National Occupational Skill Standard (NOSS)

Occupational Title : **Solar Electric Technician**

Level : **2**

Sector : **Renewable Energy Engineering**

Sub - Sector : **Solar Photovoltaic (PV)**

NOSS ID/NSCO ID :

ISCO NO :

Council for Technical Education and Vocational Training

NATIONAL SKILL TESTING BOARD

Madhyapur Thimi-17, Sanothimi, Bhaktapur, Nepal

Developed: 25-12-2023 (09-09-2080)

2045

The National Skill Standards and test was developed by:

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4.	Prof. Dr. Dinesh Sharma	Member	Asst. Dean, IOE, Pulchowk.
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Approved by the Tripartite National Skill Testing Board
1999

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Approved by the Tripartite National Skill Testing Board

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Approved by the Tripartite National Skill Testing Board.
December 2010 (2067/068)

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Recommended by Renewable Energy Technical Sub Committee: May 2015 (Jestha 2072)

The National Occupational Skill Standard Developed by:

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Recommended by Renewable Energy Technical Sub Committee: 25 December 2023 (09 Paush 2080)

1	**Occupational Title: Solar Electric Technician** **Level: 2**
2	**Job Description:** Solar Electric Technician, L-2 installs and troubleshoots off-grid solar PV system upto 10 kWp, installs and troubleshoot single/three phase on-grid solar PV system upto 10 kWp, installs and troubleshoot solar water pump upto 10 kW and installs and troubleshoot standalone/centralized solar street light.
3	**UNITS OF COMPETENCY:** 1. Install and troubleshoot off-grid solar PV system upto 10 kWp 2. Install and troubleshoot single/three phase on-grid solar PV system upto 10 kWp 3. Install and troubleshoot solar water pump upto 10 kW 4. Install and troubleshoot standalone/centralized solar street light 5. Perform communication 6. Develop professionalism ***Note: Units 5 and 6 are not for testing purpose.***
4	**Qualifying Notes/Prerequisites:** • Physical Requirements: Sound health • Entry Requirements: As per NSTB rules **Additional Information:** • Assessment Types: Performance and Written Test • Assessment Duration: 4:00 to 6:00 hours (Single Competency) 8:00 to 10:00 hours (Full Competency) • Recommended Group Size: 5 to 7 candidates

5	**Unit No: 1** **Unit Title: Install and troubleshoot off-grid solar PV system upto 10 kWp**	**Unit code:**
	Elements of competency	**Performance standards**
	1.1 Prepare tool, equipment and materials	1.1.1 ***Personal Protective Equipment (PPE)*** used in accordance with task requirement. 1.1.2 Tools, equipment and materials collected as per task requirement. 1.1.3 Working condition of tools and equipment checked and fault tagged.
	1.2 Perform site assessment	1.2.1 Solar installation area determined in consultation with client or as per drawing. 1.2.2 ***Site assessment*** conducted at peak sun hours for solar installation. 1.2.3 Solar installation area verified as per the drawing and layout for installation. 1.2.4 Feedback is provided to client based on-site assessment.
	1.3 Install PV module/array/string	1.3.1 ***Mounting structure*** installed firmly in line and level ensuring to withstand wind pressure and wind circulation. 1.3.2 ***Components*** of solar PV system verified and checked for physical damage. 1.3.3 Open circuit voltage and short circuit current measured in each module and verified with manufacturer's specification. 1.3.4 Solar PV module(s)/array/string installed firmly on mounting structure in required direction and inclination as per drawing. 1.3.5 PV module (s) connected in series or parallel as per system design to junction/combiner box along with wire conduit. 1.3.6 Conduit installed and cables laid from junction/combiner box to charge controller/inverter through protection devices.

	1.4 Install charge controller	1.4.1 Location for charge controller identified in consultation with client. 1.4.2 Charge controller fixed firmly on designated area. 1.4.3 Positive and negative terminals of solar PV module(s)/array/string connected to corresponding terminals of charge controller through protection devices. 1.4.4 Charge controller connected to DC loads**.**
	1.5 Install battery bank and solar inverter	1.5.1 Specific gravity and voltage of battery measured and verified as per manufacturer's specification. 1.5.2 Batteries placed in well-ventilated area with or without rack. 1.5.3 Batteries connected in series or parallel as per wiring diagram. 1.5.4 Positive and negative terminals of charge controller connected to corresponding terminals of batter bank/pack through protection devices. 1.5.5 Inverter firmly fixed on identified location. 1.5.6 Positive and negative terminals of battery bank connected to corresponding terminals of inverter through protection devices. 1.5.7 Inverter connected to AC loads.
	1.6 Perform electrical wiring	1.6.1 Conduit fixed along marked route. 1.6.2 AC/DC cables laid through conduit as per specification. 1.6.3 Junction box mounted at shortest distance between charge controller and DC load of building. 1.6.4 AC/DC wires connected to power sockets and loads as per single/three phase wiring diagram.

