INDIAN TECHNICAL AND ECONOMIC COOPERATION

GOVERMENT OF INDIA

NATIONAL INSTITUTE OF SOLAR ENERGY

INTERNATIONAL TRAININGPROGRAMME ON SOLAR ENERGY TECHNOLOGIES AND APPLICATIONS

(14th September 2026 – 27th September 2026）



COMPRENSIVE TRAINING REPORT

TO

Ministry of Agriculture/ Division of Training and Research/KATRIN

&

AGRISCAPE INNOVATIONS COMPANY LIMITED-TANZANIA

From:

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28th September 2026

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EXCUTIVE SUMMARY

This report presents the participation of Mr. Musa Hassan Mohamed from the United Republic of Tanzania in the International Training Programme on Solar Energy Technologies and Applications conducted under the Indian Technical and Economic Cooperation (ITEC) Programme at the National Institute of Solar Energy (NISE), Gurugram, Haryana, India, from 14th to 27th September 2026.

The programme provided an important opportunity to strengthen technical and institutional understanding of solar energy technologies, renewable energy deployment, solar photovoltaic (PV) systems, standards and certification, system components, performance and reliability, and the regulatory environment supporting renewable energy.

For Tanzania, the knowledge acquired is particularly relevant to the expansion of reliable and affordable renewable energy for productive uses. In the agricultural sector, solar technologies can support irrigation and water pumping, agricultural research facilities, cold storage systems, drying, agro-processing, rural electrification and other energy-intensive agricultural operations.

The training therefore has potential relevance to the work of the Ministry of Agriculture and AGRISCAPE INNOVATIONS COMPANY LIMITED, particularly in training, research, technology transfer and promotion of climate-smart agricultural practices and intensification of agrivoltaic and solar water pumping system for both domestic water supply and irrigation activities.

1. INTRODUCTION AND BACKGROUND

Access to reliable energy is an important enabler of agricultural production, rural development, research, processing and value addition. Solar energy offers a scalable renewable energy option for locations where grid electricity is unavailable, unreliable or costly, and can also complement existing grid and generator-based systems.

The International Training Programme on Solar Energy Technologies and Applications was organized by the National Institute of Solar Energy (NISE) under the ITEC framework, with support from the Ministry of External Affairs and the Ministry of New and Renewable Energy (MNRE), Government of India. The programme was designed to expose international participants to technical, institutional, regulatory and practical aspects of solar energy and other renewable energy resources such as hydrogen energy and thermal energy.

The training is relevant to Tanzania because the country is seeking practical approaches for increasing the use of renewable energy, improving energy access and strengthening productive applications of energy. Within agriculture, energy availability directly affects irrigation, water supply, post-harvest handling, processing, storage and research infrastructure.

2. OBJECTIVES OF THE TRAINING

2.1 Overall Objective

To strengthen knowledge and practical understanding of solar energy technologies and their applications, including solar resource assessment, photovoltaic systems, standards, technical and performance tests, reliability, regulation and institutional approaches to renewable energy deployment.

2.2 Specific Objectives

- To understand the fundamentals and practical importance of solar radiation measurement and solar resource assessment.
- To gain knowledge of photovoltaic power plants, PV technologies, system components and bills of materials.
- To understand PV module standards, certification, testing, performance parameters and reliability considerations.
- To learn from India's experience in solar energy transition and renewable energy development.
- To understand the role of regulations, standards and market mechanisms in supporting renewable energy deployment.
- To identify opportunities for applying solar technologies to agricultural production, irrigation, research and value addition in Tanzania.
- To strengthen professional networks and opportunities for future technical cooperation and knowledge exchange.

