- COP : 1.0
- Collector Area : 72 sq. m.

Figure 5.3: 15 kW double effect vapour absorption system

Table 5.1: Data of 15 kW absorption system with Air Cooling

CHW Temp in °C	CHW Temp out °C	HW Temp in °C	HW Temp out °C	Air in Temp °C	Capacity kW	COP
15.7	10.7	175.8	161.5	31.2	4.9	1
14.1	8.8	174.8	166.9	33.3	4.3	1.2
14	8.7	175.8	167.2	34.4	4.3	1.2
15.2	9.8	177.6	163	31.3	5	1.1
15.9	10.4	175.4	160.7	32.5	5.2	1.1

COMPOUND PARABOLIC COLLECTOR BASED 5 KW SOLID VAPOUR ADSORPTION SYSTEM

This system provides 5 kW of air conditioning to an office cabin with chilled water at 9^{0}C circulated through an FCU. The system was operated and maintained during the year. The data generated during the operation of this system is shown in Table 5.2. The system is shown in Figure 5.4. Configuration of the system is given below:

- Chilled water In/Out : 15 / 10 °C
- Hot Water in/Out : 80/70 °C
- COP : 0.4
- Collector area : 61 Sq m

Figure 5.4: 5 kW solid Vapour Adsorption System

Table 5.2: Data of 5 kW adsorption prototype system

CHW Temp in °C	CHW Temp out °C	HW Temp in °C	HW Temp out °C	Cooling water °C	Capacity kW	COP
15.1	8.4	97.3	87	30.4	5.8	0.4
15.2	8.5	94.6	84.2	30.7	5.8	0.4
14.7	9	98.4	87.4	31.3	5	0.3
15	9.6	85.4	74.9	32.3	4.9	0.3
15.3	9.3	82.4	71.9	29.9	5.2	0.4

SOLAR DISTILLATION SYSTEM

The performance of inclined flat plate-type solar water distillation system has been carried out by installing the system which consists of 10 panels, i.e. having aperture area of 30 m^2 at the Out-Door Test Bed of solar thermal engineering laboratory. This system has been evaluated and observations were recorded on the basis of data collected (period of 8-10 hours) during winter and summer. It was observed that with daily solar global radiation of 6.2 kWh/m^2, maximum output of distilled water achieved was 6.03 l/day per m^2 at ambient temperature of 23 °C. The inlet water was with dissolved salt of 540 ppm and distilled water was found to have almost zero ppm.

SOLAR BIOMASS HYBRID SYSTEM FOR POWER GENERATION CUM COLD STORAGE

Keeping in view the importance and need for cold storage and sustainable development of rural areas in India, NISE in collaboration with Thermax (cold storage component) and TERI (gasifier component), implemented a demonstration-cum-performance evaluation project in its campus during 2012-13. It involved design, development, fabrication, and field trial of a solar– biomass hybrid absorption cooling system operating on thermal energy to produce cooling. The hybrid system was also designed to generate electricity keeping in view the demand for electricity in rural areas. Detailed computer modelling was carried out to optimize system design before going to field-level implementation. The Specifications of the system are given below:

- Cooling Capacity: 15 kW
- Cold Storage Temperature: 0–5 °C
- Gas Engine Capacity: 50 kWe
- Biomass Consumption: 70 kg/hr
- Heat source for VAM
  - During solar hours: Solar and producer gas engine exhaust
  - During non-solar hours: Producer gas engine exhaust/auxiliary firing

TERI's biomass gasifier was coupled with Thermax's developed Vapour Absorption Machine (VAM) of 15 kW cooling capacity and concentrating solar parabolic dishes. This system can provide clean power and cold storage facility for about 25 tons of fruits and vegetables. Since the cold storage can be cooled to temperatures as low as 0°C, can store a wide variety of fruits, vegetables, and horticultural produce. The biomass gasifier produces 50 kWe electricity producing exhaust heat at 400°C. About 70% of this waste heat can be recovered to generate hot water at 135 °C for the VAM of 15 kW capacity system for cold storage. Four Scheffler dishes with aperture area of 16 m^2 each have been integrated to provide thermal energy for operation of the chiller during sunny hours of the day. The gasifier will not run at its peak-rated capacity during day time in view of the non-requirement of the lighting load in the village; therefore, solar dishes will compensate the requirement of heat for rated output of cold storage. Simultaneously, during non-sunny hours, i.e. at night, the gasifier will run at its peak-rated capacity to meet the electricity requirement of the villagers. Running the gasifier engine at full rated capacity will produce 50 kW of exhaust which would be sufficient to meet the requirement of VAM. In case of non-availability of sunshine as well as sufficient electrical load to meet the heat requirement of VAM,

special arrangements have been made to utilize the producer gas in the heat recovery unit to meet the balance amount of heat required for VAM. The hybrid system has thus been designed to provide electricity from locally available biomass to a few villages along with a cold storage plant in a remote location.

NISE, TERI, and Thermax have gained considerable experience in the operation of the proposed cold storages. Successful implementation of the solar biomass hybrid cold storage system on regular basis can open avenues for its replication in other parts of India and thus help in saving valuable agricultural produce and also in achieving rural electrification.

SOLAR DISH STIRLING ENGINE

Solar dishes can be used to capture and concentrate direct normal radiation from sun and can be coupled with Stirling engine to convert the concentrated heat into electricity. Stirling engine is considered to be one of the most efficient heat engines. One of the advantages of this method is that no water is required, hence can be used in water deficient areas as well. Three units of Solar Thermal Dish Stirling Engine System, developed by a US company, which can generate grid quality AC electricity (230V, 50 Hz), up to 3 kW peak power at solar insolation of 850 W/m^2, are installed and operational in the campus of NISE, these systems were installed by ONGC Energy Centre in year 2010-11 (Figure 5.5). These units were operated during 2018-19. Each unit was able to produce up to 2.2 kW electricity at 750 W/m^2 in isolation.

Figure 5.5: Solar Dish Sterling System

CONCENTRATING SOLAR THERMAL TECHNOLOGY

Potential & Application in India

Industrial heat is characterized by a wide diversity with respect to temperature levels, pressures and production processes to meet many different industrial process demands. Concentrated Solar Thermal (CST) technologies track the sun's incoming radiation with mirror fields, which concentrate the energy towards absorbers, which then transfer it thermally to the working medium. The heated fluid or steam may reach high temperatures and may be used for various processes heat requirement.

CST technologies can produce a range of temperatures, from 50°C up to 400°C, which can be used for a variety of industrial and commercial heat applications. The industries having good potential for deployment of CST technologies are food processing, dairy, paper and pulp, chemicals, textiles, fertilizer, breweries, electroplating, pharmaceutical, rubber, desalination and tobacco etc. Any industrial/commercial establishments currently using steam/hot water for process applications can also employ CST technologies with a minimum tinkering to the existing setup.

Deployment of CST technologies have only recently started gaining confidence of the users. MNRE has identified that CST technologies have a total market potential of 6.45 GW$_{th}$ for industrial applications in India. In order to maintain standardization among products, systems and components manufactured by various manufacturers across India, MNRE has established a state-of-art of test facility for testing and characterization of CST technologies at NISE.

CST Test Laboratory at NISE

NISE has a state-of-art of test facility for testing and characterization of CST Technologies. The CST test facility at NISE has an ability to analyse thermal and optical performance of all available types of CST technologies.

The CST test laboratory at NISE is first of its kind in the country (Figure 5.6). The laboratory was established with its own weather station and has the following facilities for testing of CST technologies:

- Test facility for testing of hot water/ Steam based CST systems.
    a) CST test rig: All available CST technology can be tested, characterized and analyzed 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.
- Mobile test facility 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.
- Concentrated Solar Thermal component test facility.
    a) Reflectometer: Reflectivity measurement of Concentrator.
    b) Heat Loss Measurement: For measurement of heat loss co-efficients of receiver tube.

Figure 5.6: Test facility for testing of hot water/steam based CST systems

Upgradation of CST Test Facility

The PLC based CST test has been successfully upgraded to the SCADA based control system to increase the accuracy in testing and decrease the testing time. The advantages after installation of the SCADA system are as follows:

a) The upgradation supports the ease of control of the test loops from single window screen and enable to achieve the test conditions as prescribed in BIS Standard (IS 16648 -Part 5) with the maximum accuracy.

b) As per the International and BIS standard, the data logging time has been significantly reduced to one minute from earlier five minutes for accuracy of assessment.

c) With the SCADA system multiple systems can be tested in parallel which aids in reduction of testing time.

Annual Maintenance Contract (AMC) of CST test facility

CST Test facility at NISE was created and commissioned in June 2015 under UNDP-GEF Project. Earlier for the Operation & Maintenance contract of CST Test was under the scope of UNDP -GEF project Fund. However, the contract terminated with successful

completion of UNDP-GEF Project on 31 March 2017. In order to maintain the testing rig and mobile testing equipment's thereafter, NISE decided to take over the facility. NISE awarded an AMC for 3 years in August 2018 for preventive as well as for break down maintenance to a third party. Major work performed under phase-I (September 2018 - March 2019) of AMC are as follows:

a) Calibration of Temperature, Pressure and Flow sensor from NABL Accredited Laboratory.

b) Cleaning of filters, nozzle, and replacement of gaskets, strainers of cooling tower feeding pumps.

c) Repair and maintenance of water softener plant.

d) A non-corrosive epoxy painting on entire CST test rig

Characterization of CST technology

In CST laboratory, the data and the results generated are used for characterization of performance of CST technologies. Performance mapping tools are developed using the test results of various CST technologies. Performance maps are also used in simulating the yearly performance/output from a CST technology for different applications and at various locations. NISE is in the process of converting this mapping tool into some software where results can be presented in the form of graphs, tables and reports.

Testing results of Different Technologies

Four systems were tested in the CST test facility at NISE as per the details given below in Table 5.3.

Table 5.3: List of Products Tested by NISE CST Test Facility during 2018-19

S. No.	Manufacturer	Technology	Size (m^2)
1.	GreenLife Solutions Pvt Ltd, Nagpur	Compound Parabolic Collector	03.00
2.	Swati Sunsource Pvt. Ltd., Andhra Pradesh	Parabolic Trough Collector	96.64
3.	Neochlorous Energy Solution Pvt. Ltd., Gurugram	Evacuated Tube Based Solar Air Heater	05.20
4.	Softech Renewables Pvt. Ltd., Ludhiana	Compound Parabolic Collector	03.00

FUTURE PROSPECTS AND DEVELOPMENT

A lot of interest has been generated among the prospective users of solar cold storage unit and solar dryer cum space heating system developed by NISE in collaboration with the industry. In this regard, NISE have received enquiries from the state of Jammu & Kashmir and North- Eastern States, where a substantial potential exists for such solar systems for income generation and improving the quality of life during severe weather conditions. NISE would also make endeavors for improving the design of bulk milk chilling unit, developed by it and its dissemination through interested agencies. NISE would make efforts for operationalization of 1 MW solar Thermal power plant installed in its campus by seeking funding from National and International funding agencies.

R&D PROJECTS & COORDINATION

NISE contributes in establishment and supervision of research and development activities in renewable energy technologies. NISE plays a pivotal role in evaluation, monitoring, validation and technical documentation of solar photovoltaic and solar thermal R&D projects. NISE has been coordinating various research activities pertaining to solar photovoltaic cells, water pumping systems, different solar technologies, etc. NISE collaborates with National/ International research institutions, other Central/ State Government organizations and industries for implementation of various R&D projects in renewable technology.

NISE has carried out R&D activities to further develop and demonstrate their three products namely Solar Dryer cum Space heating system, Solar Powered Cold Storage with Thermal Storage System and Solar Powered Bulk Milk Cooler with Thermal Storage System. These in-house developed innovative products are utilized for providing services in cooling, heating and drying application in niche areas. The target users of these products are farmers and these products are expected to help them in storing milk and preserving their agriculture produce. These R&D projects undertaken at NISE were self-financed and implemented in collaboration with industrial partners.

R&D COORDINATION CELL

Project Evaluation

During this period, a total of 18 project proposals were received by NISE. Following the evaluation, only two project proposals were scrutinized. Consequently on the basis of their concept, only agri-voltaics project was recommended to MNRE for further processing. Together with the scrutiny of project proposal, the RDPAC meeting, held in May 2018, evaluated and recommended 15 new projects (submitted in FY 2017-18) to MNRE.

Monitoring of the on-going R&D projects in Solar Photovoltaic

As a part of bi-annual project review meeting for the on-going PV R&D projects sponsored by MNRE. NISE has conducted a meeting at its premises on 26th July 2018. This meeting was attended by the PIs of the on-going R&D projects and a brief presentations were made to the Project Review Committee (PRC) comprising of external and internal PV experts. Subsequently, the PIs were sent minutes of meeting (MoM) containing suggestions to implement the project as per the recommendation of the PRC, in line with the sanctioned project objectives. These prepared MoMs were also sent to the Solar R&D Division of the MNRE with actionable points mentioned for each project.

PROJECT ON PERC SOLAR CELL DEVELOPMENT

NISE initiated the development of high efficiency Passivated Emitter Rear Cell (PERC) type Solar cells in a joint venture with BHEL-ASSCP, Gwal Pahari, Gurugram in 2018. This project involves the development of PERC type solar cells with bench mark efficiencies in the country. The major activity in the PERC project during the year 2018-19 was to determine the course of action for the procurement of special process and testing equipment. Process equipment such as Plasma Enhanced Chemical Vapour Deposition (PECVD) vacuum system, Laser Scriber and Diffusion Furnace etc. were under procurement, besides, Spectroscopic Ellipsometer, ECV Profiler and four other testing equipment. NISE positions itself as providing for

the Testing and Characterization of cells at various stages of process to identify the problem areas. Therefore, NISE initiated the design and fabrication of a 140 sq. m, Class 100,000 (ISO Class 8) clean room for housing the test and characterization equipment. The establishment of this facility is in progress and is intended to be completed shortly.

ALL INDIA SURVEY OF PV MODULES INSTALLED IN THE COUNTRY, A JOINT VENTURE BETWEEN NISE AND NCPRE, IIT BOMBAY

In this FY 2018-19, NISE in association with NCPRE, IIT Bombay conducted a study on the performance of Solar Photovoltaic Modules installed at different parts of India in different climatic conditions. This study was conducted on the basis of certain parameters such as voltage output, current output, power degradation, etc. In this survey, the long term performance, energy yield, capacity utilization factor, degradation rate, etc. were analyzed for different module technology under different weather conditions. The report of this survey is under review and it would be soon published on NISE website.

RESEARCH & DEVELOPMENT IN SOLAR PHOTOVOLTAIC DIVISION

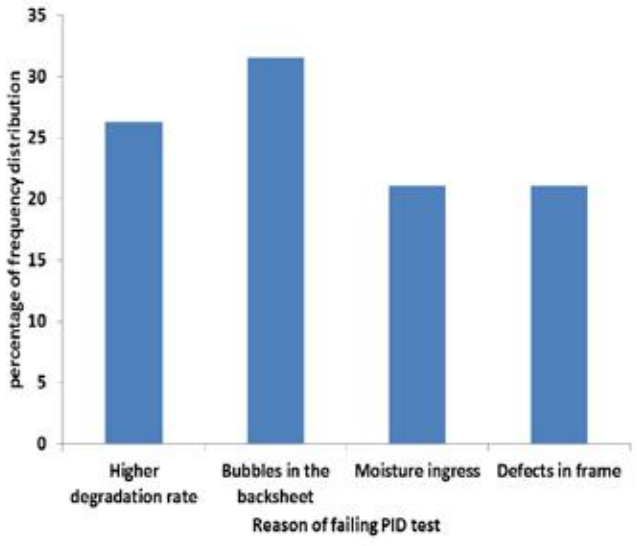

Figure 6.1: Distributions of reason of failing PID test

Potential Induced Degradation Testing of PV Module for Indian Climatic Condition

The Solar Photovoltaic Modules deployed for a large scale megawatt projects for Indian Climatic conditions were evaluated on the basis of Potential Induced Degradation. The performance analysis of these modules showed that the power degradation were varying from 25-40% after one year of installation. This degradation in the module wattage has been attributed to the PID stress. With the study of these Solar Modules under different Indian Climatic Conditions, NISE has modified the testing condition of IEC-TS 62804. The parameters such as temperature and number of cycles were modified to understand the performance of different modules. The study showed that there is a high degradation rate and loss of integrity in PV modules due to PID degradation. Figure 6.1 shows the reasons for failing PID Test.

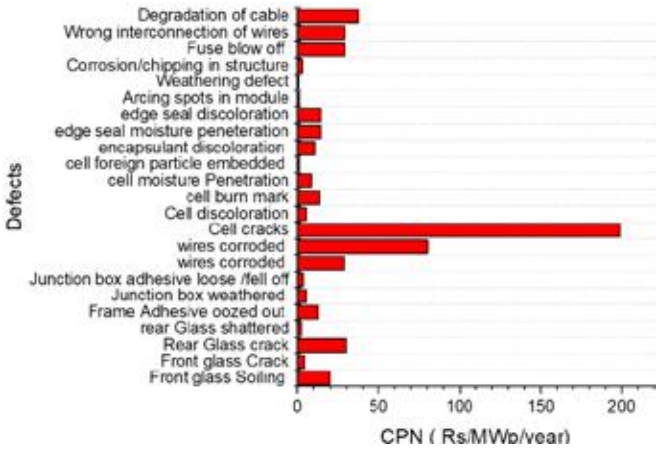

Figure 6.2: CPN of a PV power plant in India

Cost Priority Number of PV Power Plant

Occurrence of risk contributes to significant power degradation issues and adversely effects the return on investment (ROI), Levelised cost of energy (LCOE), Payback period and overall performance of PV power plant. NISE has developed a new failure mode effect analysis (FMEA) methodology to quantify economic impact of technical risks originating on field by assigning Cost Priority Number (CPN) to each

individual risk associated with PV system components. Figure 6.2 shows the CPN of a PV Power Plant in India. The developed methodology has prioritized the risk in terms of their economic impact and assisted to take better financial decisions.