	1.7 Install earthing and protection devices	1.7.1 Earthing components checked and assembled as per manufacturer's instruction. 1.7.2 Earthing with lightning arrestor installed as per drawing. 1.7.3 Earthing system connected with solar PV system as per drawing. 1.7.4 ***Protection devices*** fixed in line and level in designated area. 1.7.5 Protection devices connected with solar PV system as per wiring diagram.
	1.8 Test solar PV system	1.8.1 Solar PV system and individual components functionality checked as per system design. 1.8.2 ***Issues*** faced during installation rectified. 1.8.3 Solar PV system activated as per commissioning procedures. 1.8.4 Client oriented on operation, maintenance and cleaning of solar PV system.
	1.9 Troubleshoot solar PV system	1.9.1 Fault history collected from clients and recorded as per industry norms. 1.9.2 Solar PV system inspected visually for ***physical damage and abnormal condition***. 1.9.3 Components of solar PV system cleaned and foreign materials removed. 1.9.4 ***Electrical parameters*** measured and verified against specification. 1.9.5 Monitoring tools/display analyzed for system performance. 1.9.6 Function/performance of major components and overall system output checked as per block diagram or specification. 1.9.7 Fault and cause of fault identified based on visual inspection and test result and recorded as per industry norms. 1.9.8 Materials and cost required for repair is calculated as per industry norms. 1.9.9 ***Wiring fault*** and electrical problems fixed as per circuit diagram.

		1.9.10 Defective components replaced with new components of correct specification. 1.9.11 Post repair testing carried out as per checklist and commissioned solar PV system.
	1.10 Clean workplace	1.10.1 Tools and equipment cleaned and stored in designated location. 1.10.2 Unused and leftover materials collected and stored in designated location. 1.10.3 Workplace cleaned and waste disposed as per ***3R's principle*** at designated location.
6	**Task Performance Requirements (Tools, Equipment and Materials):** • Solar PV module(s), connecting cables (UV Protective), support structure, controller unit, battery, solar inverter, Pyranometer, magnetic compass, multi-contact (MC) connector, inline wire connectors, hammer, screw drivers, pliers, chisel, adjustable wrench, spanners, hacksaw, knife, wire cutters, crimping tools, wire strippers, angle meter/set square, measuring tape, level meter, drill machine, battery operated drill machine, hot air gun blower, IR Thermometer, multimeter, clamp on meter, megger, cables/wires, hydrometer, thermocouple, cable clips, set of nuts and bolts, cable lug, , heat shrink tube, drift, funnel, plumb bob, elbow, T-jointer, power socket, switches, junction box, bus bar, marker, connectors, screws, clips, rack, cable tie, conduit, corrugated conduit, PVC tape, petroleum jelly/grease, lightning arrestor, Earth Electrodes, Earthing Strip, Earth pit, back fill compound, Earth hole drilling machine, protection devices, dust bin, dust pan, broom, first aid kit and Personal protective equipment (PPE).	
7	**Safety and Hygiene (Occupational Health and Safety):** • Use personal protective equipment. • Safe handling of tools, equipment and materials. • Prevent from chemical and electrical hazards.	

8	Required Knowledge		
	Technical Knowledge	**Applied Calculation**	**Graphical Information**

	• Tools, equipment and materials
	  ○ Types
	  ○ Uses
	  ○ Safe handling
	  ○ Storage
	• Introduction of solar energy and photovoltaic
	• Fundamentals of standalone, grid connected and hybrid systems
	• Solar PV system
	  ○ Introduction
	  ○ Solar geometry
	  ○ Components and their uses
	  ○ Configuration
	• Solar panels
	  ○ Introduction
	  ○ PV modules, array and string
	  ○ Types
	  ○ Mounting position, direction and angle
	  ○ Installation and connection
			• Read and interpret manufacturer's instruction/specification
			• Read and interpret block diagram of solar PV system
			• Read and interpret singe line diagram
			• Read and interpret wiring diagram