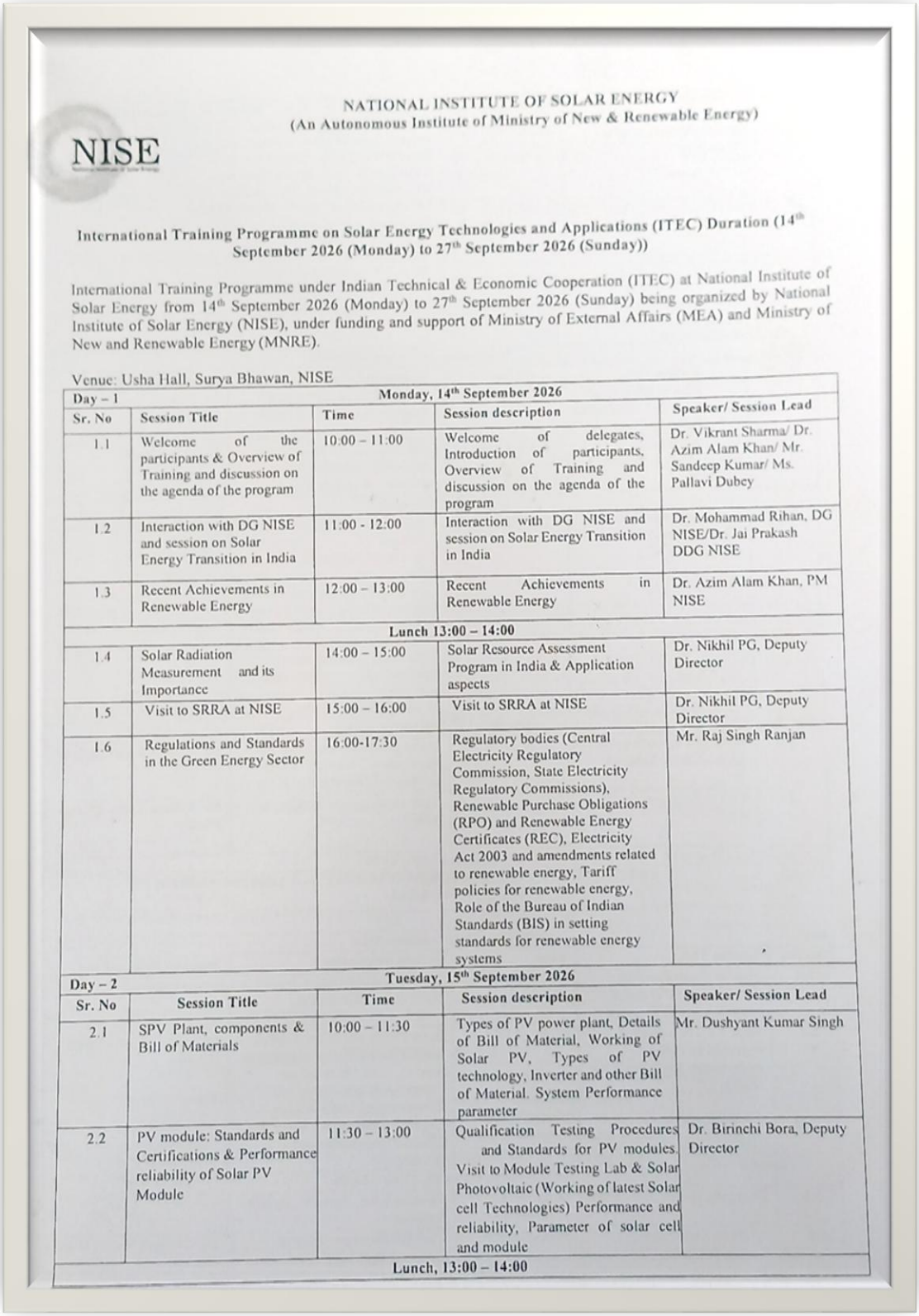
3. HOST INSTITUTION AND TRAINING FRAMEWORK

The National Institute of Solar Energy (NISE), located in Gurugram, Haryana, is a specialized institution concerned with solar energy and renewable energy technology development, assessment, testing, training and related technical activities. The training provided an opportunity to interact with NISE experts and observe specialized facilities.

The programme was conducted under the Indian Technical and Economic Cooperation (ITEC) framework. The certificate issued to the participant records successful completion/participation in the International Training Programme on Solar Energy Technologies and Applications from 14th to 27th September 2026.

4. TRAINING PROGRAMME AND SESSIONS COVERE

The following sections are based on the official programme schedule made available for all training days.