An Assessment of Series Resistance Estimation Techniques for Different Silicon based SPV Modules

The series resistance is a significant electrical parameter of the solar photovoltaic module and it is used for outdoor performance modelling, evaluation and degradation studies. The study shows that there are 33 different methods for evaluation of a series resistance of a solar modules. These methods have been broadly classified into four groups based on different approaches, i.e. numerical, graphical, a combination of numerical and graphical and advanced methods. NISE has conducted a comparative analysis of ten different methods on series resistance for three different technologies namely, hetero-junction intrinsic thin layer silicon (HIT), amorphous single junction silicon and multi-crystalline silicon. The estimation shows that computation methods are more accurate as compared to analytical methods.

Solar Photovoltaic Pumps Operating Head Selection for Optimum Efficiency

NISE has conducted an in-depth investigation on energy efficiency of Solar Photovoltaic Water Pumping system (SPVWP) based on solar radiation, temperature and operational heads. Each SPVWP were analyzed based on the Best Efficiency Point (BEP) concept. However, for each SPVWP systems, due to variations in the solar intensity, ambient temperature and water head, BEP concept does not offer the best efficiency design. The study experimentally proves that the model based on weighted system efficiency and solar operational duty head (SODH) increases the performance of SPVWP system (9% gain) and consistently provides higher efficiencies in any season or under any climatic conditions.

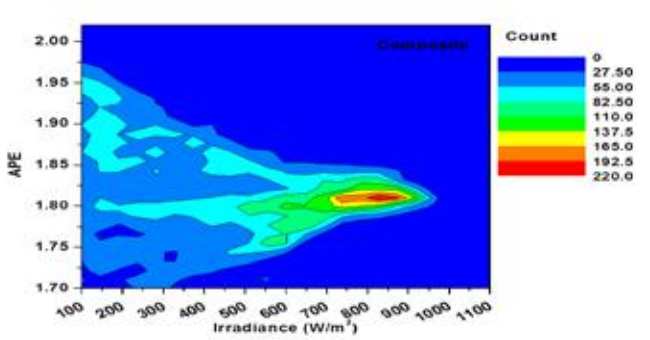

Figure 6.3: Distribution of APE at different irradiance for composite zone

Energy rating of PV module technologies

The Energy rating of a PV module as per the site-specific climatic condition is essential for a customer. To choose a suitable site specific PV technology, it is essential to design a standard datasets. NISE has conducted a study for three different technologies i.e. Amorphous silicon, HIT and multi-crystalline silicon modules for energy rating with data sets based on the angle of incidence, spectrum, irradiance, wind and temperature using existing formulae. It has been observed that all the three technologies at both cold & sunny zone shows the highest energy rating. Figure 6.3 shows the distribution of APE at different irradiance for composite zone.

Performance of Particulate Matter 10 with Soiling Losses for SPV Technology

NISE has conducted a study of correlating the soiling losses for an installed SPV module at different tilt angles. The parameters considered for this analysis were, low humidity, coarse and fine particle sticking on the surface, low wind speed with its thermal cycle heating, cooling of dust segmented and settling velocity on the surface in form of cementation process. This study has estimated the correlation of soiling loses for different Solar PV Modules under varying climatic zone and has determined the necessary intervals for cleaning of solar modules. Figure 6.4 shows the particle concentration with respect to different environmental parameters.

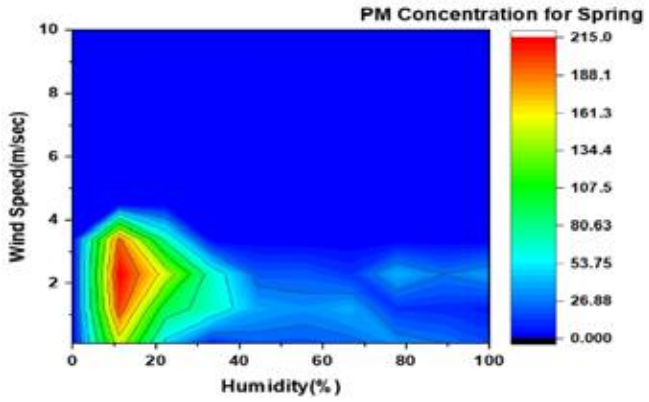

Figure 6.4 Particle concentration with respect to environmental parameters

Developing Software and Methodology for Diagnosis and Characterization of Failure Modes in PV Module using EL & IR

NISE has developed a software methodology in MATLAB for diagnosis and characterization of failure modes in PV module using Electroluminescence (EL) and Infra-Red (IR) image. EL Imaging is a useful instrument for detecting (high resolution) and analyzing distinctive kinds of defects and deformities in a PV modules. Through EL images, a computational strategy was devised for calculation of various deformities and power loss modes available in PV modules. This technique has recognized the explicit deformities sign under different illuminating conditions and determined the nature of solar PV modules. Figure 6.5 shows the EL Image of a- Si Module.

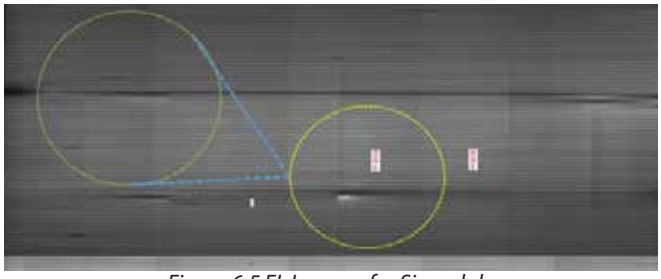

Figure 6.5 EL Image of a-Si module

Further, the IR-thermography was used to measure the thermal imbalance and thermal characteristics of the PV cells in a modules. These IR images were used to detect various imperfections such as hotspots, latent cell parts, dampness, and damaged diodes. The power losses caused due to different modes such as (i) micro-cracks (ii) shunts (iii) degradation area and (iv) Potential induced degradation were analyzed using characterization through light I-V and dark I-V methods module parameters. For further quantifying, MATLAB and python software were used to measure the length and area of the defects. Figure 6.6 shows the IR image of a-Si Module.

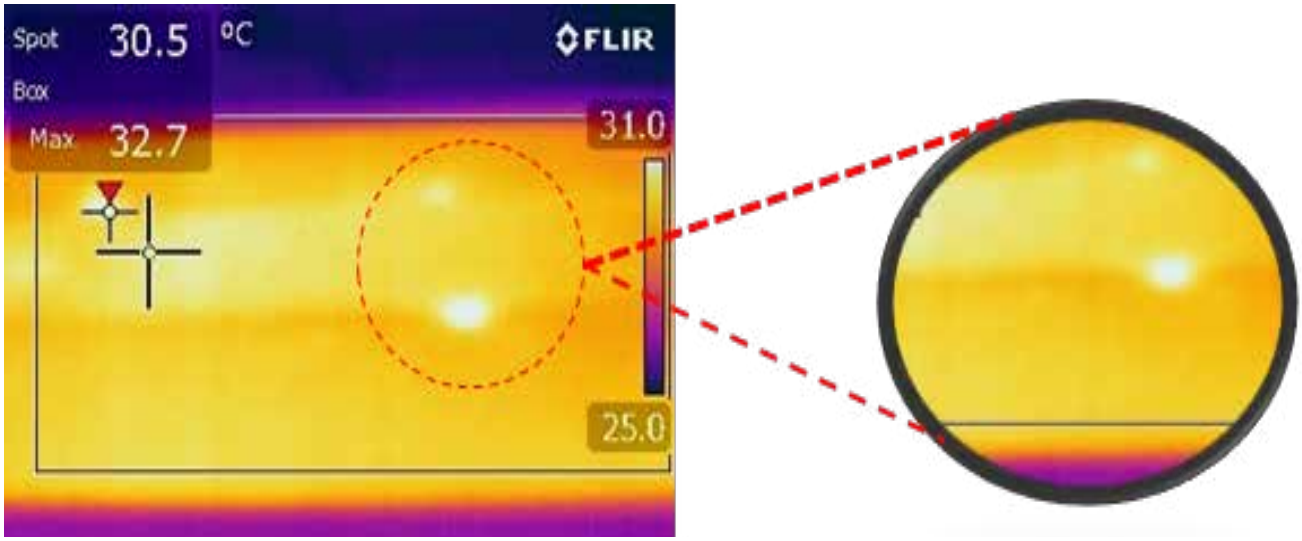

Figure 6.6 IR image of a-Si module

Solar Powered RO Based Clean Drinking Water System

NISE is jointly working with Saurya Enertech Pvt. Ltd. on a project "Development and Field Testing of Solar Powered Clean Drinking Water system for communities without piped water line and electricity". This system is fully automated with an Internet of Things (IoT) based central monitoring control and tested on in-house platforms using SIM cards. The design is to monitor and control: (i) health of the systems, i.e. data is being collected from pumps, valves, pressure gauges, solar voltages and currents etc. ; (ii) quality of water – TDS and pH; (iii) water dispensing – amount and frequency with time stamp; and (4) attendance of the operator. Figure 6.7 shows the monitoring dashboard of RO parameters.

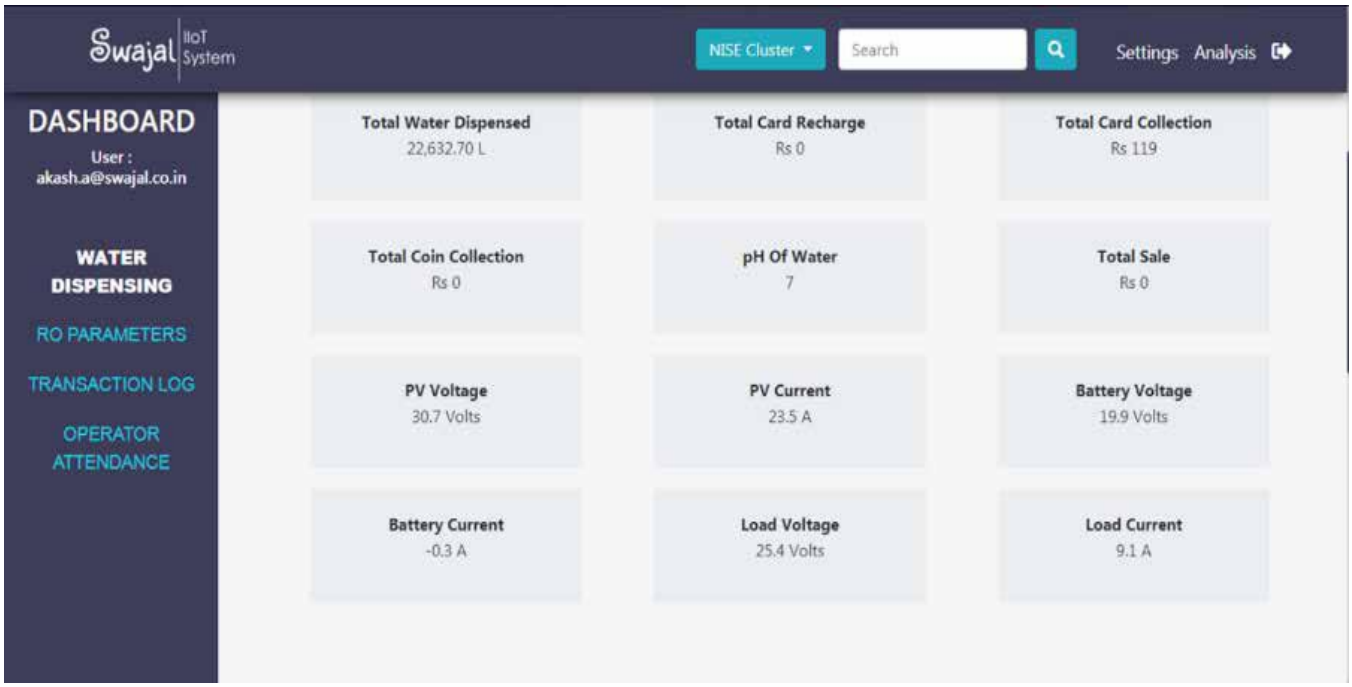

Figure 6.7 Monitoring dashboard of RO parameters

Under this project, 5 prototype centers have been setup in different location of Gurugram district. First large prototype center was set up in NISE campus in order to facilitate solar R&D. This center apart from being used for R&D is used to supply clean drinking water to NISE campus as shown in Figure 6.8. (a) The Second Prototype system, with 100LPH capacity is setup in the technical block of Aditya Bhawan, NISE campus as shown in Figure 6.8. (b) This prototype system fully runs on DC power supply with four 0.5hp DC pumps with the system voltage of 24V and current handling capacity of 40A. The third Prototype system is setup in the village khera Khurrampur of Gurugram district as shown in Figure 6.9. (a) This system is of 500LPH capacity. The fourth system is installed at Safdarjung Hospital, New Delhi with the capacity of 200LPH as shown in Figure 6.9. (b) The fifth system is installed at Primary Health Centre (PHC), Gurugram Sector-10 with the capacity of 200LHP as shown in Figure 6.10.

Figure 6.8 Prototype RO system installed at NISE

Figure 6.9 Prototype RO system installed at village khera Khurrampur of Gurugram district and Safdarjung Hospital, New Delhi

Figure 6.10 Prototype RO system installed at Primary Health Centre (PHC), Gurugram Sector-10

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

Ground water year book of Haryana state published by Central Ground Water Board in 2016 has studied 964 ground water observations points throughout the state and listed the quality of water and impurities. Quoting from this report says *"In Districts Fadridabad, Gurgaon, Hisar, Mahendergarh, Rewari, only 30-50% water samples are having potable quality as per Bureau of Indian Standards (BIS) 2012. Ground water is mostly unsuitable for drinking due to one or more of the constituent particles exceeding the maximum permissible limits. Bhiwani, Fatehabad, Jhajjar, Mewat and Sirsa districts have less than 30% of ground water parameters with in the permissible limits".*

Keeping in view all these issues NISE and Saurya Enertech. Pvt. Ltd have jointly developed solar powered water purification system. Five prototype of such systems ranging from 100LPH to 500LPH capacity were deployed and are functional in various locations. Encouraged by the success of these prototypes, NISE is looking to install a full scale pilot project to test the solar powered drinking water station at village community level.

The Project envisages to provide safe drinking water to the entire population of Faridpur village in district Gurgaon, Haryana. It employs Solar Power to operate the water purification system. The quality of raw water has been tested and found to have a TDS of 1973 (mg/l). Water has large amount of Chlorine (990 mg/l) in addition to many other impurities. Based on the quality of raw water including a factor of safety, the membrane based purification system has been designed. Energy efficient membranes have been selected. Pumps with SS fittings are selected in view of large quantity of Chlorine in the water. A 30 kW solar system has been designed to take care of water needs of the population. A battery bank of desired size is designed for an autonomy of two days. An IoT based remote monitoring has been designed.

Design and Development of High Efficiency Solar Water Pumping System

The Government has launched the scheme Kisan Urja Suraksha Evam Utthaan Mahaabhiyan (KUSUM) to provide 27.5 lakh solar pumps for irrigation purpose. This scheme has led to the development of highly efficient & reliable as well as cost effective Solar Water Pumping System with improvement in their performance. This enhanced performance in terms of higher daily water discharge (around 10%) would essentially mean the additional benefit (i.e. proportionate reduction in the overall costing) to the farmers. NISE has been sanctioned a project entitled "Design and Development of High Efficiency Solar Water Pumping Systems "by MNRE on 28th February 2019 for the development of improved solar water based pumping controllers, motors, pump sets and SCADA based solar pump testing system. NISE has associated with industry including reputed indigenous pump manufacturers and Indian Pump Manufacturers Association (IPMA) for study, research, development and analysis under this project. The project envisages the activities i.e. (i) design and development of low cost high efficiency controllers, (ii) design and development of variable frequency drive to work optimally under summer and winter profiles, (iii) to increase the overall wire to water efficiency of the solar water pumping systems up to 45%, (iv) to improve daily water discharge of solar water pumping system by at least 10 %. The test facility of Solar Pumping System established at NISE is being updated and a new state of the art facility for testing of solar PV Pumps is being developed at NISE which includes the facilities i.e.: (i) simultaneous testing of multiple Solar Water Pumps under real time conditions, as well as with Solar Array Simulators, (ii) 'SCADA' to be installed to control and log the performance, (iii) Remote Monitoring Arrangement to be configured, (iv) Development of testing procedures as per IEC, (v)

Test Setup configuration, (vi) Test procedure for both AC & DC Solar Water Pumping Systems. The project is under implementation.

RESEARCH & DEVELOPMENT IN SOLAR THERMAL DIVISION

Design, Development and Fabrication of Lab Scale Cooling System with Process Heat for Industrial Application

A lab scale cooling system with process heat has been designed, developed and fabricated in solar thermal engineering laboratory for industrial application (Figures 6.11 and 6.12 with the following objectives:

(i) Designing and simulation of vapor absorption refrigeration system (i.e. condenser, generator, absorber & evaporator) to find out another output using condenser heat like process steam, (ii) Fabrication of cooling system with process heat, (iii) Performance Evaluation of the condenser heat for various end use application i.e. desalination system, (iv) Performance Evaluation of the complete system using generated data and comparative analysis of theoretical data (generation of coding data using various software) with experimental data, (v) Optimization of various parameters i.e. Generator, Condenser and Evaporator for various Industrial end use applications, (vi) Design and simulation of this system for commercialization based on the long-term performance data, (vii) Development of operation protocol for solar thermal based vapour absorption refrigeration cooling system with process heat (i.e. multi effect desalination application), (viii) Preparation of operation and maintenance manual.

During the year, the following actions were taken: (i) The modelling and simulation of the system has been analyzed using Engineer Equitation Solver (EES) software and the system was optimized using Genetic Algorithm to increase the overall efficiency, (ii) Fabrication of cooling system with process heat system has been completed in solar thermal engineering laboratory as shown in figures and installation of solar thermal technology (i.e. compound parabolic concentrator) with heat input to generator of the system is likely to be completed shortly.