	• Inverter and charge controller
	  ○ Introduction
	  ○ Types
	  ○ Functions
	• Batteries
	  ○ Introduction
	  ○ Types
	  ○ Functions
	  ○ Electrolyte level and specific gravity
	  ○ State of charge (SoC) and Depth of discharge (DoD)
	  ○ Battery temperature
	  ○ Life cycle
	• Importance of site assessment
	• Factors of site assessment as per geographical location (Roof orientation, optimum direction, shading, air circulation, wiring requirement, and energy needs)
	• Roof preparation and mounting techniques
	• Fundamental concept of electricity
	• Electrical parameters (current, resistance, voltage, continuity, power, ampacity)
	• Electrical wiring, circuit and connection		

	• Cables/wires
	• Earthing and lightning arrestor
	  ○ Introduction
	  ○ Types
	  ○ Components and their function
	  ○ Installation technique
	  ○ Earth resistance test
	• Protection devices
	  ○ Introduction
	  ○ Types
	  ○ Function
	• Testing and commissioning of solar PV system
	• Dismantling and assembling process
	• Types and importance of maintenance
	• Servicing technique
	  ○ Visual inspection
	  ○ Cleaning
	  ○ Checking
	  ○ Leak detection
	  ○ Terminal greasing
	  ○ Performance testing		

	• Testing and fault diagnose • Repair and maintenance of electrical and mechanical components • Fundamental concept of electricity • Electrical parameters • IP protection • Electrical wiring, circuit and connection • Recent trends in photovoltaic and solar system • Cleaning and waste management • Record keeping and documentation • Importance of first aid • Occupational health and safety rules and regulations		

9	Assessment of Competency					
	Unit: 1 **Unit Title: Install and troubleshoot off-grid solar PV system upto 10 kWp**					
	Candidate Details		**Assessors Detail**			
	Candidate's Name: Registration Number: Symbol No: Test Centre: Test Date:		Assessors' Name 1. 2. 3.		ID/License No:	

Element of competency	Performance Standards	Standard Met	Standard Not Met	Evidence Type	Comments
1.1 Prepare tool, equipment and materials	1.1.1 ***Personal Protective Equipment (PPE)*** used in accordance with task requirement. 1.1.2 Tools, equipment and materials collected as per task requirement. 1.1.3 Working condition of tools and equipment checked and fault tagged.				
1.2 Perform site assessment	1.2.1 Solar installation area determined in consultation with client or as per drawing. 1.2.2 ***Site assessment*** conducted at peak sun hours for solar installation.				

	1.2.3 Solar installation area verified as per the drawing and layout for installation. 1.2.4 Feedback is provided to client based on-site assessment.				
1.3 Install PV module/array/string	1.3.1 ***Mounting structure*** installed firmly in line and level ensuring to withstand wind pressure and wind circulation. 1.3.2 ***Components*** of solar PV system verified and checked for physical damage. 1.3.3 Open circuit voltage and short circuit current measured in each module and verified with manufacturer's specification. 1.3.4 Solar PV module(s)/array/string installed firmly on mounting structure in required direction and inclination as per drawing. 1.3.5 PV module (s) connected in series or parallel as per system design to junction/combiner box along with wire conduit. 1.3.6 Conduit installed and cables laid from junction/combiner box to charge controller/inverter through protection devices.				
1.4 Install charge controller	1.4.1 Location for charge controller identified in consultation with client. 1.4.2 Charge controller fixed firmly on designated area.				

	1.4.3 Positive and negative terminals of solar PV module(s)/array/string connected to corresponding terminals of charge controller through protection devices. 1.4.4 Charge controller connected to DC loads**.**				
1.5 Install battery bank and solar inverter	1.5.1 Specific gravity and voltage of battery measured and verified as per manufacturer's specification. 1.5.2 Batteries placed in well-ventilated area with or without rack. 1.5.3 Batteries connected in series or parallel as per wiring diagram. 1.5.4 Positive and negative terminals of charge controller connected to corresponding terminals of batter bank/pack through protection devices. 1.5.5 Inverter firmly fixed on identified location. 1.5.6 Positive and negative terminals of battery bank connected to corresponding terminals of inverter through protection devices. 1.5.7 Inverter connected to AC loads.				
1.6 Perform electrical wiring	1.6.1 Conduit fixed along marked route. 1.6.2 AC/DC cables laid through conduit as per specification.				

	1.6.3 Junction box mounted at shortest distance between charge controller and DC load of building. 1.6.4 AC/DC wires connected to power sockets and loads as per single/three phase wiring diagram.				
1.7 Install earthing and protection devices	1.7.1 Earthing components checked and assembled as per manufacturer's instruction. 1.7.2 Earthing with lightning arrestor installed as per drawing. 1.7.3 Earthing system connected with solar PV system as per drawing. 1.7.4 ***Protection devices*** fixed in line and level in designated area. 1.7.5 Protection devices connected with solar PV system as per wiring diagram.				
1.8 Test solar PV system	1.8.1 Solar PV system and individual components functionality checked as per system design. 1.8.2 Issues faced during installation rectified. 1.8.3 Solar PV system activated as per commissioning procedures. 1.8.4 Client oriented on operation, maintenance and cleaning of solar PV system.				

