



GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
DIRECTORATE GENERAL OF TRAINING

COMPETENCY BASED CURRICULUM

CERTIFICATE COURSE ON

Rooftop Solar PV (Installation & Maintenance)



NSQF LEVEL- 3.0

SECTOR – POWER

ROOFTOP SOLAR PV (INSTALLATION & MAINTENANCE)

Duration: 60 Hrs.

**NSQF LEVEL- 3.0
(Version: 1.0)**

Designed in 2024

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

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CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE

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1. COURSE INFORMATION

1.1 GENERAL

During the 60 hours duration of Rooftop Solar PV (Installation & Maintenance) trade a candidate is trained on professional Skill and professional Knowledge. The components covered related to the certificate course are categorized below.

The trainees learn about characteristics of Photovoltaic cells and modules, Batteries, Charge Controllers. Learns connections and testing of Solar Panel, Charge Controller, Battery Bank and Inverter. Prepare bill of material for rooftop solar projects. Installation, testing and commissioning of Rooftop Solar system. The Trainee learns about preventive and breakdown maintenance of rooftop solar system.

1.2 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements:

S No.	Course Element	Notional Training Hours
1.	Professional Skill (Trade Practical)	30
2.	Professional Knowledge (Trade Theory)	15
3.	On the Job Training (OJT)	15
	Total	60

1.3 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude through summative assessment at the end of the course as notified by the DGT from time to time.

The assessment will be conducted by Controller of examinations, DGT as per the guidelines. There will be a computer based summative test of 30 marks (15 questions each of 2 marks) with 30 minutes duration or as being notified by DGT from time to time.

The learning outcome and assessment criteria will be basis for setting question papers for final assessment.

2. GENERAL INFORMATION

Name of the Trade	ROOFTOP SOLAR PV (INSTALLATION & MAINTENANCE)
Reference NCO-2015	7421.1401
NOS Covered	PSS/N9477, PSS/N9478, PSS/N9479, PSS/N9480, PSS/N9481
NSQF Level	3.0
Duration of Craftsmen Training	60 Hours
Entry Qualification	<p>CTS/ATS candidates (pursuing Final year or pass-out) in Electrician, Wireman, Electrician Power Distribution, Electronics Mechanic trades</p> <p style="text-align: center;">OR</p> <p>CITS candidates (pursuing or pass-out) Electrician, Electronics Mechanic trades.</p>
Instructors Qualification	<p>Degree in Electrical/ Electrical and Electronics Engineering from recognized Engineering College/ university with one year experience in the relevant field.</p> <p style="text-align: center;">OR</p> <p>Diploma in Electrical / Electrical and Electronics Engineering from recognized board of technical education with two years' experience in the relevant field.</p> <p style="text-align: center;">OR</p> <p>Existing Instructors of ITIs/NSTIs/ IToTs of Solar Technician (Electrical) / Electrician CTS/ CITS trades.</p> <p style="text-align: center;">OR</p> <p>NTC passed in the Trade of "Solar Technician (Electrical)" With three years' experience in the relevant field.</p>
List of Tools and Equipment	As per Annexure – I

3. LEARNING OUTCOME

Learning outcomes are a reflection of total competencies of a trainee and assessment will be carried out as per the assessment criteria.

LEARNING OUTCOMES

1. Measure irradiance of different sources of light. (NOS: PSS/N9477)
2. Determine characteristics of Photovoltaic cells and solar modules. (NOS: PSS/N9478)
3. Prepare bill of materials for rooftop solar projects. (NOS: PSS/N9480)
4. Install, connect, test and commission rooftop solar panel, Charge controller, Battery bank and Inverter following safety guidelines. (NOS: PSS/N9479)
5. Troubleshoot and maintain solar rooftop projects with best practices. (NOS: PSS/N9481)