Design and Development of Solar Dryer cum Space Heating System

NISE has designed and developed an innovative solar dryer cum space heating system with thermal storage system and filed an application for grant of Intellectual Property Right (IPR) with Indian Provisional Patent Application No.: 201811013091 for the system. The system is ideally suited for drying of agricultural products such as crops, fruits, vegetables, spices, chips, fish, tea etc. The system can heat incoming

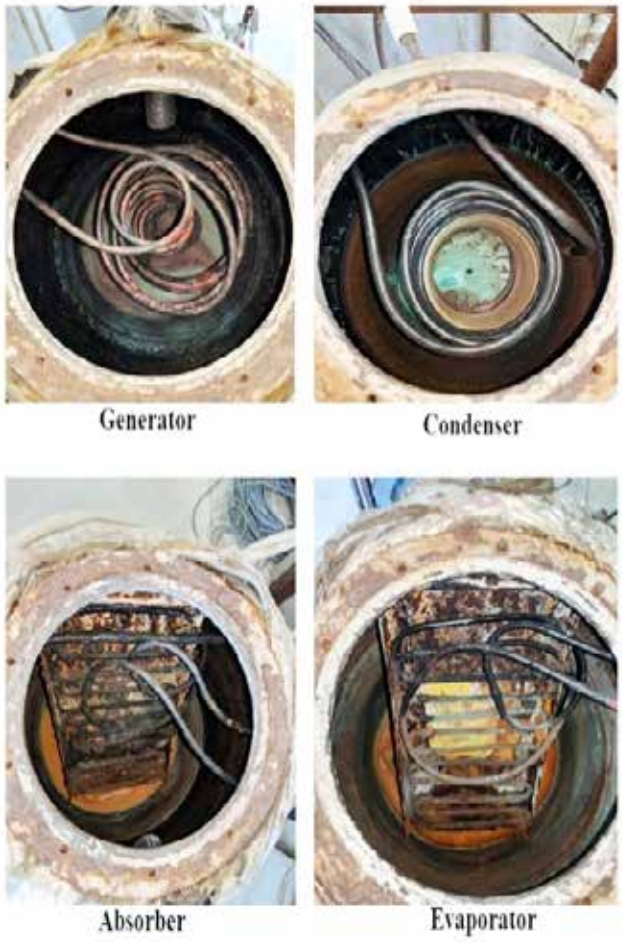

Figure 6.11: Fabrication of generator, condenser, absorber and evaporator in solar thermal engineering laboratory

air up to 60°C above ambient (ΔT=60°C), thereby making it ideally suited for many agriculture drying applications. The solar air heating system may provide all of the heat during a sunny day or act as a pre-heat system during cloudy conditions. For cold regions like Ladakh, where ambient temperatures during winters drop to -20°C, the system can be used for space heating purpose thus keeping inside temperatures of homes and offices comfortable during harsh winters. The system is modular and can be installed in any size and numbers as per the requirement of drying and space heating.

Features of Solar Air Dryer cum Space Heater

- Dryer uses very efficient and cost effective solar thermal technology for supplying heat.
- Complete off grid system that utilizes solar energy for its operation.
- Drying chamber having capacity of fresh produce of 70-80 kg per batch.
- Designed for 24x7 operation with innovative thermal storage system having heat storage capacity of 6 kWh, developed by NISE.
- System designed for dual mode of operation with plug and play connection: Drying Mode and Space Heating Mode.

Demonstration of 10 units of Solar Drier in Jammu & Kashmir

NISE has performed the feasibility study of Solar Dryer and Solar Cold Storage in Leh and Kargil District of Jammu & Kashmir (J&K) and submitted the feasibility report to Ministry of Food Processing Industries (MoFPI). Based on the feasibility report, the project was sanctioned to Horticulture Department of J&K for

Figure 6.12: Fabrication of complete system in solar thermal engineering laboratory.

deployment of Solar Dryers. Horticulture Department of J&K approached NISE for designing, development and installation of Solar Air Dryer units for drying of apricot in Ladakh region on turnkey basis. NISE has successfully undertaken the pilot installation of project and deployed 10 Nos. of solar dryer units (5 in Leh and 5 in Kargil) on trial basis to evaluate performance in actual field conditions, as shown in Figure 6.13 & Figure 6.14. The Solar dryer systems were successfully installed and commissioned in July 2018.

During apricot harvesting season i.e., July – September, the solar dryer system has been efficiently used by the farmers of Ladakh for drying apricots and other vegetables. It is observed that the time taken for drying has been reduced to 3 days in place of 7-10 days taken by traditional drying methods. The main advantage is its thermal storage which helps the system to operate round the clock. During winter in Ladakh region the ambient temperature even drops to -20 °C which affects the quality of life of local inhabitants. The locals generally uses Bukhari (a traditional kerosene based space heating system) or wooden block heating systems to keep room warmer. With the solar dryer system based space heating provision, the rooms can be heated which in return reduces the consumption of fuels and reduced health hazard caused by smokes and char. Based on the satisfactory performance of the system, Horticulture Department of J&K requested NISE to supply and install 800 units of Solar Dryers in Leh and Kargil Districts of J&K. NISE has already initiated action for implementation of the proposed project.

Figure 6.13: Solar Apricot Dryer Cum Space Heating System installed at Minjee Village, Kargil

Figure 6.14: Solar Apricot Dryer Cum Space Heating System installed by NISE

RE-INVEST- 2018 Live Demonstration of Various Innovative projects at Vigyan Bhawan and Greater Noida

A team consisting of young scientists from Solar Thermal Division of NISE has indigenously designed and developed a Solar Dryer cum space heating system (**SolDry**) which was demonstrated in the inaugural ceremony of RE-INVEST before the Hon'ble Prime Minister of India and Mr. Antonio Guterres, H.E. Secretary General of United Nations (Figure 1.1). The team has also exhibited a solar powered Cold Storage and Bulk Milk Cooler another innovative product of NISE along with **SolDry** during RE-INVEST 2018 event held at India Expo Mart, Greater Noida, from 03rd October to 5th October 2018, as shown in Figure 6.15 and 6.16.

Design and Development of solar (SPV) cold storage for 24x7 operations using thermal storage.

NISE has implemented a project for Research, Design, Development and Demonstration (RDD&D) of solar (SPV) cold storage for 24x7 operations using thermal storage in collaboration with an industry. The technology offers integration of solar photovoltaic and thermal storage system for 24x7 operation of cold storage. A model was developed and demonstrated in NISE campus. The systems along with its various components are shown in Figure 6.15. The system has following major components:

- Cold Storage unit: The cold storage unit is insulated cold room of 1600 cubic feet volume having a storage capacity of 6-8 tons of vegetables/fruits.
- Solar Photovoltaic System: The system consists of 5 kW_p of solar PV panels
- Solar VFD Based Controller: A Variable Frequency Drive (VFD) is a type of motor controller that drives an electric motor by varying the frequency and voltage supplied to the electric motor.
- Compressor Unit: The compressor unit runs on the VFD based solar controller powered through Solar PV. The compressor unit has a capacity of 3 kW.

- Thermal Storage Unit: A PCM based thermal storage unit has been designed and developed by NISE in collaboration with M/s Inficold India Pvt. Limited. It is ideally suited for providing round the clock cooling with limited solar power.
- Control Unit: The control unit integrates various components of the system. Intelligent control panel selects operation modes automatically based on electricity availability from PV and cooling requirements.

This project shows, that using the proposed control system allows the motor drive system to maintain its optimum efficiency and deliver consistently more power to the load when insolation and temperature vary from the nominal level. This method also offers an improvement in the system stability and reliability. This is achieved by adjusting the control signal frequency of the inverter in a self-adaptive manner, according to the power available from the PV array.

The DC power from the solar photovoltaic is converted to AC power using a solar controller. The solar controller is enabled with Variable Frequency Drive and is programmed to run a refrigeration system on solar energy. The output from the solar controller runs a VFD based refrigeration system. The start-up frequency for refrigeration using this system is 30 Hz at a correspondingly low solar radiation. This makes the cooling system to run for a longer duration during the day (6-8 hrs), run even on cloudy days and decrease start up surge load.

The thermal storage solution for cold storage application is configured in a manner that solar energy generated from solar photovoltaic panels is converted into cold form through a vapour compression cycle. This cold energy is either stored in a low-cost environment friendly phase change material or transferred to the cold storage unit depending on the usage needs. During non-solar hours, the cooling needs of cold storage unit are met through the stored cooling in the thermal storage. The thermal storage is sized to provide 24 hours of backup in a single charge. The thermal energy storage has three times lower capital cost and about ten times longer life in comparison to lead acid batteries. It is ideal for providing cooling backup for 6-8 metric tons perishable products stored in an approximately 1600 cubic feet cold storage at 4-15^{0}C temperature range.

Design and Development of Solar Powered Bulk Milk Cooler using Thermal Storage

NISE has designed, developed and demonstrated a solar photovoltaic powered bulk milk cooler (BMC) using thermal storage in collaboration with an industry. The developed system is totally unique

Figure 6.15: Solar Powered Cold storage of 800 CFT volume with thermal storage demonstrated at RE-INVEST 2018, Greater Noida

Figure 6.16: Solar Powered Bulk Milk Chiller System demonstrated at RE-INVEST 2018, Greater Noida

with retrofittable thermal energy storage which can convert any existing refrigeration system into power backup integrated refrigeration system. This thermal storage unit can be retrofitted between compressor and cooling units of BMC system as shown in Figure 6.16. Intelligent control panel select operation modes automatically based on electricity availability and cooling requirements.

This product is based on a thermodynamic cycle which allows retrofitting of thermal storage to existing refrigeration system, without need for any modification of existing control architecture. The system uses advanced two-phase cooling to achieve high heat transfer rate even with a small flow rate, thereby minimizing parasitic pumping losses and increasing overall system efficiency. The research is carried out to provide an efficient solution of independent adequate capacity buffer Thermal Storage System to chill milk, through power generated from Solar PV modules, as per class 2AII ISO 5708 standard for milk cooling.

Commercialization of Solar Powered Cold Storage and Solar Drier with Ministry of Agriculture and Farmers Welfare (MoAFW) under MIDH Scheme

NISE and MoAFW have jointly decided to undertake a pilot scale installation in different states through Mission for Integrated Development of Horticulture (MIDH) scheme in different states. NISE has already initiated few pilot scale installations of Solar Cold Storage in Tripura and Kerala, which are expected to be completed during 2019-20. Based on the requirements of the pilot installations of various states, R&D work is being constantly carried out to meet the specific requirements apart from the standard product.

FUTURE PROSPECTS AND DEVELOPMENT

In future, NISE would strive to further develop solar products/ systems useful for every individual in this country. The focus would be to promote the developed technology and follow for its patent filed under different developed projects in NISE.

HYDROGEN ENERGY

INTRODUCTION

Hydrogen is not only regarded as an important energy option in world water-energy nexus but also emerging as a clean and sustainable energy carrier, if produced from renewable energy resources. It can be used as an energy storage medium for variable energy resources and has the potential to solve the grid stability issues of modern power grids having increased penetration of variable renewable electricity. Industries such as fertiliser and refineries have been using hydrogen for long for different applications. Recognising the importance of hydrogen as a clean energy carrier, even for transport sector where the need for decarbonisation is being increasingly recognised to reduce emissions, a hydrogen production, storage and dispensing facility operated by electricity generated from solar photovoltaic system was installed and commissioned in the campus of NISE in 2014 under a project supported by Ministry of New and Renewable Energy (MNRE) by the University of Petroleum and Energy Studies. Since January, 2015 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 support some vehicles requiring neat hydrogen for their operations.

NISE has been facing issues relating to regular operation of the facility from time to time. With a view to ensure regular operation of the facility, efforts were initiated by NISE to put in place a mechanism for preventive maintenance of the hydrogen production cum dispensing facility by constituting a Committee of Experts to look into the matter during the period of the report. The Committee submitted its report to NISE and follow up action is being taken by NISE to operationalize the facility. NISE also made efforts for augmenting hydrogen supply at the facility by placing an order for supply of hydrogen from an external supplier that would help in meeting hydrogen requirement whenever in-house production is either insufficient or not available due to operational issues with the electrolyser. However, this arrangement could not be operationalised during the period of the report.

NISE has earlier established a fuel cell laboratory in its campus with 2x1 kW and 1x2 kW Polymer Electrolyte Membrane Fuel Cell (PEMFC) along with necessary arrangement for supply of hydrogen to fuel cells using commercial bottled hydrogen. During the year, the fuel cells in the laboratory were also demonstrated.

PRESENT ACTIVITIES

NISE carried out a detailed study on "Status of Development of Hydrogen Fuelled Vehicles and their Cost Competitiveness for Mobility in India" on the directions received from MNRE. A report was prepared in this regard by NISE based on certain cost input received from the industry and the report was submitted to MNRE. This study makes an attempt to estimate cost of ownership of different hydrogen fuelled vehicles developed in India, based on production cost of the prototype vehicles developed and cost of hydrogen fuel available from different sources. It also compares cost of ownership of these vehicles with competing vehicle technologies that use fossil fuels. It emerges out from the study that presently hydrogen fuelled vehicle technologies cannot compete with the fossil fuelled vehicles on cost of ownership basis for which a simple framework was also developed as a part of the study. The report recommends that financial incentives for acquiring the

vehicles and also for lowering the cost of hydrogen as a fuel may be necessary for making hydrogen fuelled vehicles competitive vis-a-vis comparable fossil fuelled vehicles.

MNRE has supported a number of RD&D projects in the area of hydrogen energy and fuel cells. For monitoring the progress of these projects, MNRE has set up four Project Monitoring Committees. NISE assisted MNRE to organise meetings of Project Monitoring Committees related to Fuel Cells and Hydrogen Storage during the year in its campus.

NISE successfully displayed and demonstrated a hydrogen-diesel dual fuel vehicle in association with Mahindra & Mahindra during RE-INVEST 2018 organised by MNRE during 3-5 October 2018 at India Exposition Mart, Greater Noida, Uttar Pradesh. Mr. Tim Karlsson, Executive Director, the International Partnership for Hydrogen and Fuel Cell in the Economy (IPHE), which is an international inter-governmental partnership currently consisting of 18 member countries, including India and the European Commission, visited hydrogen production cum refuelling facility at NISE along with MNRE officials on 5th October, 2018 and had discussions over decade long development of hydrogen energy in the country with support of the Government of India and role of NISE in it alongside other academic and research institutions/organisations (Figure. 7.1). Activities of NISE relating to hydrogen energy were also exhibited during an exhibition held at Pragati Maidan, New Delhi during 27-29 July, 2018.

Figure 7.1: Visit of Executive Director, IPHE and MNRE Scientists to Hydrogen Facility at NISE

NISE was also engaged in having preliminary discussions for possible technical cooperation with international institutions from the Netherlands, France and Germany. Exploratory discussions were held with the representatives of Hyundai Motor India Ltd. regarding refuelling of their fuel cell car (NEXO) and possible co-operation between the two organisations. A number of visitors from international as well as national organisations have been visiting hydrogen production cum storage facility at NISE. Hydrogen Energy Division of the NISE has also been delivering lectures on hydrogen production cum dispensing facility of NISE in particular and hydrogen energy and fuel cells in general for the benefit of participants attending different training programmes at NISE.

A poster presented by the scientists of NISE on "Availability and Cost of Hydrogen from Chlor-alkali Units for Transport Applications in India and Vehicles

that can be Supported Using it" during the 7th International Hydrogen and Fuel Cell Conference at Jodhpur was well appreciated. Dr. V. K. Saraswat, Member, NITI Aayog showed keen interest in the paper and had discussions with the scientists of NISE on its findings (Figure: 7.2). An article authored by the Scientists of NISE on "Emerging clean public transport options for India and associated challenges" was accepted for publication in the Newsletter of MNRE.

Figure 7.2: Dr. V.K. Saraswat, Member, NITI Aayog having discussions on Poster by NISE at 7th International Hydrogen and Fuel Cell Conference at Jodhpur

During the period of the report, Hydrogen Energy Division of NISE submitted two RD&D project proposals for seeking financial support from MNRE, namely: (i) Setting up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Haryana, and (ii) Technology Validation of different hydrogen fuelled vehicles developed in India by way of undertaking field trials and demonstration. NISE has secured financial assistance of about Rs.10.30 Cr. for implementation of the R&D project entitled "Setting up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Haryana" for a period of three years.

FUTURE ACTIVITIES

NISE would work towards creation of a Centre of Excellence on Hydrogen Energy. NISE will aim to operate and maintain its hydrogen production cum dispensing facility. Under this project, augmentation of hydrogen production capacity by setting up 10 Nm^3/hr electrolyser is also envisaged. This would help NISE in providing hydrogen fuel to vehicles for demonstration/field trials.

SKILL DEVELOPMENT & CAPACITY BUILDING

INTRODUCTION

NISE extends capacity building opportunity for skilling up young minds across the world. This organisation empowers people by conducting skill development programmes, training, short term courses, client specific courses on solar photovoltaic and thermal technologies. The proposed mandate enable 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 scrutinized 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 individual to prospective employer.

During the year, NISE have imparted trainings to wide variety of participants from Government Departments, Schools, Colleges, Armed Forces and Nodal agencies through short term training courses specifically devised according to the need of the participants. The International training programmes are also organised for active growing solar environment and sustainability. The participants of Armed Forces for five day skill development programme on renewable energy are shown in Figure 8.1. In the FY, newly developed training courses were introduced for enhancement of knowledge sharing. A total of 26 training courses were conducted and 717 National/International individuals participated in these training programmes. The details of the Training Programme conducted at NISE for the FY 2018-19 is given in Table 8.1.

NISE offers highly motivated individual an opportunity to contribute in latest research, learn testing of solar photovoltaic technologies and improve their skills through internship at the institute. The students are considered for internship based on their professional and academic background. NISE encourages women candidates to join in the field of solar dominion. The students are enrolled for a minimum period of three months. The students here are trained to gain experience and work in a varied environment.