NATIONAL INSTITUTE OF SOLAR ENERGY
(An Autonomous Institute of Ministry of New & Renewable Energy)

NISE

International Training Programme on Solar Energy Technologies and Applications (ITEC) Duration (14th September 2026 (Monday) to 27th September 2026 (Sunday))

International Training Programme under Indian Technical & Economic Cooperation (ITEC) at National Institute of Solar Energy from 14th September 2026 (Monday) to 27th September 2026 (Sunday) being organized by National Institute of Solar Energy (NISE), under funding and support of Ministry of External Affairs (MEA) and Ministry of New and Renewable Energy (MNRE).

Venue: Usha Hall, Surya Bhawan, NISE

Day – 1	Monday, 14th September 2026			
Sr. No	**Session Title**	**Time**	**Session description**	**Speaker/ Session Lead**
1.1	Welcome of the participants & Overview of Training and discussion on the agenda of the program	10:00 – 11:00	Welcome of delegates, Introduction of participants, Overview of Training and discussion on the agenda of the program	Dr. Vikrant Sharma/ Dr. Azim Alam Khan/ Mr. Sandeep Kumar/ Ms. Pallavi Dubey
1.2	Interaction with DG NISE and session on Solar Energy Transition in India	11:00 - 12:00	Interaction with DG NISE and session on Solar Energy Transition in India	Dr. Mohammad Rihan, DG NISE/Dr. Jai Prakash DDG NISE
1.3	Recent Achievements in Renewable Energy	12:00 – 13:00	Recent Achievements in Renewable Energy	Dr. Azim Alam Khan, PM NISE
Lunch 13:00 – 14:00				
1.4	Solar Radiation Measurement and its Importance	14:00 – 15:00	Solar Resource Assessment Program in India & Application aspects	Dr. Nikhil PG, Deputy Director
1.5	Visit to SRRA at NISE	15:00 – 16:00	Visit to SRRA at NISE	Dr. Nikhil PG, Deputy Director
1.6	Regulations and Standards in the Green Energy Sector	16:00-17:30	Regulatory bodies (Central Electricity Regulatory Commission, State Electricity Regulatory Commissions), Renewable Purchase Obligations (RPO) and Renewable Energy Certificates (REC), Electricity Act 2003 and amendments related to renewable energy, Tariff policies for renewable energy, Role of the Bureau of Indian Standards (BIS) in setting standards for renewable energy systems	Mr. Raj Singh Ranjan
Day – 2	**Tuesday, 15th September 2026**			
Sr. No	**Session Title**	**Time**	**Session description**	**Speaker/ Session Lead**
2.1	SPV Plant, components & Bill of Materials	10:00 – 11:30	Types of PV power plant, Details of Bill of Material, Working of Solar PV, Types of PV technology, Inverter and other Bill of Material. System Performance parameter	Mr. Dushyant Kumar Singh
2.2	PV module: Standards and Certifications & Performance reliability of Solar PV Module	11:30 – 13:00	Qualification Testing Procedures and Standards for PV modules. Visit to Module Testing Lab & Solar Photovoltaic (Working of latest Solar cell Technologies) Performance and reliability, Parameter of solar cell and module	Dr. Birinchi Bora, Deputy Director
Lunch, 13:00 – 14:00				

2.3	Field Visit/Lab Visit Familiarization of solar Simulator	14:00-16:00	Measurement of Solar Module Parameter, 2. Understanding I-V curveof Solar Module, 3. Series and Parallelconnection of Solar Modules Classification of solar simulator for PV Module testing PV module: Familiarization of name plate and Technology. Measurement of PV current, PV Voltage and irradiance parameter in the field. I-V measurement using IV Tracer in the field, Translation of IV at STC	Mr. Dushyant Kumar Singh