SYLLABUS – ROOFTOP SOLAR PV (INSTALLATION & MAINTENANCE)			
Duration: 60 Hours			
Duration	Reference Learning outcome	Professional Skills (Trade Practical)	Professional Knowledge (Trade Theory)
Professional Skills – 2 hrs. Professional Knowledge – 2 hrs.	Measure irradiance of different sources of light.	<ol style="list-style-type: none"> 1. Measure intensity of solar radiation. 2. Identify various parts of Rooftop solar power plant and its uses (On grid, off grid & hybrid). 	<ul style="list-style-type: none"> • Solar energy fundamentals. • On grid, off grid & hybrid rooftop solar power plant (with help of single line diagram) • Study of daily and seasonal changes of sunlight. • Angle of inclination of radiant light and its relation with latitude and longitude of different locations on Earth. • Definition of GHI & DNI • Sunlight spectrum.
Professional Skills – 7 hrs. Professional Knowledge – 4 hrs.	Determine characteristics of Photovoltaic cells and solar modules.	<ol style="list-style-type: none"> 3. Plot I-V curve for photovoltaic cell based on the illumination at constant temperature. 4. Plot I-V curve for photovoltaic cell based on temperature at constant illumination. 5. Test photovoltaic cell in sunlight at various angles of inclination and direction. 6. Record specification of different solar panels and compare specifications to select a panel) 7. Select & connect suitably rated wires in the terminal box of a solar panel and connect end terminals using suitable MC 4 connectors. 8. Connect solar panels in series and measure voltage 	<ul style="list-style-type: none"> • Conversion of solar radiation to electricity. • Difference of photo electric and photo voltaic effects of a PN junction. • PV cell characteristics, I-V curve, effects of temperature. • Photo voltaic module: minimal functional specification, cells per module, max watts per module, maximum voltage at max power, maximum current at max power. • Standard test conditions (STC) of a PV module. • Terminal box and connectors of a Solar PV module.

		<p>and current. Repeat with different rated panels.</p> <p>9. Connect solar panels in parallel and measure voltage and current. Repeat with different rated panels.</p>	
<p>Professional Skills – 5 hrs.</p> <p>Professional Knowledge – 3 hrs.</p>	<p>Prepare bill of materials for rooftop solar projects.</p>	<p>10. Perform site survey for installation of rooftop solar plant.</p> <p>11. Prepare bill of material for a 1 KW solar PV installation as per customer's need.</p> <p>12. Prepare a Bill of materials for a 5 KW solar PV installation as per customer's need.</p> <p>13. Demonstrate Standard Operating Procedures of Off grid Solar Rooftop Installation.</p> <p>14. Demonstrate Standard Operating Procedures of On grid Solar Rooftop Installation</p>	<ul style="list-style-type: none"> • Understanding customer's requirement. • Single Line Diagram (SLD) and identifying different component symbols in SLD. • System sizing: Selection of components of the Solar Photovoltaic Electrical system. • Load calculation and system sizing. • Battery sizing. • Solar panel sizing. • System types based on: Backup requirements, Grid availability, Budget and space. • Guidance for Solar Installation by MNRE
<p>Professional Skills – 12 hrs.</p> <p>Professional Knowledge – 5 hrs.</p>	<p>Install, connect, test and commission rooftop solar panel, Charge controller, Battery bank and Inverter following safety guidelines.</p>	<p>15. Install a rooftop (RCC/Tin) Solar panel mounting structure for 1 KW installation including grouting following safety procedures.</p> <p>16. Make fastening and concrete/ ballast foundation over mounting base.</p> <p>17. Mount Solar panels on the Mounting structure.</p> <p>18. Wire Solar panels and connect the array junction box to the above installation and draw wires to on grid inverter/ off grid inverter, ACDB with AC-</p>	<ul style="list-style-type: none"> • Safety related to solar panel installation. • Safety at rooftop. • Various components of different solar structure (RCC/Tin) • Solar panel terminal wires and MC-4 connectors. • Choice of wires (DC cables) used in the solar PV Electrical system. • Choice of battery (tubular stationary/ VRLA gel/ lithium ion) • Array junction box (AJB) or combiner box.

		<p>SPD, Remote monitoring device, net/gross meter.</p> <p>19. Install & test AC, DC & lightning arrester earthing.</p> <p>20. Verify the checklist, carry out final test and commission the rooftop solar system.</p>	<ul style="list-style-type: none"> • Protection devices in AJB (DC SPD). • PWM charge controller. • MPPT charge controller. • Safety Standards IEC 61730-1,2 (Electrical Hazards, Mechanical Hazards, Thermal Hazards, Fire Hazards) • Understanding of different safety risk and its mitigation. • Use of Proper PPE kit and its importance • Understanding the safety Protocol during installation testing and commissioning.
<p>Professional Skills – 4 hrs.</p> <p>Professional Knowledge – 1 hr.</p>	<p>Troubleshoot and maintain solar rooftop projects with best practices.</p>	<p>21. Carry out of Solar Panel maintenance: - Cleaning and DC array Inspection.</p> <p>22. Execute battery maintenance- checking of electrolyte level, specific gravity using hydrometer, physical damage, terminal voltage, cleaning of battery terminals.</p> <p>23. Inspect mounting structure of Solar Modules.</p> <p>24. Verify that the inverters, panels, protection devices conforming to IEC standards or relevant Indian standards.</p> <p>25. Verify and assess the safety of earthing and lightning protection of the rooftop solar system.</p>	<ul style="list-style-type: none"> • Battery maintenance, capacity test, Safety precautions while handling Batteries. • Procedure of replacement of defective Fixtures.
15 Hrs.	On the Job Training		
Examination			