Figure 8.1: Armed Forces Participants for five days skill development programme on "Renewable Energy Technologies"

Table 8.1: Details of Skill Development Programmes conducted at NISE during 2018-19

S No.	Program	Number of Programmes	Duration of Programmes (Days)	Date	Number of Participants
1	Solar PV System Design using "PVSYST & PVSOL" Software with cost Economic and Policies	4	5 5 5 5	23-27April 2018 25-29 June 2018 24-28 Sept 2018 18-22 Feb 2019	22 16 21 15
2	Workshop on Start-up India Skill Development programme	3	5 5 5	28- 01 June 2018 30-03 Aug 2018 24-28 Sep 2018	29 43 30
3	RE Training Programme for Armed Forces	2	5 5	30-03 Aug 2018 04-08 Feb 2019	43 44
4	Solar Rooftop Grid Engineers Course	2	12 12	22-02 Nov 2018 27-08 Mar 2019	28 35
5	Advance Solar Professional Course	2	180 180	06 Feb 2018 to 05 Aug 2018 08 Oct 2018- 07 April 2019\	41 32
6	International Training Programme	10	21 21 21 21 21 21 21 21 21 21	27-14 Sep 2018 10-29 Sep 2018 24-12 Oct 2018 15-03 Nov 2018 26-14 Dec 2018 26-15 Dec 2018 07-25 Jan 2019 21-09 Feb 2019 04-22 Feb 2019 18-09 Mar 2019	30 29 16 24 32 21 23 24 27 29
7	Solar Water Pumping (Varunmitra)	1	21	01-19 Feb 2019	27
8	Solar Analytics	1	5	17-21 Dec 2018	11
9	Designing and Performance Evaluation of Solar Thermal System	1	4	10-13 April 2018	25
		26		**Total**	**717**

DESIGN, INSTALLATION & COMMISSIONING OF SOLAR WATER PUMPING SYSTEM TRAINING PROGRAMME

Solar Water Pumping System is anticipated to attain an impressive growth in Global market and while witnessing to its allied activities in irrigation, farming, drip irrigation, drinking, cooking etc. NISE has aimed to create a trained manpower for solar water pumping system. NISE, under the sponsorship of MNRE has started a solar water pumping course known as 'Varunmitra Training 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 DC- DC converter, inverter, battery, motors, pump – motor set etc. This course provides a hands on practise for Solar PV Water Pumping System. Figure 8.2 shows the participants of Solar water Pumping Programme at NISE.

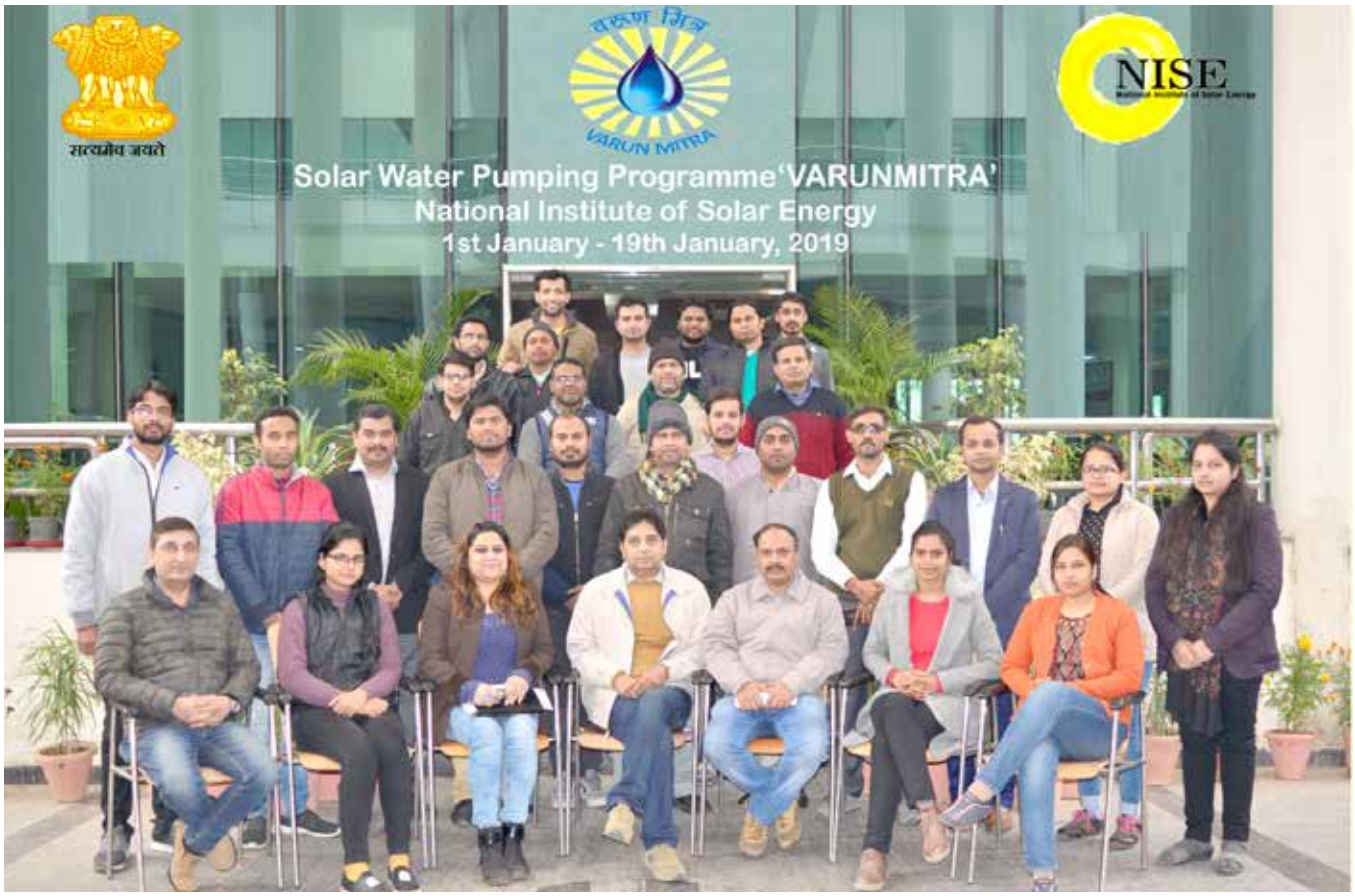

Figure 8.2: Participants for Solar Water Pumping Training Programme (Varunmitra) at NISE

During the year, a total of 20 programmes were started at various institutions. NISE has allocated 15 institutions in 13 states for implementation of this programme. A total of 425 participants were trained in the Varunmitra Training programme on Pan India Basis. The course follows SGJ/Q0112 (SGJ/N0134) Qualification Pack of Skill Council for green Jobs (SCGJ). Table 8.2 shows the state wise progress of varunmitra training programme conducted at various centres across different states. Figure 8.3 shows the participants of solar water pumping training programme conducted by GERMI, Gandhinagar, Gujarat.

Table 8.2: State Wise progress of Varunmitra Training Programme

S. No	State	Number of Batches	Number of Participants
1	Andhra Pradesh	2	20
2			20
3	Assam	2	20
4			21
5	Gujarat	1	20
6		1	21
7	Haryana	1	27
8	Punjab	1	20
9	Maharashtra	2	20
10			20
11	Bihar	1	20
12	Jharkhand	1	20
13	Rajasthan	2	20
14			20
15	Tamil Nadu	2	28
16			28
17	Madhya Pradesh	1	20
18	Chhattisgarh	1	20
19	Uttar Pradesh	1	20
20		1	20
		20	**425**

Figure 8.3: Solar Water Pumping Training Programme (Varunmitra) conducted by GERMI, Gandhinagar, Gujarat

SOLAR PV SYSTEM DESIGN USING "PVSYST & PVSOL" SOFTWARE WITH COST ECONOMICS AND POLICIES

A sustainable solar solution and appropriate financing of a solar PV System depends upon the solar PV system design and its simulation. This training programme foresee to enable an individual to design and analyse a PV system. The participants are given knowledge regarding 3D simulation, 3D modelling, calculation of production and economic profitability, etc. During the year, NISE completed four training programmes for PV SYST and PV Sol Software training and a total of 78 participants were trained through this programme. Figure 8.4 shows the participants of Solar PV System Design using "PVSYST and PVSOL" Software with cost economics and policies.

Figure 8.4: Participants of Solar PV System Design using "PVSYST and PVSOL" Software with cost economics and policies.

WORKSHOP ON PROSPECTS FOR START-UP IN SOLAR ENERGY TECHNOLOGIES

NISE is organising start up training programme in solar energy technologies. Every year it has trained entrepreneurs, EPC contractors, Engineers, Govt. Officials across the globe. This course covers implementation methodologies, latest market strategies, new trends and technology concept, etc. NISE has conducted three workshops on prospects of solar energy technologies. Figure 8.5 shows the participants of Start-up Training programme conducted at NISE.

Figure 8.5: Participants of Start-up Training programme conducted at NISE

SOLAR ANALYTICS PROGRAMME

NISE has commenced a new skill development training programme 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. This Solar Analytics programme aims at developing Centre of Excellence (CoE) on analytics for organization as well as developing skills for managing the same. This first five days skill development programme was organized in Dec 2018 at NISE in which 11 participants actively participated. Figure 8.6 shows the participants of Solar Analytics Training Programme.

Figure 8.6: Participants of Solar Analytics Training Programme

INTERNATIONAL TRAINING PROGRAMMES

The Skill Development Division at NISE organizes and conducts various International training programmes for delegates from different countries under International organisations (groups) politically connected to India, viz. Indian Technical and Economic Cooperation (ITEC), India –Africa Forum Summit (IAFS-III) and International Training Programme for International Solar Alliance (ISA). The International Training Division plays a central and collaborative role within an institution by leading and facilitating visits of these international delegates and educating them on Renewable Energy and Solar Technologies. The countries such as Afghanistan, Bangladesh, Cambodia, Cuba, Sudan, South Africa, Algeria, Ghana etc. participated in the training programme. In the FY 2018-19, a total of 10 International training programme were conducted at NISE. A total of 255 participants from 59 countries were imparted training on various aspects of solar energy technologies.

The primary objective of these training programmes were to appraise the participants with the latest developments about Solar Technologies, Policy Aspects, Quality Control and Utilization Aspects of Renewable Energy. These training programmes also helped them to understand the possibilities of bilateral and multilateral cooperation in the field of solar energy projects. The programme enhanced the technical capabilities of the participants and impart knowledge of the Global trends on Solar Technology by exchange of information. The knowledge gained during the programme was utilized by the participants to further develop an understanding of the respective field and its implementation. The officials were nominated from different countries to attend these training programmes. The followings International Training Programmes were concluded during the FY 2018-19:

Renewable Energy Capacity Building Programme for Delegates from African Countries under India –Africa Forum Summit (IAFS-III)

This programme under India- Africa Forum Summit (IAFS-III), was fully funded and supported by Ministry of External Affairs, Govt. of India. Under these programme, a total number of 39 participants joined the course from 11 African Countries. Different topics on Renewable Energy were covered by speakers from the Institute and other organizations and Industry as well. During the programme, the participants visited the project sites on solar pumping solar power plant and rooftop solar projects in different cities of India. Figure 8.7 shows the participants of International Training programme on "Renewable Energy Capacity Building" under India- Africa Forum Summit (IAFS)–III.

Figure 8.7 International Training programme on "Renewable Energy Capacity Building" under India- Africa Forum Summit (IAFS) -III

International Training Programme of Solar Energy Technologies and Application under Indian Technical Economic Co-operation (ITEC)

Every year NISE organizes, three weeks Indian Technical and Economic Co-operation (ITEC) programmes funded by Ministry of External Affairs, Govt. of India. Under these programmes, 89 participants joined the course from 36 developing countries around the world in three batches. This programme was planned for the delegates from developing countries, hence countries like Russia, Egypt, Armenia Guatemala, Sudan etc. have participated in the course. It also brought in

mutual knowledge under development in the field of Solar Energy around the world. Figure 8.8 shows the participants of the International Training Programme of Solar Energy Technologies and Application under Indian Technical an Economic Co-operation (ITEC).

Figure 8.8 Participants of International Training Programme of Solar Energy Technologies and Application under Indian Technical an Economic Co-operation (ITEC)

International Training Programme for International Solar Alliance (ISA)

ISA is an alliance of solar rich countries lying fully or partially between the Tropic of Cancer and Tropic of Capricorn. This programme was conducted for ISA Member country by NISE at its campus. Under these programmes NISE has successfully organized and completed five programmes, in which 127 participants from 26 ISA member countries attended these programmes. Figure 8.9 shows the participants of International Training Programme for International Solar Alliance (ISA). The Table 8.3 shows the details of International Training Programme conducted at NISE for the year 2018-19.

Figure 8.9 Participants of International Training Programme for International Solar Alliance (ISA).

Table 8.3: International Training Programmes during Financial Year 2018-19.

S. No.	Programme Name	Period	Number of Participants	Number of Countries
1.	International Training Programme on Solar Technologies and Applications	27th Aug 2018 - 14th Sep 2018 26th Nov 2018 - 14th Dec 2018 04th Feb 2019 - 22nd Feb 2019	30 32 27	
2.	ITEC Programme in Solar Energy for Master Trainers from ISA Member Countries	10th Sep 2018 – 29th Sep 2018 15th Oct 2018 – 03 Nov 2018 26th Nov 2018 – 15th Dec 2018 21st Jan 2019 – 09th Feb 2019 18th Feb 2019 – 09th Mar 2019	29 24 21 24 29	59
3.	Renewable Energy Capacity building Programme for India Africa Forum Summit III	24th Sep 2018 – 12th Oct 2018 07th Jan 2019 - 25th Jan 2019	16 23	
		Total	**255**	**59**

* IAFS: India-Africa Forum Summit,

SURYAMITRA SKILL DEVELOPMENT PROGRAMME PAN INDIA BASIS

The Suryamitra Skill Development Programme was designed with an objective to develop a skilled and employable workforce (Suryamitras) for catering to the needs of Solar PV industries and EPC projects. These participants were trained to perform jobs related to Installation, Commissioning and Operation & Maintenance of a Solar PV system in EPC projects. After completion of the training programme, Suryamitras were offered positions such as technician, supervisor, and managers in Solar PV organizations and also an opportunity to emerge as an entrepreneur in the Solar PV Industry. Figure 8.10 shows the Suryamitra Training programme conducted at various affiliated institutes in India.

NISE had issued an Expression of Interest (EOI) for FY 2018-19 & 2019-20 to empanel Training Partners (TP) for Suryamitra Skill Development Programme. The TPs were shortlisted by adopting transparent mechanism through a committee which consists of officials of MNRE, NISE, IREDA and SECI. After various levels of screening a total no. of 103 TPs with 228 training centers were empanelled by NISE to impart Suryamitra Skill Development Programme in various location of the country.

During the financial year 2018-19, a total of 417 batches were organised wherein 11,912 Suryamitra were trained to develop skilled manpower in the field of solar photovoltaic system. Table 8.4 shows the state wise progress of suryamitra training programme conducted at various institutes in different states.

Figure 8.10 Suryamitra Training Programme conducted at various affiliated institutes in India

Table 8.4 State Wise Progress of Suryamitra Training Programme

S. No.	State	Number of Batches	Number of Participants
1	Andhra Pradesh	19	464
2	Assam	15	400
3	Bihar	15	420
4	Chandigarh	3	90
5	Chhattisgarh	13	360
6	Delhi	7	201
7	Goa	2	60
8	Gujarat	23	550
9	Haryana	15	390
10	Himachal Pradesh	5	150
11	Jammu & Kashmir	7	158
12	Jharkhand	6	180
13	Karnataka	14	348
14	Kerala	5	142
15	Madhya Pradesh	36	1164
16	Maharashtra	30	883
17	Manipur	2	60
18	Odisha	19	567
19	Punjab	5	120
20	Rajasthan	26	775
21	Tamil Nadu	30	912
22	Telangana	32	950
23	Tripura	2	60
24	Uttar Pradesh	34	964
25	Uttarakhand	8	231
26	West Bengal	44	1313
	Total	**417**	**11912**

DISCOM ENGINEERS TRAINING PROGRAMME

NISE is focussing on developing a framework for scaling up of Solar PV rooftop installations. Considering the key aspect of capacity building for commissioning of these rooftop projects, there is a requirement to impart training to the developers, the utility engineers and the bankers. NISE in consultation with a number of experts in the country, has designed a comprehensive and a standardized training programme on solar PV rooftop for entrepreneurs and utility engineers. This programme has been the sponsored by MNRE. It aims to train 5000 utility engineers and 1000 entrepreneurs in partnership with USAID PACE-D TA Programme. During the year, 63 utility engineers programme and 21 entrepreneur programmes were conducted in standardised selected training institutes. A total of 2419 Utility engineers and 866 entrepreneurs participated in this programme.

ADVANCED SOLAR PROFESSIONAL COURSE (6 MONTHS) COURSE CODE: NISE/010/2017-18

NISE is organising a flagship training programme for young professionals. This advanced solar professionals course is a very new job oriented and technologically advanced training programme. This course profile covers the solar energy concepts for both technical and non-technical individuals (business persons). During the year, NISE conducted second course starting from 8th October 2018 to 7th April 2019. A total of 32 number of candidates were shortlisted as per their qualifications and experiences. Figure 8.11 participants of Six Months Advanced Solar Course with eminent faculty and scientist.

Figure 8.11 participants of Six Months Advanced Solar Course with eminent faculty and scientist.

ROOFTOP SOLAR GRID ENGINEERS COURSE

The Rooftop Solar Grid Engineer course was successfully launched at National Institute of Solar Energy. This training has been conducted based on Qualification Pack (QP) SGJ/0106 duly certified by the National Skill Development Corporation (NSDC). QP has been developed based on Industry Requirement in the field of Solar Rooftop Grid-tied system. The course assessment and certification were conducted by the Skill Council for Green Jobs. During the year two courses are conducted at NISE during 22nd Oct 2018 to November 2018 and 27th Feb 2019- 8th March 2019. Figure 8.12 and 8.13 show the glimpse of the solar rooftop grid engineer courses conducted at NISE.

This programme is proposed to be conducted at various institutes across different states. A total of 30 batches for Rooftop Solar Grid Engineer has been sanctioned by MNRE. A total of 22 courses have been conducted across the country in different states. The state wise progress for rooftop solar grid engineer training programme is given in Table 8.5. In the FY 2018-19, a total of 923 participants have been trained across different states under this rooftop solar grid engineer course.

Figure 8.12 Participants of Rooftop Solar grid Engineer Course at NISE

Figure 8.13 Participants of Rooftop Solar Grid Engineer Course conducted at NISE

Table 8.5 State Wise Progress for Rooftop Solar Grid Engineer Training Programme

s. No.	State / UTs	Number of Programmes	Number of Participants
1	Gujarat	02	45
			48
2	Haryana	02	28
			33
3	Karnataka	02	37
			43
4	Kerala	02	40
			40
5	Madya Pradesh	02	40
			40
6	Maharashtra	02	40
			40
7	Orissa	02	29
			51
8	Rajasthan	02	40
			54
9	Tamil Nadu	02	44
			43
10	Uttar Pradesh	02	40
			40
11	Delhi	02	51
			57
	Total	**22**	**923**

INTERNSHIP TRAINING FOR B.TECH/ M.TECH/ MSc/ Ph.D.