1.9 Troubleshoot solar PV system	1.9.1 Fault history collected from clients and recorded as per industry norms. 1.9.2 Solar PV system inspected visually for ***physical damage and abnormal condition***. 1.9.3 Components of solar PV system cleaned and foreign materials removed. 1.9.4 ***Electrical parameters*** measured and verified against specification. 1.9.5 Monitoring tools/display analyzed for system performance. 1.9.6 Function/performance of major components and overall output checked as per block diagram or specification. 1.9.7 Fault and cause of fault identified based on visual inspection and test result and recorded as per industry norms. 1.9.8 Materials and cost required for repair is calculated as per industry norms. 1.9.9 ***Wiring fault*** and electrical problems fixed as per circuit diagram. 1.9.10 Defective components replaced with new components of correct specification.				

	1.9.11 Post repair testing carried out as per checklist and commissioned solar PV system.				
1.10 Clean workplace	1.10.1 Tools and equipment cleaned and stored in designated location. 1.10.2 Unused and leftover materials collected and stored in designated location. 1.10.3 Workplace cleaned and waste disposed as per ***3R's principle*** at designated location.				

WT- Written Test **OQ**- Oral Question **PT-** Practical Test **DO** – Direct Observation **SR**- Supervisor's report **SN**–Simulation

RP- Role Play **PG –**Photographs **VD**- Video **CT** – Certificates **TS** – Testimonials (Reward) **PP** – Product Produced

CS – Case Study

Range Statement

Variable	Range
Personal protective equipment	*May include but not limited to:* • Mask • Apron • Gloves • Safety shoes • Safety belt • Helmet
Site assessment	*May include but not limited to:* • Roof/ground orientation/direction/solar geometry • Shading • Available space for other components • Wiring requirement
Mounting structure	*May include but not limited to:* • Frame • Pole
Components	*May include but not limited to:* • PV modules/array/string • Solar inverter • Charge controller • Battery • Protection devices

	• DC-DC convertors • Combiner box
Protection devices	*May include but not limited to:* • Surge Protection Device (SPD) • Transient Voltage Suppressor (TVS) • Miniature Circuit Breaker (MCB) • Moulded Case Circuit Breaker (MCCB) • AC/DC fuse • High Rupturing Current (HRC) fuse
Issues	*May include but not limited to:* • Electrical connection problem • Malfunctioning of components • Mechanical fixtures
Physical damage and abnormal condition	*May include but are not limited to:* • Leak • Wear and tear • Crack • Loose support • Position, direction and inclination of panel • Array orientation and tilt • Disconnection • Broken or damaged wiring • Broken wires and dirty connection • Blown fuse or tripped

	• Loose connection • Potential Induced Degradation (PID) • Soiling • Hotspots • Micro cracks • Electrical system • Shading
Electrical parameters	*May include but not limited to:* • Voltage • Resistance • Continuity • Current • Capacitance • Voltage drop • Short circuit • Open circuit • System output (Power/energy)
Wiring fault	*May include but not limited to:* • Broken wires • Loose connection • Short circuit • Earth fault
3R's principle	*May include but not limited to:* • Reduce • Reuse • Recycle

5	**Unit No: 2** **Unit Title: Install and troubleshoot single/three phase on gird solar PV system upto 10 kWp**	**Unit code:**
	Elements of competency	**Performance standards**
	2.1 Prepare tool, equipment and materials	2.1.1 ***Personal Protective Equipment (PPE)*** used in accordance with task requirement. 2.1.2 Tools, equipment and materials collected as per task requirement. 2.1.3 Working condition of tools and equipment checked and fault tagged.
	2.2 Perform site assessment	2.2.1 Solar installation area determined in consultation with client or as per drawing. 2.2.2 ***Site assessment*** conducted at peak sun hours for solar installation. 2.2.3 Solar installation area verified as per the drawing and marked/layout for installation. 2.2.4 Feedback is provided to client based on-site assessment.
	2.3 Install PV module/array/string	2.3.1 ***Mounting structure*** installed firmly in line and level ensuring to withstand wind pressure and wind circulation. 2.3.2 ***Components*** of solar PV system verified and checked for physical damage. 2.3.3 Open circuit voltage and short circuit current measured of each module and verified with manufacturer's specification. 2.3.4 Solar PV module(s)/array/string installed firmly on mounting structure in required direction and inclination as per drawing. 2.3.5 PV module (s) connected in series or parallel as per system design to junction/combiner box through protection devices along with wire conduit.