6. ASSESSMENT CRITERIA

LEARNING OUTCOME	ASSESSMENT CRITERIA
1. Measure irradiance of different sources of light. (NOS: PSS/N9477)	Identify various parts of Rooftop solar power plant (On grid, off grid & hybrid).
	Measure intensity of solar radiation.
2. Determine characteristics of Photovoltaic cells, Modules, Batteries and Charge controllers. (NOS: PSS/N9478)	Plot I-V curve for photovoltaic cell based on temperature at constant illumination.
	Test photovoltaic cell in sunlight at various angles of inclination and direction.
	Specification of different solar panels and compare specifications to select a panel
	Connect suitably rated wires in the terminal box of a solar panel and connect end terminals using MC 4 connectors.
	Connect solar panels in series and measure voltage and current.
3. Prepare bill of materials for rooftop solar projects. (NOS: PSS/N9480)	Perform site survey for installation of rooftop solar plant.
	Prepare bill of material for a 1 KW rooftop solar system as per customer's need.
	Prepare a Bill of materials for a 5 KW rooftop solar system as per customer's need.
	Demonstrate Standard Operating Procedures of off grid Solar Rooftop Installation.
4. Install, connect, test and commission rooftop solar panel, Charge controller, Battery bank and Inverter following safety guidelines. (NOS: PSS/N9479)	Install a rooftop (RCC/Tin) Solar panel mounting structure for 1 KW installation following safety precautions.
	Mount Solar panels on the Mounting structure.
	Wire up rooftop Solar panels.
	Connect the array junction box to the given installation and draw wires.
	Install & test AC, DC & lightning arrester earthing.
	Prepare checklist for commission the rooftop solar system and carry out final test.
5. Troubleshoot and maintain solar rooftop projects with best practices. (NOS: PSS/N9481)	Carry out of Solar Panel Maintenance: - Cleaning, DC Array Inspection.
	Execute battery maintenance - checking of electrolyte level, specific gravity using hydrometer, physical damage, terminal voltage, cleaning of battery terminals.
	Inspect mounting structure of Solar Modules.
	Verify and assess the safety of earthing and lightning protection of the solar PV power plant.

LIST OF TOOLS & EQUIPMENT

ROOFTOP SOLAR PV (INSTALLATION & MAINTENANCE)

Sl. No. 1 to 60 are not required if ITI/NSTI affiliated in Solar Technician (Electrical), Electrician trades

S No.	Name of the Tools and Equipment	Specification	Quantity
1.	Measuring Steel Tape	5 meter	06 Nos.
2.	Combination Plier Insulated	200 mm	06 Nos.
3.	Screw Driver Insulated	4mm X 150 mm, Diamond Head	06 Nos.
4.	Screw Driver Insulated	6mm X 150 mm	06 Nos.
5.	Electrician screw driver thin stem insulated handle	4mm X 100 mm	06 Nos.
6.	Heavy Duty Screw Driver insulated	5mm X 200 mm	06 Nos.
7.	Electrician Screw Driver thin stem insulated handle	4mm X 250 mm	06 Nos.
8.	Hammer, cross peen with handle	250 grams	06 Nos.
9.	Hacksaw frame (with blade)	Adjustable 300 mm Fixed 150 mm	2 Nos. Each
10.	Pliers long nose insulated	150 mm	4 Nos.
11.	Pliers flat nose insulated	200 mm	4 Nos.
12.	Pliers, round nose insulated	100 mm	4 Nos.
13.	D.E. metric Spanner Double Ended	6 - 32 mm	2 Set
14.	Gauge, wire imperial stainless steel marked in SWG & mm	Wire Gauge - Metric	2 Nos.
15.	Portable Electric Drill Machine	0-12 mm capacity 750W, 240V with chuck and key	1 No.
16.	Crimping Tool	<ul style="list-style-type: none"> • 1.5 sq mm to 16 sq mm • 16 sq mm to 95 sq mm • MC 4 connector 	1 No. Each
17.	Pliers Side Cutting	150 mm	2 Nos.
18.	Wire stripper adjustable length		2 Nos.
19.	Hammer, ball peen With handle		2 Nos.
20.	Load Bank (variable)	Up to 1.2 KW (Lamp / heater Type)	1 No.
21.	Rooftop Mounting Structure	For 3 x 335 Wp solar panels mounting practice, with tilt adjustment (as per available in market)	2 sets
22.	SPD	DC & AC	2 Nos. each
23.	MCCB	100Amps, Triple pole	1 No.
24.	ELCB and RCCB	25Amps, double pole and 25Amps, double pole, 30 mA	1 Each