Apart from various training programmes, NISE has conducted internship training programmes for B.Tech/M.Tech/MSc/Ph.D. students on solar energy technologies every year. For the year 2018-19, there were 15 B. Tech and 09 M. Tech students from reputed institutions. These interns were involved in research and testing activities for their research projects at NISE.

FUTURE PROSPECTS AND DEVELOPMENT

NISE intends to introduce new structured courses such as data analytics, design and development of power electronics, converters and solar radiation, etc. NISE shall organise International Training programmes with enhanced practical trainings and structured modules. NISE has planned for extensive courses on solar thermal technologies.

COORDINATION & INTERNATIONAL COLLABORATIONS

NISE extends an extraordinary opportunity for encouraging cooperation, collaboration, knowledge sharing and research with National and International organisations. We invite 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 aid for Government of India (GoI) aided projects. It acknowledges the large scale implementation of projects while maintaining its quality and enhancement.

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

Figure 9.1: NISE Exchanging MoU with Central Electronics Limited (CEL), Ghaziabad

Figure 9.2: NISE Exchanging MoU with Aligarh Muslim University (AMU)

MOU'S SIGNED BY NISE

In the FY 2018-19, NISE has established its partnership with various organization as given in Table 9.1. A total of 7 MoUs were signed during the year. Figure 9.1 & 9.2 shows, NISE exchanging MoU with Central Electronics Limited, CEL, Ghaziabad and Aligarh Muslim University. These associates are looking forward for the activities such as: (i) Joint research and innovation, (ii) Training programme for skill development, (iii) Exchange of Knowledge for testing, product development and execution of projects, (iv) Joint association for conducting seminar, conferences, training and workshop.

Table 9.1: MoUs signed during 2018-19

S. No.	MoU	Date of Signing	Validity
1	NISE & Inficold India Pvt. Ltd.	9th July 2018	8th July 2020
2	NISE & JMI University (Jamia Millia Islamia University)	10th July 2018	9th July 2023

S. No.	MoU	Date of Signing	Validity
3	NISE & Aligarh Muslim University (AMU)	27th September 2018	26th September 2023
4	NISE & International Solar Alliance (ISA)	27th September 2018	6th December 2020
5	NISE & Central Electronics Limited (CEL)	3rd October 2018	2nd October 2023
6	NISE & IIT Patna (India Institute of Technology Patna)	3rd December 2018	2nd December 2023
7	NISE & Rewa Ultra Mega Solar Park Limited (RUMSL), Bhopal, Madhya Pradesh (Independent Engineer Services Agreement)	14th January 2019	Till the project is completed

INTERNATIONAL ALLIANCE

Project with PTB Germany

NISE has continued to establish its tie up with PTB Germany under Indo-German cooperation for Solar Industry. NISE has entered into Phase–II of the project "Strengthening of Quality Infrastructure for the Solar Industry". The objective of this project under Phase–II is (i) to conduct round robin tests and inter lab comparisons among metrology and testing labs, (ii) to provide support for cooperation and establishment of a network of participating laboratories, (iii) to impart training, awareness programme and Training of Trainer (ToT) in quality aspects in the solar sector, (iv) to conduct studies/ research on quality challenges in the solar sector. NISE shall play an active role in intervening with the implementing partner agencies, wherever necessary, for ensuring proper progress and success of the activities.

Collaboration with International Solar Alliance (ISA)

NISE has a key focus on promotion of projects and trainings for International member countries of ISA. NISE aspires to transform every international member via technical assistance, skill development and investments. Considering this well-defined objective, NISE collaborates with International Solar Alliance (ISA). In this FY 2018-19, NISE imparted training to 255 International individuals of ISA member countries. It arranged for visits of International delegates across the country presenting them with technical knowledge and assistance in solar photovoltaic technologies. During the year, NISE, under the sponsorship of ISA, organised to implement an ISA Solar Fellowship Scheme for the Mid-Career Professionals in ISA Member countries. In this programme, the middle level officers/technical officers of ISA member countries working in the area/sector of solar energy were nominated by different countries for two years for "Master of Technology on Renewable Energy Technologies and Management". A total of 22 participants have been nominated to this course being commenced with Centre of Energy Studies, IIT Delhi. The programme is designed to meet the requirements of policy makers, planners, administrators, managers in the government, public and private sectors, non-governmental organizations, who have a public service commitment, demonstrated leadership potential, and commitment to their own country's development.

NISE is continually participating in various events/ meetings organised by ISA. NISE has developed an initiative for promoting solar alliance and provides support to ISA for administrative services and financial assistance. NISE is hosting the headquarter of ISA in its campus.

SUPPORT PROGRAMMES AND ACTIVITIES

CONSULTANCY SERVICE

NISE is handling various consultancy projects on Solar Photovoltaic & Solar Thermal Technologies. The consultancy division provides specialized services to its clients in designing and offers excellent 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. Figure 10.1 shows the consultancy services and activities imparted by consultancy division at NISE.

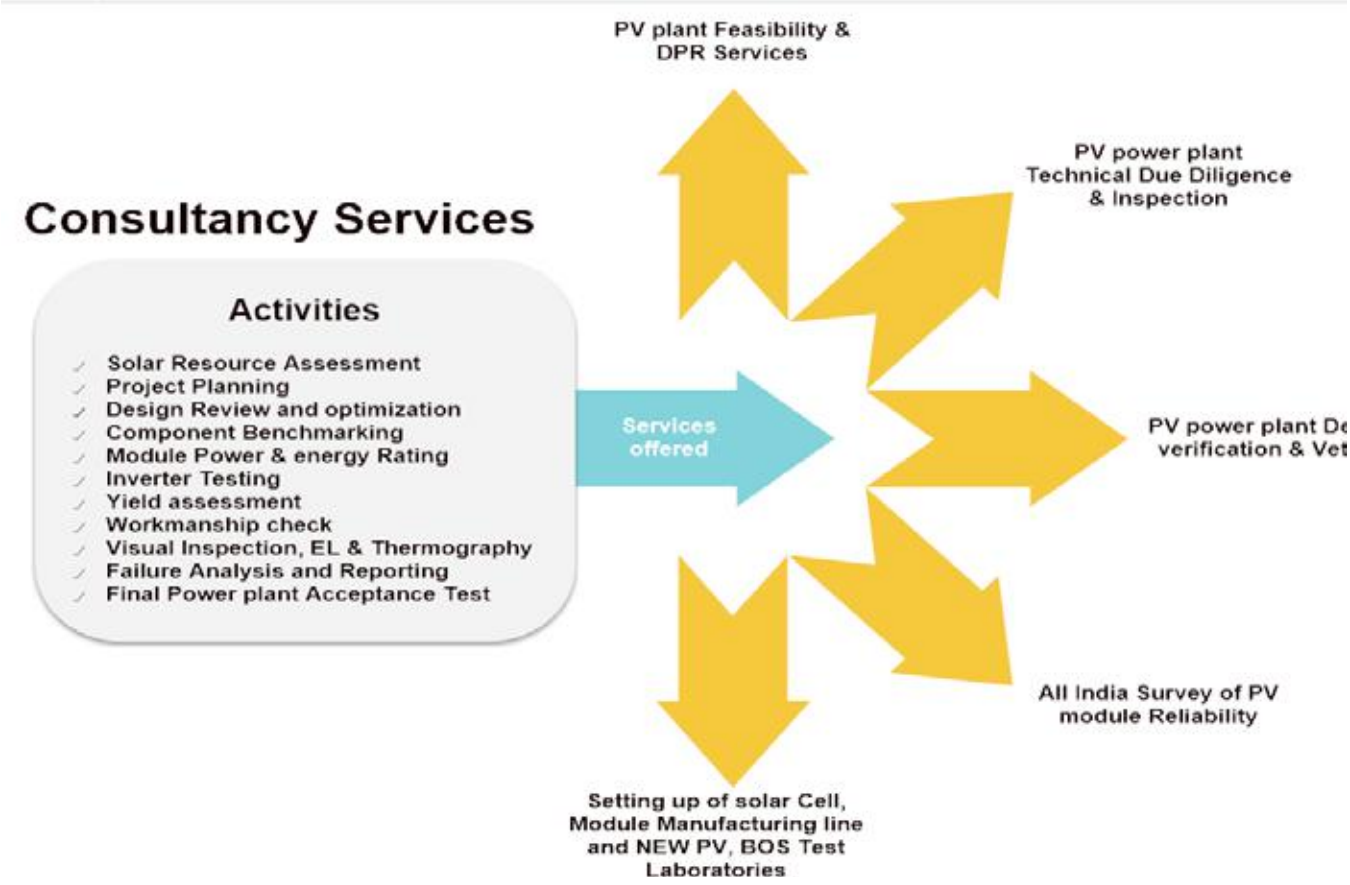

Figure 10.1: Consultancy services provided by NISE

NISE has been engaged as an independent engineering institution for evaluation and commissioning services of 750 MW REWA Ultra Mega Solar (RUMS) Project at REWA Madhya Pradesh. NISE has started on site testing of large scale Solar Photovoltaic Projects for quality and performance behaviour of Solar Plants. Figure 10.2 shows the testing and services provided by NISE at various sites. 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. NISE has also supported ISA Member Countries i.e. Ghana, Peru, Guyana through International Solar Alliance (ISA) Headquarter for deployment of Solar Power Projects. This helps in incremental revenue generation. NISE has vetted design & drawing documents of more than 25 MW SPV Power Plant in Financial Year 2018-19 at different locations and more are in pipe line for next coming years. Different consultancy services provided by NISE, is given in Table 10.1.

Figure 10.2: Consultancy services provided by NISE

Table 10.1: Consultancy Services provided by NISE during 2018-19

S. No.	Plant Capacity	No. of Time	Vendor Details	Amount (Rs. In Lakh)
1	Design & drawing vetting of documents (1 MW Bareily, 1MW Maharajpur, 1 MW Pune, 1 MW Naliya, 1 MW Gandhinagar, 1 MW Bhuj)	1	M/s Vivan Solar Pvt. Ltd. (Uttar Pradesh, Madhya Pradesh, Maharashtra, Gujarat) (MES Project)	18.00
2	Design & drawing vetting of documents (2 MW Surat, 2 MW Sri Ganganagar, 1 MW Mahajan, 1 MW Kanasar)	1	M/s Sukhbir Agro Energy Ltd., Village Devgaon/Kankua, Tehsil-Kulpahar, Distt Mahoba, U.P. **(Military Station Surat, Mahajan, Kanasar, Sri Ganganagar)**	19.55
3	Design & drawing vetting of documents (1 MW Jodhpur, 1 MW Jamnagar)	1	M/s Rays Experts (Risabh Construction) Pvt. Ltd., 7th Floor, Okay Plus Tower, New Govt. Hostel, Crossing, Ajmer Road, Jaipur-302006 **(Air force station Jamnagar & Jhodhpur)**	6.00
4	Design & drawing vetting of documents (1 MW MES Lucknow)	1	M/s Sawan Electricals, Gomti Nagar, Lucknow, U.P-226024 **(MES, Headquarters, Chief Engineers (AF) Allahabad)**	3.00

S. No.	Plant Capacity	No. of Time	Vendor Details	Amount (Rs. In Lakh)
5	1 MW site testing including designing and development of product	1	M/s SDS Solar Pvt. Ltd., Village-Burak, Burak Balsamand Road, Distt Hissar-125001	2.74
6	Design & drawing vetting of documents (200 kW Power Plant)	1	M/s Mittal Machine Pvt. Ltd., 108/3, Chander Nagar, Dehradun, Uttarakhand-248001 **(MES Project Bihata Bihar)**	2.00
7	Site testing including designing and development of product (2 MW at IOCL, Refinery, Panipat, Haryana)	1	M/s Sunsmith Infra Pvt. Ltd., B-29, Phase-2, Mayapuri Industrial Area, New Delhi-110064	5.90
8	Design & drawing vetting of documents (613.14 kW Power Plant at Garuda Naval Kochi)	1	M/s Sterlling & Wilson Pvt. Ltd., VI/962 (A) 1st Floor,Krishna Tower, Opp. Thrikkakara Temple, Edappally- Pukkattupady Road Thrikkakara, Kerala **(INS Garuda, Naval, Kochi, Kerala)**	2.74
9	Design & drawing vetting of documents (100 kW Power Plant at Air Force Station, Vadsar)	1	M/s UR Energy (India) Pvt. Ltd., B2/9th Floor, Palladium, B/h, Divya Bhaskar Press, Corporate Road, Prahlad Nagar, Ahemdabad-380015 **(Airforce station, Vadsar, Ahmedabad, Gujarat)**	1.18
10	Performance Evaluation of 600 kW Grid Interactive Power Plant at CEL, Ghaziabad, U.P.	1	M/s Central Electronics Limited (CEL) (A Public Sector Enterprise) 4, Industrial Area, Sahibabad - 201 010 (U.P.) India	0.40
11	Inspection of 1 MW Solar Power Plant at Jhansi, Uttar Pradesh	1	M/s Dhurav Milkose Pvt. Ltd. Jhansi, Uttar Pradesh	3.24
			Total Amount (Rs. In Lakh)	**64.75**

LIBRARY

The Library has established its fully automated facilities and services for international training participants, official/ Staff, visitors and many trainees of different departments. A total number of 35 books were purchased in the FY 2018-19. The library has continued to maintain its 8285 volumes of books, bound volumes of Journals and other reading material, to cater to the requirements of its users. The library has continued subscription of Scientific Journals and collection of Newspapers, reports and academic journals in both Hindi and English Languages. Figure 10.3 shows the library section at Surya Bhawan, NISE.

Figure 10.3: Library Facility at Surya Bhawan in NISE

SPORTS FACILITIES

The sports facility developed at NISE 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 well-trained coach within the institute. 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 provided for the staff and trainees at NISE. During the year, various indoor activities and games such as badminton, table tennis, chess were organized at foundation day in NISE. Figure 10.4 shows the sports facility available at NISE.

Figure 10.4: Sports facility at NISE

INFORMATION TECHNOLOGY DIVISION (IT)

The IT Division implemented several important projects and upgraded the infrastructure of NISE to make it tech savvy and progressive. The IT infrastructure of NISE was upgraded by connecting the entire campus with Local Area Networking and complete Wi-Fi connected campus has been created successfully. This networking project has been completed and implemented successfully followed by the installation

of CCTV cameras throughout the entire campus of NISE, indoor and outdoor which is now covered with CCTV cameras. A centralised monitoring system has been created to access data from all cameras at one point for which 96 devices were acquired including 12 PTZ cameras, 23 Bullet Cameras, 57 Dome Cameras, 2 Professional Displays and 2 NVRs. Figure 10.5 shows the IT Division facility at NISE. The National Knowledge Network (NKN) was acquired to connect the entire campus for e-Office implementation under a safe network of NIC. NISE has initiated efforts to implement e-Office, to execute all file work digitally. It will help to save paper and save resources tremendously. Over One Lakh existing file pages have been scanned by the division under this project. During the year, the Government e- Market (GeM) portal procurement was commenced by IT division. The IT Division successfully registered NISE on the Central Public Procurement Portal for e-publishing of all tenders, corrigendum and re-tenders were uploaded on the portal too.

The IT division has reached a new milestone by awarding a tender to Roman Networks for National Centralised Monitoring Centre (NCMC), after a strenuous analysis, the process to install Data Loggers for Supply, Installation, Commissioning, and Maintenance of Data Acquisition Systems for Performance Monitoring of SPV Systems at various locations in India was completed. National Centralised Monitoring Centre under the leadership of the IT Team, NISE in collaboration with United States Agency for International Development (USAID) under the supervision of the Ministry of New and Renewable Energy (MNRE), GoI, is working on a National Level Centralized Monitoring Centre (NCMC), an ambitious project to create a Centralized Online Monitoring System for capturing and processing of live data from solar energy projects/plants across Northern India.

Over 10 new web portals were created for NISE, such as Suryamitra portal, IFD portal, recruitment portal, training portal, NCMC portal, accounts , testing , biometric portal for Suryamitra, file entry portal, GeM portal for smoother and smarter functioning of work in house by the IT team. The UPS maintenance, electricity maintenance, IT cell maintenance configuration of switch, routers and firewall, printing the updated ID cards and purchase of cloud space from National Informatics Center has been completed successfully.

Figure 10.5: Information Technology (IT) Division facility at NISE

CUSTOMER SERVICE CELL

Customer Service Cell (CSC) division is centrally responsible for management of testing services in the institute, it 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, payment and release of reports. NISE offers comprehensive range of testing services (IEC, BIS, MNRE specifications etc.) that facilitates testing as per National /International standards for various solar energy products and their components. In the FY, all personnel in NISE were ISO/IEC 17025:2017certified, ensuring quality, better administration and technical operations.

Consultancy for testing of various solar products has been started. Testing protocols for various tests 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. CSI for 2018-2019 is 97.5%. Figure 10.6 shows the various testing services available at NISE.

Solar Cells
PV crystalline silicon solar cell testing as per 60904-1:2006/IS 12762 (Part1).

Solar Photovoltaic Module
Crystalline Silicon/Thin Film PV Module for Individual Testing and complete as per IEC 61215/ IEC 61646, IS 14286 etc. safety standard as per IEC 61730-1, 61730-2 and salt spraytest as per IEC 61701, Potential Induced Degradation as per IEC 62804, Electroluminescence and Bypass diode, IEC 61853.

Solar Inverter
Solar PV Power off -grid or on- grid Inverters/Converters testing as per IEC61683, IEC62509, EN50530, Converter MPPT Test, Test procedure of islanding prevention measures for utility-interconnected Photovoltaic inverters as per IS 16169/IEC61727/IEC62116, Photovoltaic (PV) systems - Characteristics of the utility interface as per IEC 61727, IEC60068-2(1, 2, 14 and 30) and MNRE Guidelines, user Specifications up to 50 KVA.

Battery
Capacity Test as per IS 16270, 13369, IS15539, IS 1651 Efficient test (Ah & Wh), Self-discharge test/Charge Retention, Endurance Test, Sulphation Test, Water Loss Test, Equilibrium Test along with Water loss, Endurance at Extreme Conditions, Test Conductance test, Environmental Testing, Type test and Life cycle tests are available as per IEC 61427, Tubular Lead Acid / VRLA / GEL up to a capacity of 18V and 2000Ah.