Day-3	Wednesday, 16th September 2026			
Sr. No.	**Session Title**	**Time**	**Session description**	**Speaker/ Session Lead**
3.1	Visit to 500 kW SPV Plant and Outdoor test facility in NISE	10:00-11:30	Visit to 500 kW SPV Plant/ Outdoor test facility in NISE	Dr. Birinchi Bora, Deputy Director
3.2	Grid integration of SPV power plants & Quality Aspects	11:30 – 13:00	Grid integration of power plants - components and functioning of equipment & quality aspects	Dr. N. S. Saxena
		Lunch, 13:00 – 14:00		
3.3	Basics of Solar Water pumping systems, Operation & maintenance.	14:00-16:30	• Basics of solar water pumping systems • Surface vs Submersible. • Components: PV panels, controller/inverter, motor, pump. • Sizing of solar pumps (based on head, discharge, water needs) - Applications: irrigation, livestock, drinking water Daily/periodic maintenance and troubleshooting - Hands-on session or case study.	Ms. Richa Parmar, Deputy Director
Day-4	**Thursday, 17th September 2026**			
4.1	Hydrogen, technology and its applications & Schemes	10:00-11:30	Hydrogen, technology and its applications, National Green Hydrogen Mission (NGHM)	Mr. Vikrant Yadav, Deputy Director
4.2	Visit to Hydrogen Facility in NISE	11:30 – 13:00	Visit to Hydrogen Facility in NISE	Mr. Vikrant Yadav, Deputy Director
		Lunch, 13:00 – 14:00		
4.3	**VISIT TO SOLAR MANUFACTURING FACILITY from 14:00 PM -17:30 PM** **Ballabagarh, Faridabad**			

Day – 5	Friday, 18th September 2026			
Sr. No.	**Session Title**	**Time**	**Session description**	**Speaker/ Session Lead**
5.1	Visit to Water Pumping facility in NISE & micro irrigation	10:00-11:30	Visit to Water Pumping facility in NISE & micro irrigation	Dr. Ramesh Redhu
5.2 –	Solar PV Technology & overview of different technologies available in the Market	11:30 – 13:00	Solar Photovoltaic, Solar cell & module Technologies available in Market, Solar Photovoltaic (Working of latest Solar cell Technologies) understanding I-V Curve, Efficiency, fill factor, the effect of temperature and Insolation	Dr. Mrinal Dutta, Deputy Director
		Lunch, 13:00 – 14:00		
5.3	Emerging Trends in Solar PV	14:00-16:00	Floating Solar, Agri-PV, Hybrid Systems	
5.4	Inverters: Operation, Configuration, and Troubleshooting	16:00-17:30	Types of inverters, Inverter anatomy, Data logs, Common faults	Dr. Kamlesh Yadav, Deputy Director
Day – 6	**Saturday, 19th September 2026**			
Day – 7	**Sunday, 20th September 2026**			

Day – 8	Monday, 21th September 2026			
Sr. No	Session Title	Time	Session description	Speaker/ Session Lead
8.1	Solar Lighting System	10:00 – 11:30	Solar Lighting System and Applications	Mr. Arup Dhar, Deputy Director
8.2	Solar Lighting System Lab. Visit	11:30 – 13:00	Solar Lighting System and Applications	Mr. Sunil Kumar Prajapati, JPE
	Lunch 13:00 – 14:00			
8.3	Overview of International Solar Alliance (ISA)	14:00 – 15:30	Detailed presentation on activities of International Solar Alliance (ISA)	Mr. Sudhanshu Mishra, ISA

Day – 9	Tuesday, 22th September 2026			
Sr. No	Session Title	Time	Session description	Speaker/ Session Lead
9.1	Operation and Maintenance of PV system	10:00 – 11:30	• O & M issues of PV plant Periodic check of plant performance/ Cleaning of Modules – Robotics importance in Solar Module/ cleaning	Dr. Birinchi Bora, Deputy Director
9.2	Policies and Regulations for Roof top and Large Solar PV Powerplants.	11:30– 13:00	• Policies and Regulations forRoof top and Large Solar PV Power plants, PM Surya Ghar Muft Bijli Yojana, Subsidies etc.	Nomination from MNRE
	Lunch, 13:00 – 14:00			
9.3	PM KUSUM Scheme Various Governments initiative to promote SPV water pumping systems	14:00 – 16:00	Brief about PM KUSUM Scheme	Nomination from MNRE

Day – 10	Wednesday, 23th September 2026			
Sr. No	Session Title	Time	Session description	Speaker/ Session Lead
10.1	Solar Thermal Technology Basics and Facility in NISE along with NISE Products	10:00-11:30	Solar Thermal Technology Basics and Facility in NISE along with NISE Products	Mr. Vikrant Yadav, Deputy Director
10.2	Visit to Solar Thermal Facility in NISE and NISE Products	11:30 – 13:00	Visit to Solar Thermal Facility in NISE and NISE Products	Mr. Vikrant Yadav, Deputy Director
	Lunch 13:00 – 14:00			
10.3	VISIT TO SOLAR FACILITY/SCADA SITE of NPTI from 13:00 PM – 17:30 PM Coordinated by Dr. Azim Alam Khan & Mr. Sandeep Kumar & Ms Pallavi Dube			