25.	Solar cable (Red)	6 square mm	As required
26.	Solar cable (Black)	6 square mm	As required
27.	Battery cable	7.5 sq mm	As required
28.	MC – 4 connectors	1 way, 2 way, 3 way & 4 way	As required
29.	lugs	7.5 mm	As required
30.	Bolts, nuts, anchor bolts, washers, screws, other pins, lugs etc		As required
31.	Multi meter	Digital 0 to 2 M Ohms, 2V to 700 V, 100 micro A to 10A DC and AC	02 Nos.
32.	Insulation tester	Analog - 500 V	01 No.
33.	Earth tester	0 to 100 ohm (analog)	01 No.
34.	Hydrometer	Lead acid type	04 Nos.
35.	1 KW Solar PV power plant	Grid tie type with suitable panels, A/B, Inverter, AC/DC cables, safety devices and grid tie arrangement	01 No.
36.	Tong Tester / Clamp Meter	0 - 100 A (Digital Type) (AC & DC)	1 No. each
37.	Magnetic compass		04 No.
38.	Lead Acid battery (VRLA gel)	12V, 75Ah	01 No.
39.	Lead Acid battery (tubular)	12V, 40 Ah	01 No.
40.	Solar simulator for solar cell characteristic study	To study IV curve of a solar cell of minimum 2 watt under variable illumination, temperature and suitable load	01 No.
41.	Solar energy trainer with grouping of solar cells	To group (series or parallel) at least six solar cells each with minimum 2 W with suitable loads	01 No.
42.	Halogen lamp with stand for illumination of solar panels in lab	AC mains operated to provide 0 to 1000 watts per meter square	02 Set
43.	Battery Charger	0 - 6 - 9 - 12 - 24 - 48 V, 30amp	01 No.
44.	Solar photovoltaic module	5W, 10W, 40W, 75W, 265W	05 Each
45.	Solar panels	335 Wp	03 Nos.
46.	Solar Charge controller with Dusk to Dawn automatic switching	12V 10A, 24V 20 A	01 No. each
47.	Solar charge controller with manual switch (Day lighting)	12 V, 20 A	02 Nos.
48.	Array junction box	for connecting 265W x 4 Nos. solar panel with DC fuse, DC MCB, and surge suppressor protection	02 Nos.
49.	Home light system	12 V DC with FM receiver, LED bulb and mobile charger as loads	1 No.
50.	Clinometer	for Angle measurement	1 No.
51.	Spirit level	For floor level check	1 No.
52.	DC table fan	12 V, 15W	1 No.

53.	A.C. Energy Meter	Single Phase, 10 A, 240 V induction type	01 No.
54.	Net meter	Single Phase, 10 A, 240 V induction type	01 No.
55.	Inverter with Battery	0.5KVA with 12 V Battery Input- 12 volt DC, Output- 220 volt AC	01 No.
56.	Solar PCU	Off grid 1 KW MPPT Sine wave Solar Power Conditioning Unit	04 Nos.
57.	Complete Solar Grid tied inverter with Remote Monitoring System Panel Demonstrator kit	1 KW	1 No.
58.	Instructor's table		01 No.
59.	Instructor's chair		01 No.
60.	Steel Almirah	2.5 m x 1.20 m x 0.5 m	02 Nos.

ANNEXURE-II

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts and all others who contributed in designing/ revising the curriculum. Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

Trade committee meeting to finalize the syllabus of “Rooftop Solar PV (Installation & Maintenance)”			
(60 hrs.) held on 22.05.2024 at CSTARI, Kolkata.			
Sl. No.	Name and Designation (Shri/Smt./Kumari)	Organization with Address	Remarks
1.	Sunil Kumar Gupta, DDG (ER)	CSTARI, Kolkata	Chairman
2.	Gautam Chandra Saha, JD/HOD	CSTARI, Kolkata	Member
3.	Surja Sekhar Shaw, Instructor (Wireman)	Govt. ITI, Suri- Birbhum	Member
4.	Debasish Mondal, Assist. Professor (EE)	Saroj Mohan Institute of Technology	Member
5.	Rahul Gupta, Instructor (Electrician)	Govt. ITI, Suri- Birbhum	Member
6.	Anupam Baral, Founder & CEO	Geetanjali Solar Enterprise, Kolkata	Member
7.	Pradip Kumar Mondal, Instructor (Electrician)	Govt. ITI, Gariahat	Member
8.	Sk. Altaf Hossain, Asst. Director	CSTARI, Kolkata	Member
9.	B. Sharanappa, Asst. Director	CSTARI, Kolkata	Member
10.	Bharat Kumar Nigam, TO	CSTARI, Kolkata	Member
11.	K.V.S. Narayana, TO	CSTARI, Kolkata	Member
12.	P.K. Bairagi, TO	CSTARI, Kolkata	Member