Solar Pumps
Performance evaluation testing of SPV Water Pumping System as per IEC 62253, JNNSM, MNRE, 2015-2016 specifications up to 10HP.

Solar Lights
MNRE and user Technical Specifications for White LED(W-LED) based Solar Photovoltaic Lighting systems (Lantern, Home lighting system, Solar Home Systems (Solar Power Packs), Charge Controller, LED Luminaires Photometry, Electrical and Colour parameters of the luminaires (Total Luminous flux, Luminous efficiency, CCT, CRI and Power measurement) as per IES LM 79 / IS 16106,Optical flicker testing of the luminaires, Horticultural lighting testing (PPF, PRF, and Photon efficiency), IESNA LM-82-12

Solar Thermal Systems
Testing as per MNRE and user specification EPC and FPC Based.
1. Flat Plate Collector System
2. Evacuated Tube Collector System
3. Solar Cooker (i.e. Boxed Type & Paraboloid Cooker) test procedures & test protocols.

Calibration
Pyranometer and Pyreheliometer Calibration

Figure 10.6: Testing Services available at NISE

PROMOTION OF OFFICIAL LANGUAGE HINDI

With a view to implement the Official Language Policy of the Government of India, a Hindi 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 provision 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 include, (i) To make the Institute's revamped website bilingual, (ii) All documents coming under section 3(3) of the O.L. 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 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 2017-18 of the institute was printed in both Hindi and English languages. (vii) All navigation boards, general boards, name plates and rubber stamps etc. in the institute are bilingual, (viii) During the year, 03 Hindi training workshops were organized in the institute. Figure 10.7 shows the Hindi Training Workshop conducted at NISE.

Figure 10.7: Hindi Training Workshop conducted at NISE

To review the progress made in the implementation of Official Language policy, quarterly meetings of Official Language Implementation Committee were held regularly. The Sections/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 celebrated in the Institute during 1st to 14th September 2018 to create awareness and to increase the use of Hindi in official work. Various competitions like Hindi Essay writing, poetry, and dictation were organized among the officers and employees of the Institute. In these competitions, the officers and staff of the institute enthusiastically participated. Based on their performances, memento, certificates and cash prizes were awarded to the participants by the DG, NISE. (Figure 10.8).

Figure 10.8: Prize Distribution ceremony by Dr. Arun K Tripathi, DG NISE on the Closing Ceremony of Hindi Pakhwada.

On October 30th, 2018, Dr. Devdutt Ojha (Secretary, Science Prasar Prayag, Jodhpur) was invited to give a special lecture on 'Need of Clean and Green Energy' in Hindi. This lecture was attended by all the officers and employees of the institute with great enthusiasm. Figure 10.9 shows the lecture delivered by Dr. Devdutt Ojha, Secretary, Science Prasar Prayag, Jodhpur on 'Need of Clean and Green Energy'.

Figure 10.9: Lecture delivered by Dr. Devdutt Ojha, Secretary, Science Prasar Prayag, Jodhpur on 'Need of Clean and Green Energy'.

The National Institute of Solar Energy has been inspected by the Parliamentary Official Language Committee in Hotel Ashoka on 03/10/2018. Figure 10.10 shows the glimpse of event held at Ashoka Hotel. Dr. Satyanarayan Jatiya, Vice President of the Committee emphasized that the Annual Programme specified by the Ministry of Home Affairs should be completed by the institute as soon as possible. The event held for the discussion of the Parliamentary Official Language Committee's article and evidence sub-committee with the NISE was organized on February 18, 2019 in Hotel Ashok, New Delhi. NISE is the member of Town Official language Implementation Committee (TOLIC), Gurugram since 27/09/2018 and has participated in various programs organized under the aegis of TOLIC, Gurugram.

Figure 10.10: Parliamentary Official Language Committee held at Hotel Ashoka

INFORMATION & PUBLICITY

NISE actively participated in "2nd Global RE-INVEST" from 3rd to 5th of October 2018 at India Expo Mart, Greater Noida. NISE demonstrated its products such a Sol Dry, Solar Powered Cold Storage, Bulk Milk Chilling and Mobile Testing Facility. NISE set up a stall showcasing the technological developments taking place at the institute. A Memorandum of Understanding was signed with the Central Electronics Limited at the event. The participants from various countries visited the stall and appreciated NISE for its innovative ideas. Figure 10.11 shows the stall of NISE at 2nd RE-INVEST conducted at India Expo Mart, Greater Noida.

NISE participated in the "Inter Solar Exhibition and Conference" hosted at Bangalore. NISE showcased its services, certifications, testing and products available in the solar Industry. Over 300 visitors, from Public and Private Sector Enterprises particularly from the Renewable sector, Electrical industry, Media Houses, etc. visited the stall. Shri. Arun K Tripathi, Director General, NISE presented the current status of Solar Technologies in this conference. Figure 10.12 shows the glimpse of Inter Solar Exhibition and Conference conducted at Bangalore.

Figure 10.11: 2nd RE-INVEST conducted at India Expo Mart, Greater Noida.

Figure 10.12: Presentation on Solar Energy Technologies and Inter Solar Exhibition conducted at Bangalore

FOUNDATION DAY AT NISE

NISE hosted its 5th Annual Foundation Day Celebration on the 29th of October 2018. Shri Upendra Tripathi, DG, ISA, graced the event as the Chief Guest, along with Shri Vinay Pratap Singh, Dy. Commissioner, Gurugram, and Shri Munish Sharma Add. Dy. Commissioner, Gurugram, as the Guests of Honour. The Chief Guest, Guests of Honour and the dignitaries of NISE, all participated in the various events held in the premises on the day including Lighting of Lamp, NISE's innovation exhibition, etc. Figure 10.13 shows the glimpse of Foundation Day conducted at NISE. They also facilitated NISE employees with awards and gifts for outstanding performance in their respective domains, during an award distribution ceremony.

NISE's bi-monthly newsletter 'Surya Rashmi' was also launched on the occasion. Figure 10.14 shows the launch of 'Surya Rashmi' newsletter. Several schools in the district were invited to be a part of the celebration. The students enthusiastically performed dance and song pieces and participated in quiz and art competitions hosted by the institute, whereupon they were facilitated by prizes. The theme of the quiz was Renewable Energy in which, Alpine School, Sector 10, Gurugram, bagged the first prize and Delhi Public School, Gurugram, stood third. The young artists in the painting competition produced astonishing and prolific works, all of them were widely appreciated by the judges. DPS, Gurugram won the first and the second prizes in painting, followed by Alpine School, Gurugram, and DPS, Gurugram, won the third position.

A series of Sports events were also held, for NISE employees as a part of the Foundation day, prior to it. All the employees participated enthusiastically, including Dr. Arun K. Tripathi, DG, NISE, and bagged several prizes. Table Tennis, Carom, Chess, Snookers, and Badminton were played, with two separate categories of men and women. The participants who won the first prizes include, Naresh Mehta for Snooker, Suman Chaudhry and Gauri Ganesh for Chess, Shri Vikas and Snehlata for Carom, Sunil Sangwan and Rashmi Singh for Badminton.

Figure 10.13: Shri Upendra Tripathi, DG, ISA, along with Director General, NISE, Shri Arun K Tripathi graced the Foundation Day event at NISE.

Figure 10.14: Launch of 'Surya Rashmi'Newsletter at Foundation Day event in NISE.

REPUBLIC DAY CELEBRATION

Republic Day is one of the national festivals of India, which is celebrated on 26th January with great zeal and respect throughout the country. Like every year, Republic Day was celebrated with great enthusiasm in NISE. Figure 10.15 shows the Republic Day celebration conducted at NISE. On this occasion, the DG hoisted the flag in the courtyard of Aditya Bhawan of the institute and a small parade was also organized by the security personnel of the institute. The Director General addressed the officers and employees of the institute. Advisor Dr. D.R. Das and Deputy Director General Mr. Sanjay Kumar expressed their views while congratulating all the scientists and employees on this occasion.

Figure 10.15: Republic Day Celebration conducted in NISE.

SWACHH BHARAT ABHIYAAN

A Cleanliness Fortnight was observed from 01st to 15th June 2018. All officers and employees of the institute actively participated. Figure 10.16 shows the Swachhta Pakhwada celebration held at NISE. Dr. Arun Kumar Tripathi, Director General inaugurated the program. The Director General NISE, spoke about the importance and maintenance of cleanliness in our homes and how we should constantly take care of cleaning our offices, equipment related to our work, tools and machines etc. The officials and staff present on this occasion also pledged to take full care of cleanliness.

On this occasion, Dr. Chandan Banerjee, Deputy Director General, said that the plants in the institution which are a few miles away from the main buildings, should be as clean as the Surya Bhawan and Aditya Bhawan. After this, cleanliness was done throughout the fortnight at all the places of the institute.

Figure 10.16: Swachhta Pakhwada celebration at NISE

VIGILANCE AWARENESS WEEK

The Central Vigilance Commission observes the Vigilance Awareness Week every year. This observance of Vigilance Awareness week is conducted during the birthday of Honorable Sardar Vallabhbhai Patel. This year it was observed during 29th October – 3rd November 2018. The theme of the Vigilance Awareness Week-2018 was 'Eradicate Corruption - Build a New India'. 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. Figure 10.17 shows the oath taking ceremony celebrated during vigilance awareness week at NISE.

VIGILANCE

The Vigilance Division of the Institute is entrusted with taking anti-corruption measures in accordance with various rules, guidelines, instructions issued by the Government of India and the Central Vigilance Commission. In addition to taking anti-corruption measures, the division also upkeeps the Annual Performance Appraisal Reports (APARs) of all the officials of NISE. No complaints were received in the vigilance division during the year 2018-19.

Figure 10.17: Oath taking ceremony during vigilance awareness week at NISE

INTERNATIONAL YOGA DAY

International Yoga Day was organized in the NISE on June 21st 2018. About 50 officers and employees of the institute participated, who were imparted yoga training by the Yogacharya Shri Ramesh Kandpal. Figure 10.18 shows the International Yoga Day celebration conducted at NISE. In the beginning of the yoga class, Shri Kandpal told that the day of June 21 is the longest in the year and Yoga also provides a long life to man. He practiced the smallest, important verbs of yoga and asana-pranayama.

Dr. D.R. Das, Scientist, 'G', informed that for the first time this day was celebrated on June 21, 2015, which was initiated by Honorable Prime Minister Shri Narendra Modi by his speech at the United Nations General Assembly on September 27, 2014. In his speech Shri Modi said, "Yoga is an invaluable gift of the ancient tradition of India, it symbolizes the unity of mind and body, it is harmony between man and nature, giving thought, restraint, fulfillment, health and there is also a holistic approach to the good of others." Dr. Das presented a memento on behalf of the Institute to Mr. Ramesh Kandpal and urged that continuous yoga classes should be organized in NISE.

Figure 10.18: International Yoga Day celebration 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.

RIGHT TO INFORMATION ACT

The Institute is implementing the Right to Information (RTI) Act, 2005 as per the guidelines issued by for 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 listed below. Respective CPIOs and First Appellate Authorities reply to RTI applications/Appeals within the stipulated timelines to the extent possible.

A total of 173 applications were received during the period and the same were suitable disposed off. The details of the CPIOs and Appellate Authorities is given in Table 10.2.

Table 10.2 Details of CPIOs and Appellate Authorities in NISE

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 Financial	Dr. Chandan Banerjee Scientist 'F' (Deputy Director General)	Dr. Arun K Tripathi Director General
2	All matters concerning Laboratory and Technology	Er. Sanjay Kumar Scientist 'F' (Deputy Director General)	
3	All Administrative Matters (Except Financial Matters)	Ms. Akanksha Sharma Administrative Officer	
4	Public Grievance Officer	Shri Ankeshwar Mishra Deputy Director Administration	

ADMINISTRATION & STAFF

NISE is an autonomous institute under the Ministry of New & Renewable Energy (MNRE). The institute is set up for assisting the Government of India in the national solar mission under the official and authoritative decisions made by MNRE. The organisation is administered by the head of the institution, Director General, NISE. The various departments in this institution function under the supervision of the Deputy Director General, NISE. The scientific staff, senior consultants, consultants, executive assistants, multi-tasking staff and other staff 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 the following sanctioned 41 regular scientific, technical and administrative posts. The Rules were approved by the Governing Council in its 3rd meeting held on 6th April 2015. The posts were advertised on All India basis in Employment News, and on the Ministry and Institute websites. The recruitment is in progress and the posts are listed in Table 10.3.

Table 10.3: Recruitment post 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	• 2 post filled • 02 post (recruitment under process)
3.	Director	PB- 3+7600	2	1	3	Vacant
4.	Deputy Director	PB- 3+6600	6	2	8	• 01 filled (Admn.) • 01 vacant (Admn.) • 06 (Technical) recruitment under process
5.	Assistant Director	PB- 3+5400	7	2	9	• 02 Admn. Post (filled) • 07 Tech. (recruitment under process)
6.	Administrative Officer	PB- 3+6600	0	1	1	Filled
7.	Office Secretary	PB- 2+5400	0	1	1	Recruitment under process
8.	Office Secretary -I	PB- 2+4800	0	3	3	Recruitment under process
9.	Executive Officer	PB- 2+4800	4	0	4	Recruitment under process
10.	Executive Assistant-I	PB- 2+4600	8	0	8	Recruitment under process
		Total	**31**	**10**	**41**	

RESEARCH PUBLICATIONS, BOOKS AND PATENTS

INTRODUCTION

NISE has emerged as a centre established for National and International research with its focus area in Solar Photovoltaic Technology. NISE envisages a strong collaboration and networking to carry out cutting edge research in solar photovoltaic and solar thermal domain. The scientists at NISE follow a unique mandate to monitor real-time data, analyse system and provide specific emphasis on industrial interaction. NISE has always carried out applied research to exchange knowledge, improve skills and contribute towards enrichment of the society. During 2018-19, 11 research papers were published in reputed international/national journals. Besides, 3 papers were also published in the proceedings of national/international conferences/workshops. NISE has filed three patent applications for solar powered technologies. The list of publications is given below:

INTERNATIONAL/NATIONAL JOURNALS

[1] Gourab Das, Sukanta Bose, Sumita Mukhopadhyay, Chandan Banerjee and Asok K. Barua, "Innovative Utilization of Improved n-doped µc-SiOx: H Films to Amplify the Performance of Micromorph Solar Cells", *Proceeding of Silicon, Vol. 11, No. 1, pp. 487-493, Feb 2019.*

[2] Najib H. Umar, Birinchi Bora, Chandan Banerjee, B. S. Panwar, "Comparison of different PV power simulation softwares: case study on performance analysis of 1 MW grid-connected PV solar power plant", *Proceeding of International Journal of Engineering Science Invention (IJESI) Vol. 7, No. 7 Ver II, pp.- 11-24, 2018.*

[3] Hemanta Ghosh, Suchismita Mitra, M. S. Siddiqui, A. K. Saxena, Partha Chaudhuri, Hiranmay Saha, Chandan Banerjee ,"Back scattering involving embedded silicon nitride (SiN) nanoparticles for c-Si solar cells", *Proceedings of Optics Communications, Vol. 413,Pages -72, 2018.*

[4] Soma Ray, Sugato Ghosh, Hemanta Ghosh, Suchismita Mitra, Chandan Banerjee, Anup Kumar Mondal, Hiranmoy Saha, Sukhendu Jana, Sayan Das, Baishakhi Pal, Utpal Gangopadhyay, " Process: A comparative study of solar cell performance", *Proceedings of Materials Today, Vol. 4, No. 14, pp. 12678-12683, 2018.*

[5] Rashmi Singh, Madhu Sharma, Sastry O S, Rahul Rawat, Kamlesh Yadav, Chandan Banerjee, "Non-destructive in-situ performance monitoring of high-efficiency SPV modules using infrared thermography in composite climate of India", *MOJ Solar and Photoenergy System, Vol. 2, No. 2, pp. 54–60, 2018.*

[6] Yadav K., Kumar, A., Sastry, O.S., Wandhare, R., "An assessment for the selection of weather profiles for performance testing of SPV pumps in Indian climate", *Proceeding of Solar Energy, Vol. 179,pp. 11–23, Feb 2019.*

[7] Yadav K., Kumar, A., Sastry, O.S., Wandhare, R, "Solar Photovoltaic Pumps Operating Head Selection for the Optimum Efficiency", *Proceeding of Renewable Energy, Vol. 134, pp. 169–177, 2019.*

[8] Rashmi Singh, Madhu Sharma, O.S. Sastry, Kamlesh Yadav, Chandan Banerjee ,"Estimation of Dynamic resistance of HIT technology module in dark and illuminated condition", *Proceedings of Material today, Volume 5, Issue 11, Part 2, 2018, Pages 23242-23248.*

[9] Rashmi Singh, Madhu Sharma, Chandan Banerjee, "Performance Monitoring of High – Efficiency Maxeontm based sunpower PV plant in the composite climate of India", *PDPU Journal of Energy and Management, Vol. 3, No.1, pp. 21-27, October, 2018.*

[10] Rashmi Singh, Madhu Sharma, Rahul Rawat, Chandan Banerjee "An assessment of series resistance estimation techniques for different silicon based SPV modules", *Proceedings of Renewable and sustainable Energy Reviews, Vol. 98, Dec 2018, pp. 199-216.*

[11] Rashmi Singh, Madhu Sharma, Chandan Banerjee, "Field Analysis of three different Silicon-based Technologies in Composite Climatic Condition", *Proceedings of Solar Energy, Vol. 182, April 2019, pp. 102-116.*

INTERNATIONAL/NATIONAL CONFERENCES

[1] Asim Bisayee, Mahesh C. Sharma, Praveen Mishra and Chandan Banerjee, "Characterization of CdTe and CIGS Thin Film Photovoltaic Modules by Infrared thermography (IR) and electroluminescence (EL) imaging techniques", *International Conference on materials for Energy Applications for renewable Energy", 8th Dec., 2018.*

[2] Asim Bisayee, Mahesh C. Sharma and Praveen Mishra, "Characterization of Hotspots on Photovoltaic modules and its analysis with MATALB", *National conference on recent Advancement in Mechanical Engineering", 19th February, 2019.*

ORAL PRESENTATION 2018-19

Rudranath Sarkhel, Prakash Jha, Chandan Banerjee, A. K. Tripathi, M. R. Nouni, "Availability and Cost of Hydrogen from Chlor-alkali Units for Transport Application in India and Vehicles that can be Supported Using it" at 7th International Hydrogen and Fuel Cell (IHFC-2018) conference at Jodhpur.