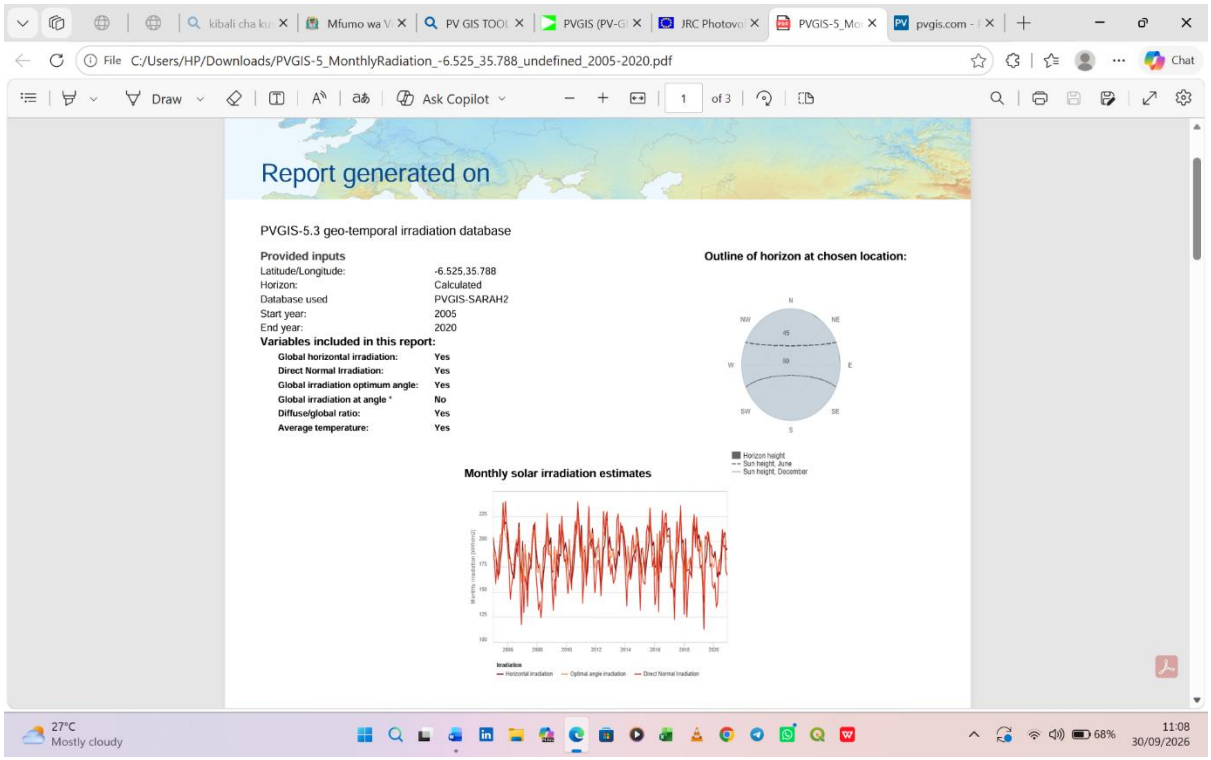
Day-11	Thursday, 24th September 2026			
Sr. No	Session Title	Time	Session description	Speaker/ Session Lead
11.1	Site Assessment of Solar Power Plant	10:00 – 11:30	Understanding of Site assessment tools and Techniques	Dr. Nikhil PG, Deputy Director
11.2	AI in Renewable Energy	11:30 – 13:00	Application of AI in Renewable Energy	Mr. Ishaan Kapoor
	Lunch 13:00 – 14:00			
11.3	Country Presentation	14:00 – 15:30	Country Presentation Presented by Participants	Dr. Azim Alam Khan/Mr. Sandeep Kumar
11.4	Feedback and Assessment	15:30-17:30	Feedback and Assessment	