INTELLECTUAL PROPERTY RIGHTS FILED ON INNOVATIVE PROJECTS DEVELOPED AT NISE

NISE has designed and developed three different innovative products during the year 2018-19 and applied for grant of Intellectual Property Rights (IPR) as per details given below:

Table 11.1: Intellectual Property Rights (IPR) filed for Innovative projects at NISE

S. No.	Title	Indian Provisional Patent App. No
i.	Solar Powered Cooling Apparatus	201811012872
ii.	Solar Powered Cooking System	201811013090
iii.	Solar Drier Cum Space Heating System	201811013091

FINANCE AND ACCOUNTS

NISE has both Integrated Finance as well Finance & Accounts Division which looks after the concurrence and preparation of accounts respectively. The Integrated Finance division scrutinises and concurs to all payment proposals 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 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 is approved by the Finance Committee before submission of the Governing Council (GC) for adoption of the same.

The Independent Auditor's Report for the year 2018-19 is presented herewith after duly approved by the Finance Committee in its 8th meeting held on 19.09.2019 and duly adopted by the Governing Council of NISE, in its 9th meeting and 3rd Annual General Meeting (AGM) held on 24.09.2019.

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 31 March 2019 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.

S.M.SAINI & ASSOCIATES
Chartered Accountants

120, Mohyal Colony
B/H MMI School Sector-40, Gurgaon-122001
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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.

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.

S.M.SAINI & ASSOCIATES
Chartered Accountants

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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 31,2019;
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 * Chartered Accountants * Gurgaon

(Laxmikant Saini)
(Partner)
Membership No. 512056
Place : Gurugram

Dated: 18th September 2019
UDIN :- 19512056AAAAAF3710

S.M.SAINI & ASSOCIATES
Chartered Accountants

120, Mohyal Colony
B/H MMI School Sector-40, Gurgaon-122001
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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 2018-19 as referred in the said report.

1. Certain Advances were found outstanding for more than three years. The list of such advances as on 31.03.2019 is as under:

Party Name	Amount
C- DAC	20,731,550.00
Executive engineer Delhi aviation division CPWD	7,996,000.00
Tata Power Solar system LTD	36,793,151.00
Executive engineer E (Delhi elect Div. VII)	5,592,468.00
Total	**71,113,169.00**

Management Remark:

i) The advances 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 matter is again being taken up for utilization certificate from there end for purpose of adjustment.
ii) The utilization certificate for the execution of work is still awaited from CPWD. Matter is being taken up for settlement.
iii) The power plant constructed by M/s Tata Power Solar System Ltd. is under process of observation and will be commissioned during the year.
iv) The utilization certificate for Rs.4864617 has been received during 2019-20. For balance amount, the same is still awaited from CPWD. Matter is being taken up for settlement.

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	Amount	Reason of Outstanding	Related

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	Ministry			Period
1.	Ministry of External Affairs	13,600,695	Programme conducted, UC submitted but grant not received	2017-18 and 2018-19
2.	Ministry of New & Renewable Energy	8,163,259	Programme conducted but grant not received	2017-18

Management Remark:

These are the balance amount of grant which will be released after submission of Utilization Certificate. We are perusing the matter for release of payment.

3. The Utilization Certificate in respect of advances released in earlier years to different State Nodal Agencies amounting Rs. 2,541,660/- has not been received. These advances are 2 to 3 years old.

Management Remarks:

The State Nodal Agencies, where advances are outstanding, have partially completed the programme which is not as per the norm of the Suryamitra Scheme and hence they were asked to refund the full amount. We are pursuing with the SNA's to refund the amount.

4. Advances to Staff: An amount of Rs.34478 is outstanding against advance to staff since 2016-17.

Management Remark:

The necessary action is being taken to recover the above amount.

5. During the course of audit we have come across the cases (14 Nos.) where TDS was deducted by the customers but the same is not showing in 26AS. Financial implications is of Rs. 559,393.00/-

S.M.SAINI & ASSOCIATES
Chartered Accountants

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Email:info@smsaindia.in

Management Remark:

We are taken the matter with concerned parties for remitting the above amount. In case of the regular customer the same will be deducted from their next payment.

For SM Saini & Associates
Chartered Accountants
FRN: 014267N

(Laxmikant Saini)
(Partner)
Membership No.512056
Place: Gurugram
Dated: 18th September 2019

UDIN:- 19512056AAAAAF3710

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 2019

CORPUS/CAPITAL FUND AND LIABILITIES	SCHEDULE	AS AT MARCH 31, 2019	TOTAL	AS AT MARCH 31, 2018	TOTAL
Corpus/Capital Fund	1				
Gross Corpus/ Capital Fund		10577,91,580		26140,81,466	
Less : Accumulated Depreciation		1669,91,105		942,69,430	
Net Corpus/ Capital Fund			8908,00,475		25198,12,037
Current Liabilities & Provisions	2	9426,28,299	9426,28,299		10816,56,922
Total			**18334,28,774**		**36014,68,959**

ASSETS	SCHEDULE	AS AT MARCH 31, 2019	TOTAL	AS AT MARCH 31, 2018	TOTAL
Fixed Assets	3				
Gross Block		7852,38,328		7083,92,764	
Less : Accumulated Depreciation		1669,91,105		942,69,430	
Net Block			6182,47,222		6141,23,335
Current Assets, Loans & Advances	4		12151,81,551		29873,45,624
Total			**18334,28,774**		**36014,68,959**
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 Chartered Accountants Gurgaon

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

Place: Gurugram
Dated: 17.09.2019

UDIN:-
19512056AAAAAF3710

For NATIONAL INSTITUTE OF SOLAR ENERGY

Dr. Chandan Baherjee
(Dy. Director General)

Dr. A.K. Tripathi
(Director General)

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 2019

PARTICULARS	Schedule	2018-19	2017-18
		TOTAL	TOTAL
INCOME			
Receipts from Testing & Operations	5	487,13,280	536,16,780
Grants/Subsidies utilised for Revenue Expenditure	6	5191,63,985	4098,72,061
Interest Earned	7	48,17,096	602,89,491
Other Income		35,47,492	17,05,126
Depreciation (As per Contra)	3	735,85,816	737,95,026
Total (A)		**6498,27,669**	**5992,78,483**
EXPENDITURE			
Establishment Expenses	8	288,51,082	418,74,139
Other Administrative Expenses	9	766,88,718	1058,92,649
Operational Expenses	10	4554,47,001	2788,31,102
Depreciation (As per Contra)	3	735,85,816	737,95,026
Total (B)		**6345,72,617**	**5003,92,915**
Net Surplus/(Deficit) for the year		152,55,052	988,85,568
Provision for Taxation		-	-
Balance being Surplus/(Deficit) for the year transferred to General Reserve (A-B)		***152,55,052***	**988,85,568**
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 * Gurgaon *

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

Place: Gurugram
Dated: 17.09.2019

For NATIONAL INSTITUTE OF SOLAR ENERGY

Dr. Chandan Banerjee
(Dy. Director General)

Dr. A.K. Tripathi
(Director General)

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 2019

SCHEDULE 1- CORPUS/ CAPITAL FUND	AS AT MARCH 31, 2019	Total	AS AT MARCH 31, 2018	Total
General Reserve				
Balance as at the beginning of the year	1814,51,503		825,65,935	
Less : Transfer to ISA	947,72,768			
Add : Excess of income over expenditure during the year	152,55,052	1019,33,787	988,85,568	1814,51,503
Corpus Fund				
Balance of Grant Received from Govt. Non-Refundable				-
Opening Balance(Refer Grant Sheet)	14648,85,000		11418,72,500	
Add: Amount received during the Year	-		3230,12,500	
Less : Amount transfer to ISA	14548,85,000			
Closing Balance		100,00,000		14648,85,000
Capital Reserve				
Grants adjusted against purchase of assets				
Opening Balance	3134,93,673		997,45,263	
Add : Addition during the period	810,96,234		2137,48,410	
Less : Transfer to ISA	38,49,111			
Closing Balance		3907,40,796	3134,93,673	3134,93,673
Capital Reserve for Building (SEC)	3929,66,000	3929,66,000	3929,66,000	3929,66,000
Grant utilised for advances given during the year				
Opening Balance	2612,85,290		3156,60,531	
Less : Net Adjusted during the Year	983,09,063		543,75,241	
Less : Transfer to ISA	8,25,230			
Closing Balance		1621,50,997	2612,85,290	2612,85,290
Total		**10577,91,580**		**26140,81,466**

S.M. Saini & Associates Gurgaon Chartered Accountants

SCHEDULE 2- CURRENT LIABILITIES AND PROVISIONS	AS AT MARCH 31, 2019		AS AT MARCH 31, 2018	
		Total		Total
Current Liabilities				
Sundry Creditors				
- For goods and services	7,89,176		9,75,829	
- Creditors For Capital Goods	31,55,102	39,44,278	5,42,664	15,18,493
Deposits				
- Earnest Money Deposit	46,15,200		21,75,200	
- Guest House Security Deposits	3,53,911		2,51,250	
- Advance Received from Customers	58,22,200	107,91,311	57,85,830	82,12,280
Statutory Liabilities				
- TDS Payable	2,59,526	2,59,526	27,12,109	27,12,109
Other Current Liabilities				
- Salary & Remuneration Payable	1,29,996		34,201	
- Interest refundable to Ministry	492,49,817		457,63,763	
- Advances received against trainning (ISA)	343,73,589		-	
- Other misc. liabilities	12,00,322	849,53,725	-	457,97,964
Balance of Grants Payable to Government of India	8394,56,729	8394,56,729	10234,16,076	10234,16,076
Provisions				
Provision for Income Tax	32,22,730	32,22,730	-	
Total		**9426,28,299**		**10816,56,922**

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 2019

SCHEDULE 3- FIXED ASSETS & DEPRECIATION

Amount in ₹

PARTICULARS	GROSS BLOCK					DEPRECIATION					NET BLOCK	
	As at 01.04.2018	Addition before 30.09.2018	Addition After 01.10.2018	Sales/ Adjustment during the year	As at 31.03.2019	As at 01.04.2018	Current Depreciation on L+C	Current Depreciation on D	Total Current Year Depreciation	Total Depreciation (G+H)	WDV as on 31.03.2019 (F-I)	WDV as on 31.03.2018
A	B	C	D	E	F		G	H		I	J	
NATIONAL INSTITUTE OF SOLAR ENERGY												
Building-NISE	5806,24,655	7,88,138	-	-	5814,12,793	576,29,533	523,78,326	-	523,78,326	1100,07,859	4714,04,934	5229,95,122
Desktop Computers	45,12,742	5,40,127	1,59,702	-	52,12,571	26,17,384	9,74,194	31,940	10,06,134	36,23,518	15,89,053	18,95,358
Printers and other IT Peripherals	71,10,178	38,62,967	149,60,185	-	259,33,330	13,79,030	14,39,117	11,22,014	25,61,131	39,40,161	219,93,169	57,31,148
Air Conditioner	17,40,577	2,11,300	81,311	-	20,33,188	6,83,326	1,90,283	6,098	1,96,381	8,79,707	11,53,481	10,57,251
Misc. Assets Guest House/ Office	199,90,161	10,53,222	12,75,128	-	223,18,511	51,52,867	23,83,577	95,635	24,79,212	76,32,079	146,86,432	148,37,294
Scientific & Laboratory Equipments	753,49,629	91,86,925	452,43,846	-	1297,80,400	199,16,644	96,92,987	33,93,288	130,86,275	330,02,919	967,77,481	554,32,985
Vehicles	5,90,361	-	-	-	5,90,361	2,54,998	50,304	-	50,304	3,05,302	2,85,059	3,35,363
Furniture & Fixtures	27,89,492	18,37,801	6,64,780	-	52,92,073	4,12,960	4,21,433	33,239	4,54,672	8,67,632	44,24,441	23,76,532
Laptops	5,51,986	2,51,555	-	-	8,03,541	4,40,008	1,45,413	-	1,45,413	5,85,421	2,18,120	1,11,978
Other Assets (Training)	75,89,954	1,92,979	1,45,457	-	79,28,390	19,66,464	8,72,470	10,909	8,83,380	28,49,844	50,78,546	56,23,490
Softwares	36,93,917	-	2,39,253	-	39,33,170	29,52,075	2,96,737	47,851	3,44,587	32,96,662	6,36,508	7,41,842
Total (1)	**7045,43,652**	**179,25,014**	**627,69,662**	**-**	**7852,38,328**	**934,05,289**	**688,44,842**	**47,40,975**	**735,85,816**	**1669,91,105**	**6182,47,222**	**6111,38,363**
INTERNATIONAL SOLAR ALLIANCE												
Printers and other IT Peripherals	6,88,740	-	-	6,88,740	-	-	-	-	-	-	-	-
Computer and Laptops	23,00,190	-	-	23,00,190	-	-	-	-	-	-	-	-
Miscellaneous other Assets	7,30,117	-	-	7,30,117	-	-	-	-	-	-	-	-
Furniture & Fixtures	1,50,065	-	-	1,50,065	-	-	-	-	-	-	-	-
Total (2)	**38,69,112**	**-**	**-**	**38,69,112**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total	**7084,12,764**	**179,25,014**	**627,69,662**	**38,69,112**	**7852,38,328**	**934,05,289**	**688,44,842**	**47,40,975**	**735,85,816**	**1669,91,105**	**6182,47,222**	**6111,38,364**

SCHEDULE 4- CURRENT ASSETS, LOANS & ADVANCES	AS AT MARCH 31, 2019		AS AT MARCH 31, 2018	
		Total		Total
Current Assets				
Cash Balance in hand	-			
Balance with Bank :				
-Saving Accounts	2808,97,779		3327,34,446	
Auto Sweep Account	6067,26,192		2551,92,032	
Fixed Deposits	1005,40,397		20758,55,674	
Fixed Deposits under Lien	-		101,79,446	
Sundry Debtors	230,15,316		229,96,773	
Stamps in Hand	-	10111,79,684	-	26969,58,371
Loan & Advances & other assets				
Advances and other amounts recoverable in cash or in kind or for value to be received				
- Advances against capital assets	1307,14,673		1039,49,451	
- Advances against trainning programs	316,67,705		1607,99,612	
- Advance to Vendors	132,35,919		53,09,740	
- Recoverable against Training	-		-	
- Balances in Staff Imprest Accounts	6,32,542	1762,50,839	3,58,382	2704,17,185
Deposits				
- Security Deposits	3,10,965		4,27,465	
- Input Credit (GST)	27,01,798		49,62,177	
- TDS Recoverable	171,00,488		101,65,380	
- Advance Tax/Income Tax Refundable	76,37,776	277,51,028	44,15,046	199,70,068
Total		**12151,81,551**		**29873,45,624**

SHEDULES FORMING PART OF INCOME AND EXPENDITURE ACCOUNT AS AT 31ST MARCH 2019

SHEDULE 5- RECEIPTS FROM TESTING AND OPERATIONS	2018-19		2017-18	
		Total		Total
Receipts from Testing				
- Testing of Solar Components	184,99,854	184,99,854	274,03,422	274,03,422
Other Operational Receipts				
- Receipts from Trainings and Seminars- For Domestic Participants	53,30,100		146,15,205	
-for International Participants	94,85,594		40,47,648	
- Administrative Charges -Training	91,35,685		62,40,143	
- Consultancy on Techno Economic Feasibility Study	62,62,047	302,13,426	13,10,362	262,13,358
Total		**487,13,280**		**536,16,780**

S.M. Saini & Associates Chartered Accountants Gurgaon

SCHEDULE 6- GRANTS/SUBSIDIES (Irrevocable Grants & Subsidies Received)	2018-19		2017-18	
		Total		Total
Grants Received during the year-NISE(Core Grants)	1800,00,000		1464,01,841	
Grant Received during the Year -ISA	-		1500,00,000	
Less : Grant Refunded	-	1800,00,000	-	2964,01,841
Grants Received during the Year-NISE(Project Grants)	6903,94,214		5691,78,875	
Less : Grant Refunded	3071,38,672		6,35,497	5685,43,378
Grant Unutilised brought forward from Previous Year-NISE	7800,62,105		5809,03,130	5809,03,130
Grant Unutilised brought forward from Previous Year-ISA	-	11633,17,647	1444,81,453	1444,81,453
Grant Adjusted towards Revenue Expenditure :				
Current Year Expenditure-NISE	5609,86,801		3794,79,460.44	
Current Year Expenditure-ISA	-		471,18,429.00	
Less : Expenses adjusted towards current year Revenue-NISE	418,22,816		167,25,828	
	5191,63,985		4098,72,061	
Less: Expenses Adjusted against Previous Advances-NISE	1642,52,910	3549,11,075	127,71,794	
Less: Grant Utilised for Purchase of Fixed Assets-ISA	-		31,83,822	
Less : Grants utilised for purchase of Fixed Assets-NISE	684,37,187		256,94,674	
Less : Grants utilised for Advances against Capital Expenses	377,10,520		366,81,574	
Less : Grants utilised for Advances against projects	427,49,920		1005,61,041	
Less: Grant Utilised for Advance agaist General Exp.-NISE	52,216		28,67,118	
Less: Grant Utilised for Advance agaist General Exp.-ISA		1489,49,843	8,25,230	5669,13,726
Grants Payable to Government of India		**8394,56,729**		**10234,16,076**

P.M. Saini & Associates Chartered Accountants Gurgaon

SCHEDULE 7- OTHER INCOME	2018-19		2017-18	
Bank Interest	Credited in Revenue	Total	Credited in Revenue	Total
- Interest earned on Savings account-NISE	9,96,950		8,17,623	
- Interest earned on Savings account-ISA	-		18,92,228	
- Interest earned on Grants account	23,73,907		-	
- Interest earned on Auto Sweep account/F.D	14,46,239	48,17,096	575,79,640	602,89,491
Miscellaneous Income				
- Guest House Charges	19,96,100		11,57,695	
- Other Income	15,51,392	35,47,492	5,47,431	17,05,126
Total		**83,64,588**		**619,94,617**