Day – 12	Friday, 25th September 2026			
Sr. No	Session Title	Time	Session description	Speaker/ Session Lead
12.1	Country Presentation	10:00 – 11:30	Country Presentation Presented by Participants Remaining candidates from Day-11	Dr. Azim Alam Khan/Mr. Sandeep Kumar
12.2	Brief about ALMM & PLI Scheme	11:30 – 13:00	Approved List of Models & Manufacturers (ALMM) Production Linked Incentive (PLI) Scheme	Dr. Nikhil PG, Deputy Director
	Lunch, 13:00 – 14:00			
12.3	Certification & Valedictory	14:00-17:30	Assessment, Feedback and Certification & Valedictory	
Day – 13	Saturday, 26th September 2026			
Day – 14	Sunday, 27th September 2026			

5. KEY TECHNICAL KNOWLEDGE AND LESSONS LEARNED

5.1 Solar Resource Assessment

A major lesson from the programme is that effective solar energy project development begins with adequate understanding of the available solar resource. Solar radiation measurement and resource assessment provide the basis for estimating energy yield, selecting appropriate system configurations and assessing project feasibility. Exposure to the SRRA facility at NISE demonstrated the importance of reliable solar resource data in planning and evaluating solar-energy applications.



Picture 1 : *Solar Irradiance Software Tools for Solar Potential Visualization (Source: PV GIS Tool Website)*

5.2 Solar Photovoltaic Systems and Components

The Solar PV plant session introduced the main categories of PV power plants, PV technologies and system components. Understanding the relationship between PV modules, inverters and other balance-of-system components is essential for appropriate system sizing, procurement, installation, operation and maintenance.



Picture 2: *Solar PV Power Plant at NISE*

5.3 Bill of Materials and Project Planning

The Bill of Materials (BoM) concept is important for transparent project planning and procurement. A technically sound BoM should account for the required PV modules, inverters and other system components, together with their specifications and quantities. This knowledge can improve the preparation and evaluation of solar projects in agricultural facilities.

5.4 PV Standards, Testing and Reliability

The module standards and certification session highlighted the importance of qualification testing, performance parameters and reliability assessment. For long-term investments such as solar-powered irrigation systems, agricultural research stations and cold-storage facilities, equipment quality and compliance with applicable standards are essential considerations.



Picture 3: *Thermal Pyranometer at Nise*



Picture 4: *Solar Panel Testing Facilities at NISE Lab*

5.5 Renewable Energy Regulations and Standards

The programme also demonstrated that successful renewable-energy deployment depends not only on technology but also on an appropriate regulatory and standards framework. The Indian experience presented during the training included regulatory institutions, Renewable Purchase Obligations (RPO), Renewable Energy Certificates (REC), electricity-law provisions, renewable-energy tariffs and the role of the Bureau of Indian Standards (BIS).

6. RELEVANCE TO TANZANIA

The training has direct relevance to Tanzania's efforts to increase the productive use of renewable energy. Solar energy can support decentralized services and productive activities in areas where conventional electricity supply is limited or where energy costs affect the viability of agricultural operations.

6.1 Agriculture and Irrigation

Solar photovoltaic systems can be integrated with irrigation and water pumping systems. Proper solar resource assessment, system sizing, component selection and performance monitoring are important to ensure that such systems meet irrigation water requirements and operate reliably.



Picture 5: *Solar Water Pumping System at NISE*

6.2 Agricultural Research and Training Facilities

Agricultural research stations, training centers and demonstration farms can use solar systems to improve the reliability of electricity for laboratories, water pumping, communications, ICT equipment and other essential loads.

6.3 Post-Harvest Management and Value Addition

Solar energy has potential applications in crop drying, cold storage, refrigeration, milk cooling, food processing and other value-addition activities. These applications can reduce dependence on diesel-based generation and improve energy access for rural enterprises.

6.4 Climate-Smart Agriculture

Solar energy can support climate-smart agriculture by reducing reliance on fossil-fuel-based energy for selected productive activities while enabling farmers and agricultural institutions to maintain essential services.



Picture 5: *Solar Water Pumping Model Farm (20m x 13m) for Irrigation Applications at NISE*

7. APPLICATION OF THE TRAINING TO THE MINISTRY OF AGRICULTURE

Considering the participant's responsibilities and professional interest in agriculture, training and research, the knowledge gained can be translated into practical activities within the agricultural sector.

- Promoting evidence-based assessment of solar-energy options for agricultural irrigation and water supply.
- Supporting development of technical specifications and Bills of Materials for solar-powered agricultural projects.
- Strengthening capacity of agricultural officers and technicians on basic solar PV applications and system performance.
- Supporting technology-transfer initiatives that demonstrate solar applications to farmers and agricultural institutions.
- Integrating renewable-energy considerations into agricultural infrastructure planning and climate-smart agriculture programme.
- Supporting pilot projects for solar irrigation, solar drying, cold storage and other productive uses of renewable energy.
- Documenting performance and lessons from solar-powered agricultural systems for future scale-up.

8. PROPOSED POST-TRAINING ACTION PLAN

Action	Expected output	Indicative timeframe	Responsible/partners
Prepare a technical brief on solar applications in agriculture	Technical brief for internal use	0–3 months	Ministry of Agriculture / relevant technical units
Identify potential sites for solar irrigation and agricultural facilities	Prioritised pilot sites	0–6 months	Agriculture authorities and technical partners
Develop a demonstration solar-agriculture project	Operational demonstration system	6–12 months	Ministry, local authorities and partners
Conduct knowledge-sharing sessions	Agricultural staff trained	3–12 months	Training and research units
Document performance and lessons from pilot systems	Monitoring and evaluation report	12 months onward	Implementing institutions
Explore technical cooperation and knowledge exchange with Indian institutions	Potential cooperation areas identified	On-going	Relevant Tanzanian and Indian institutions

9. RECOMMENDATIONS

1. Agricultural institutions should assess solar-energy applications as part of planning for irrigation, water supply, post-harvest management and rural productive infrastructure.
2. Solar projects should be preceded by appropriate resource assessment, technical sizing, load assessment and lifecycle-cost analysis.
3. Procurement specifications should clearly define PV module, inverter, storage and balance-of-system requirements, including applicable quality and performance standards.
4. Capacity building should be extended to agricultural engineers, technicians, extension personnel and researchers so that solar systems are properly planned, operated and maintained.
5. Pilot projects should be established to demonstrate solar-powered irrigation, drying, cold storage and other agricultural applications under Tanzanian conditions.
6. Experience from India should be adapted to Tanzania's institutional, regulatory, climatic and economic context rather than transferred without local assessment.
7. Monitoring and evaluation should be incorporated into solar-agriculture projects to generate evidence on energy production, operating costs, reliability, agricultural productivity and economic benefits.

10. CONCLUSION

Participation in the International Training Programme on Solar Energy Technologies and Applications at the National Institute of Solar Energy in Gurugram provided an important opportunity to strengthen technical and institutional understanding of solar energy. The sessions covered during the first part of the programme demonstrated the breadth of the training, including India's renewable-energy transition, solar-resource assessment, regulatory frameworks, PV plant components, Bills of Materials, standards, testing and module reliability.

The knowledge acquired can be applied to Tanzania's agricultural sector, particularly in solar-powered irrigation, water pumping, agricultural research infrastructure, post-harvest management, agro-processing and other productive uses of renewable energy. The next step should be to translate the training into practical knowledge-sharing, pilot projects and technically sound solar-energy applications suited to Tanzanian conditions.

11. ACKNOWLEDGEMENT

I sincerely acknowledge the Government of India through the Indian Technical and Economic Cooperation (ITEC) Programme, the Ministry of External Affairs, the Ministry of New and Renewable Energy, and the National Institute of Solar Energy for providing the opportunity to participate in this international training programme.

I further appreciate the NISE management, course coordinators, facilitators, technical experts and all institutions involved in delivering the programme for sharing their knowledge, experience and practical insights. The opportunity to learn from India's experience in solar energy technologies and applications is highly valuable for strengthening renewable energy knowledge and its application in Tanzania.

My experience in India was a great learning opportunity. I am grateful to AgriScape Innovations Company Limited (ASI Co. Ltd.) for facilitating and supporting my training program in India. The training gave me valuable practical knowledge, international exposure, and an opportunity to learn from experienced professionals. The experience has increased my confidence, expanded my knowledge, and motivated me to apply what I learned in my future agricultural work.