S.M. Saini & Associates * Chartered Accountants * Gurgaon

SCHEDULE 8- ESTABLISHMENT EXPENSES	2018-19				2017-18		
	Adjusted with grant	Adjusted against Advances	Charged to Revenue	Total	Adjusted with Grant	Charged to Revenue	Total
Consultancy Charges	166,87,917	-	24,40,766	191,28,683	322,38,632	8,700	322,47,332
Remuneration	95,63,284	-	1,59,115	97,22,399	93,37,865	2,88,942	96,26,807
Total	**262,51,201**	**-**	**25,99,881**	**288,51,082**	**415,76,497**	**2,97,642**	**418,74,139**

SHEDULES FORMING PART OF INCOME AND EXPENDITURE ACCOUNT AS AT 31ST MARCH 2019

SCHEDULE 9- OTHER ADMINISTRATIVE EXPENSE	2018-19				2017-18			
	Adjusted with grant	Adjusted against Advances	Charged to Revenue	Total	Adjusted with Grant	Adjusted against Advance	Charged to Revenue	Total
Electricity / Fuel Expenses	57,49,012	-	24,68,273	82,17,285	41,24,298	-	41,03,477	82,27,776
Outsourcing Services	154,94,319	-	91,35,204	246,29,523	179,62,194	-	19,52,775	199,14,969
Security Services	89,28,404	-	35,06,515	124,34,919	94,32,333	-	-	94,32,333
Bad Debts	-	-	4,39,924	4,39,924	-	-	69,198	69,198
Loss of Input Tax Credit	-	-		-	-	-	17,56,853	17,56,853
Miscellaneous Exp.	-	-	40,003	40,003	16,476	-	35,161	51,637
Office Expenses	10,78,433	-	2,65,301	13,43,734	55,03,602	-	13,389	55,16,991
Refreshment/Hospitality/Meetings	15,60,962	-	1,98,187	17,59,149	7,19,480	-	-	7,19,480
Legal & Professional Charges	7,49,240	-	4,48,300	11,97,540	6,66,401	-	-	6,66,401
Bank Charges	58,665	-	20,711	79,376	28,670	-	49,198	77,868
Gateway charges	-	-	1,17,677	1,17,677	-	-	-	-
Horticulture Expenses	22,80,496	-	2,768	22,83,264	33,27,142	-	-	33,27,142
Advertisement Expenses	78,750	-	-	78,750	3,61,895	-	-	3,61,895
Guest House Expenses	-	-	5,49,846	5,49,846	-	-	40,388	40,388
Thermal Power Project Expenses	20,49,862	-	-	20,49,862	37,03,312	-	-	37,03,312
R&D Cell Expenses		57,793	7,28,216	7,86,009	2,17,445	-	-	2,17,445
Testing/Accredation Charges	38,840	-	20,78,586	21,17,426	-	-	8,01,068	8,01,068
Seminars/Conferences/Training Programmes	20,64,541	-	28,15,116	48,79,657	202,00,072	2,35,689	21,30,734	225,66,495
Exhibition/ Events Expenses	-	-	-	-	-	-	-	-
Consumables/ Laboratory/Workshop Exp.	33,040	-	1,77,756	2,10,796	6,490	6,43,640	6,22,244	12,72,374
Library Books & Periodicals	2,85,136	-	2,67,594	5,52,730	17,66,195	-	3,327	17,69,522
Postage , courier, Printing and Stationery	12,49,076	-	3,88,299	16,37,375	56,44,733	-	23,473	56,68,206
Interest & Penalty	74,457	-	11,710	86,167	-	-	53,560	53,560
Repairs & Maintenance Expenses	24,86,387	4,50,000	6,67,767	36,04,155	24,69,270	46,000	-	25,15,270
Telephone Expenses	22,18,000	-	10,93,980	33,11,980	40,38,356	-	-	40,38,356
Vehicle Running & Maintenance	1,85,037	-	17,975	2,03,012	17,57,590	-	-	17,57,590
Tour / Travel & Transport	29,17,765	-	11,60,795	40,78,560	113,65,027	-	1,494	113,66,521
Total	**495,80,422**	**5,07,793**	**266,00,503**	**766,88,718**	**933,10,981**	**9,25,329**	**116,56,338**	**1058,92,649**

SCHEDULE 10- OPERATIONAL EXPENSES	2018-19				2017-18			
	Adjusted with grant	Adjusted against Advances	Charged to Revenue	Total	Adjusted with Grant	Adjusted against Advance	Charged to Revenue	Total
SERIIUS Project Expenses	-	1,05,152	14,16,886	15,22,038	22,36,401	-	-	22,36,401
NAM S&T Center Research Training Felloship	-	-	-	-	-	-	-	-
North East Training Programme	-	-	-	-	59,04,894	58,02,057	2,47,565	119,54,516
Released to State Nodal Agencies for Skill Development	2372,99,993	1576,45,493	-	3949,45,486	2247,84,495	-	-	2247,84,495
Expenses on Skill Development Programmes	-	-	51,09,203	51,09,203	-	-	45,24,283	45,24,283
Indian African Forum Summit Traning (P12- TP MEA- IAF	9,80,566	-		9,80,566	62,83,596	-	-	62,83,596
Advance orientation Program for Focal Points(IRENA) (P1	-	-	-	-	52,00,444	3,51,880	-	55,52,324
Skill Development Program for SAARC	-	-	-	-	29,56,917	-	-	29,56,917
ITEC/SCAAP/TCS Columbo Training Progrme (P11-TP ME	150,48,608	-	39,46,857	189,95,465	55,27,767	-	-	55,27,767
Hydrogen Project Exp. (P02- Hydrogen)	-	-	18,25,570	18,25,570	19,58,122	-	-	19,58,122
UNDP-GEF Project Expenses	-	-	-	-	16,83,163	-	-	16,83,163
MNRE-USAID T.A Program (P08- TP DISCOM ER)	156,71,478	47,93,170	-	204,64,648	32,81,230	-	-	32,81,230
Solar Resource Assessment Exp.(NSRSC), Hyderabad	-	12,01,302	-	12,01,302	-	6,92,528	-	6,92,528
Solar Powered Clean Drinking Project (P03- SDWP)	31,83,734	-	-	31,83,734	23,95,760	50,00,000	-	73,95,760
BHEL R&D Project (P01- PERC)	1240398	-	-	12,40,398	-	-	-	-
R & D Concentrated Solar Sunborn Project (P04- CONC.	1297427	-	-	12,97,427	-	-	-	-
Solar Radiation Calibration Lab (SRCL) (P05- SRRA)	2362608			23,62,608	-	-	-	-
Department of Science and Technology Project (P06- WF	170000	-	-	1,70,000	-	-	-	-
Rooftop Grid Engineer Skill Development Project (P09 TP	1652803	-	-	16,52,803	-	-	-	-
Varunmitra Skill Development Programme (P10- TP VARU	1,71,837	-	3,23,916	4,95,753	-	-	-	-
Total	**2790,79,452**	**1637,45,117**	**126,22,432**	**4554,47,001**	**2622,12,789**	**118,46,465**	**47,71,848**	**2788,31,102**

NATIONAL INSTITUTE OF SOLAR ENERGY

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

STATEMENT OF GRANTS FOR THE FINANCIAL YEAR 2018-19

PARTICULARS	Opening Balance01.04.2018	Refund/Transfer during the year 2018-19		Receipt/Transfer during the year 2018-19		Utilization against advances 18-19	Utilization against Fixed Assets 18-19	Utilization against Revenue Expenses 18-19	Total Utilization 18-19	Closing Balance 18-19
National Institute of Solar Energy		Refund to Ministry	Transfer	Received in Bank	Received Through Transfer					
Grant for Creation of Capital Assets	434,72,676	-	-	950,00,000	-	377,10,520	675,02,249	-	1052,12,769	332,59,907
Grant in aid- General	-	-	-	500,00,000	-	52,216	-	495,80,422	496,32,638	3,67,362
Grant in aid- Salaries	43,63,830	-	-	350,00,000	-	-	-	262,51,201	262,51,201	131,12,629
Grant for BHEL R&D Projects (P01- PERC)	350,00,000	-	-	-	-	-	-	12,40,398	12,40,398	337,59,602
Grant for Training on Small Power Plants	6,15,562	6,15,562	-	-	-	-	-	-	-	-
Grant for Project Hydrogen (P02- Hydrogen)	1,38,530	5,31,051	-	770,00,000	4,70,728	-	78,206	-	78,206	770,00,001
Grant- Skill Development Programme	2832,98,945	4,37,118	-	5392,03,135	19,52,590	326,34,665	-	2372,99,993	2699,34,658	5540,82,894
Grant UNDP	9,14,291	-	9,14,291	-	-	-	-	-	-	-
Grant for SERIUS (Indo US Project)	4,29,838	-	-	-	39,666	-	-	-	-	4,69,504
Grant for USAID TA Program (P08- TP DISCOM ER)	321,02,190	-	-	-	-	13,74,375	-	156,71,478	170,45,853	150,56,337
Grant -Solar Based Pilot Proj. (for African Countries)	3046,00,000	3046,00,000	-	-	-	-	-	-	-	-
Grant- World Renewal Energy Muesum	266,55,548	-	-	-	-	-	-	-	-	266,55,548
Grant- Solar Powered clean drinking water project (P03-SDWP)	44,40,084	-	-	-	-	-	8,56,732	31,83,734	40,40,466	3,99,618
Grant -Adv. Oreintation program for focal points(IRENA) (P13-TP MEA IRENA)	40,650	-	40,650	-	-	-	-	-	-	-
Grant- Project Rooftop Grid Engineering (P09- TP ROOFTOP)	131,32,000	-	-	-	-	44,06,200	-	16,52,803	60,59,003	70,72,997
Grant- R&D Concentrated Solar Project (P04- Conc. Solar)	298,77,395	-	-	-	-	-	-	12,97,427	12,97,427	285,79,968
Grant for IAFS (P12- TP MEA-IAFS)	9,80,566	-	-	-	-	-	-	9,80,566	9,80,566	-
Grant - Solar Radiaton Sensor Project (P05- SRRA)	-	-	-	40,00,000	-	1,00,000	-	23,62,608	24,62,608	15,37,392
Grant - Varunmitra Skill Development Programme (P10- TP Varunmitra)	-	-	-	105,57,500	-	1,80,000	-	1,71,837	3,51,837	102,05,663
Grant- International Training Programme (P11- TP MEA- ITEC)	-	-	-	191,17,395	-	-	-	150,48,608	150,48,608	40,68,787
Grant - Solar Pumpting Project (P07- SWPUMP)	-	-	-	231,00,000	-	-	-	-	-	231,00,000
Grant - Department of Science & Technology (P06- WPDST)	-	-	-	149,53,200	-	40,54,680	-	1,70,000	42,24,680	107,28,520
Total (A)	**7800,62,105**	**3061,83,731**	**9,54,941**	**8679,31,230**	**24,62,984**	**805,12,656**	**684,37,187**	**3549,11,075**	**5038,60,918**	**8394,56,729**
International Solar Alliance										
Grant-General	2433,53,972		2433,53,972	-		-	-	-	-	-
Total(B)	**2433,53,972**	-	**2433,53,972**	-		-	-	-	-	-
Total Grant (A+B)=C(Balance of Grant payable to Govt. of India)	10234,16,077	3061,83,731	2443,08,913	8679,31,230		805,12,656	684,37,187	3549,11,075	5038,60,918	8394,56,729
Contributions for Corpus Fund										
NISE										
Contribution by IREDA	100,00,000	-	-	-		-	-	-	-	100,00,000
Total(D)NISE	**100,00,000**	-	-	-		-	-	-	-	**100,00,000**
ISA										
Contribution by Ministry of New & Renewable Energy	10000,00,000	-	10000,00,000	-		-	-	-	-	-
NTPC	636,10,000	-	636,10,000	-		-	-	-	-	-
SOFT BANK	1299,75,000	-	1299,75,000	-		-	-	-	-	-
CLP	647,77,500	-	647,77,500	-		-	-	-	-	-
POWER GRID	646,50,000	-	646,50,000	-		-	-	-	-	-
Contribution from Indian Renewable Energy Dev. Agency	669,40,000	-	669,40,000	-		-	-	-	-	-
Contribution from Solar Energy Corporation of India	649,32,500	-	649,32,500	-		-	-	-	-	-
Total(E) ISA	**14548,85,000**	-	**14548,85,000**	-		-	-	-	-	-
Balance of Grant Received from Govt. Non-Refundable(D+E)	**14648,85,000**	-	**14548,85,000**	-		-	-	-	-	**100,00,000**

1. Transfer includes adjustment due to inter grant transfer & allocations
2. Transfer of ISA Balances (Refer Note 2 schedule 11(b).

NATIONAL INSTITUTE OF SOLAR ENERGY

SCHEDULE 11

SIGNIFICANT ACCOUNTING POLICIES AND NOTES TO ACCOUNTS FORMING INTEGRAL PART OF THE FINANCIAL STATEMENTS FOR THE F.Y. 2018-19

A. SIGNIFICANT ACCOUNTING POLICIES

1. Basis of Accounting

The financial statements have been prepared as prescribed by ICAI in accordance with generally accepted accounting principles. The National institute of Solar Energy (here in after referred to as Institute) adopts cash system of accounting in respect of its income as well expenditure. The accounting policies adopted and applied in the preparation of financial statements are consistent with GFR rules 2017 in general.

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 depreciation has been charged to the grant (Capital Fund) and is recognized in the Income & Expenditure account as a contra item.

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

Income and expenditure are accounted for on cash basis, as they are earned or incurred.

B. NOTES TO ACCOUNTS

1. In line with the direction of the Governing Council, the institute is required to create a corpus fund with a view to achieve sustainability in the longer run. Necessary guidelines for creating such corpus fund is under finalization.

2. The Government of India has approved formation of International Solar Alliance (ISA) consisting of countries rich in solar resources having its head-quarter in India. It was approved that till the time a separate legal entity in the name of ISA is formed the funds for preparatory work will be routed through the Institute. Accordingly, financial figures relating to grants received for ISA and expenses incurred on its behalf, have been consolidated in the financial statement of the Institute. Subsequently, Ministry of External Affairs vide notification no.SO2296(E) dated 05.06.2018 has confirmed that the ISA has attained the legal entity and hence the practice of consolidating the accounts of ISA with the Institute has been discontinued from current Financial Year.

3. The accumulated depreciation amounting to Rs.16,69,91,105/- (Current Year Rs.7,35,85,816) 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 (Capital Fund) and is recognized in the Income & Expenditure account as a contra item.

4. 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.

5. The Surya Bhavan Complex along with the guest house facility has been capitalized for an amount of Rs.57,89,66,000. The payment of Rs. 39,29,66,000, released by erstwhile Solar Energy Center (MNRE) has been credited to capital reserve (building) A/c.

6. Additions made during the F.Y. 2018-19 in Capital Reserve (Purchase of Assets) amounting to Rs. 8,10,96,234.

7. The Institute has received a demand of Rs. 5.64 crore and Rs. 27.42 crore from income tax department for A.Y. 2015-16 and A.Y. 2017-18 respectively U/S 143(1) of the Act. An appeal has been filed for the A.Y. 2015-16 and Management is of the view that the same demand will be abolished for the A.Y. 2015-16 and for the A.Y. 2017-18 case is under process.

8. A letter of credit has been opened by SBI as under:-

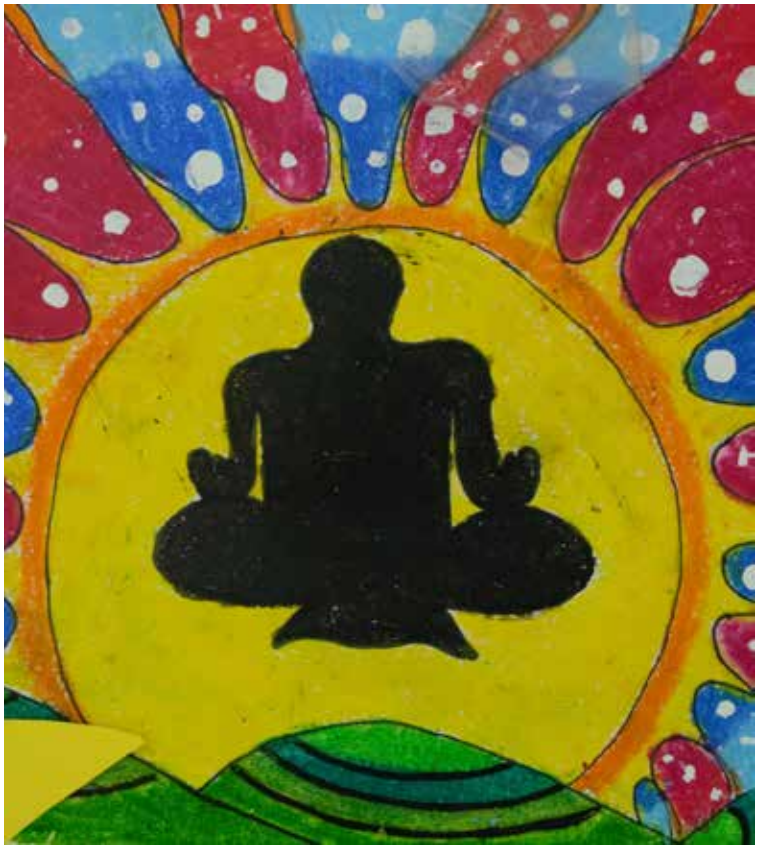
Party Name	LC Value
M/s Qunatel Pvt Ltd, Singapore	US $ 4,54,059.00
M/s Enli Technology, Taiwan	US $ 72,625.50
M/s Labsphere Inc, USA	US $ 2,38,516.00

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

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

Shagun, Group B, DPSG

Nishtha Mandal, Group B, Lion Public School



Aditya Gupta, Group A, Indraprastha International School

Vibhuti Yadav, Group A, DPSG

Winners of Painting Competition organised by NISE during 5th Foundation Day, 2018

National Institute of Solar Energy

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

Gurugram FAridabad Road, Gwal pahari, Gurugram - 122003 (Haryana)
Tel: 0124-2853056

www.nise.res.in