		2.3.6 Conduit installed and cables laid from junction/combiner box to grid-tied inverter through protection devices.
	2.4 Install solar grid-tied inverter	2.4.1 Grid-tied inverter firmly fixed on identified location. 2.4.2 Positive and negative terminals from junction/combiner box connected to corresponding terminals of grid-tied inverter through protection devices. 2.4.3 Grid-tied inverter connected through smart meter to NEA national grid as per NEA regulation.
	2.5 Perform electrical wiring	2.5.1 Conduit fixed along marked route. 2.5.2 DC/AC cables laid through conduit as per specification. 2.5.3 Junction box mounted at shortest distance between solar PV modules and grid-tied inverter.
	2.6 Install earthing and protection devices	2.6.1 Earthing components checked and assembled as per manufacturer's instruction. 2.6.2 Earthing with lightning arrestor installed as per drawing. 2.6.3 Earthing system connected with solar PV system as per drawing. 2.6.4 ***Protection devices*** fixed in line and level in designated area. 2.6.5 Protection devices connected with solar PV system as per wiring diagram.
	2.7 Test solar PV system	2.7.1 Solar PV system and individual components functionality checked as per system design. 2.7.2 ***Issues*** faced during installation rectified. 2.7.3 Solar PV system activated as per commissioning procedures. 2.7.4 Client oriented on operation, maintenance and cleaning of solar PV system.

	2.8 Troubleshoot solar PV system	2.8.1 Fault history collected from clients and recorded as per industry norms. 2.8.2 Solar PV system inspected visually for ***physical damage and abnormal condition***. 2.8.3 Components of solar PV system cleaned and foreign materials removed. 2.8.4 ***Electrical parameters*** measured and verified against specification. 2.8.5 Monitoring tools/display analyzed for system performance. 2.8.6 Function/performance of major components and overall system output checked as per block diagram or specification. 2.8.7 Fault and cause of fault identified based on visual inspection and test result and recorded as per industry norms. 2.8.8 Materials and cost required for repair is calculated as per industry norms. 2.8.9 ***Wiring fault*** and electrical problems fixed as per circuit diagram. 2.8.10 Defective components replaced with new components of correct specification. 2.8.11 Post repair testing carried out as per checklist and commissioned solar PV system.
	2.9 Clean workplace	2.9.1 Tools and equipment cleaned and stored in designated location. 2.9.2 Unused and leftover materials collected and stored in designated location. 2.9.3 Workplace cleaned and waste disposed as per ***3R's principle*** at designated location.
6	**Task Performance Requirements (Tools, Equipment and Materials):** • Solar PV module(s), connecting cables (UV Protective), support structure, grid-tied inverter, Pyranometer, magnetic compass, MC connector, hammer, screw drivers, pliers, chisel, adjustable wrench, spanners, hacksaw, knife, wire cutter, crimping tools, wire strippers, angle meter/set square, measuring tape, level meter, drill machine, battery operated drill machine, hot air gun blower, IR thermometer, multimeter, clamp	

	on meter, megger, cables/wires, cable clips, galvanized/stainless steel nuts and bolts, cable lug, heat shrink tube, drift, funnel, elbow, T-jointer, power socket, switches, junction box, bus bar, inline cable connectors, marker, connectors, screws, clips, rack, cable tie, conduit, corrugated conduit, PVC tape, petroleum jelly/grease, lightning arrestor, Earth Electrodes, Earthing Strip, Earth pit, back fill compound, Earth hole drilling machine, protection devices, dust bin, dust pan, broom, first aid kit and Personal protective equipment (PPE).
7	**Safety and Hygiene (Occupational Health and Safety):** • Use personal protective equipment. • Safe handling of tools, equipment and materials. • Prevent from chemical and electrical hazards.

8	Required Knowledge		
	Technical Knowledge	**Applied Calculation**	**Graphical Information**

	• Tools, equipment and materials
	  ○ Types
	  ○ Uses
	  ○ Safe handling
	  ○ Storage
	• Introduction of solar energy and photovoltaic
	• Fundamentals of standalone, grid connected and hybrid systems
	• Solar PV system
	  ○ Introduction
	  ○ Components and their uses
	  ○ Configuration
	• Solar panels
	  ○ Introduction
	  ○ PV modules, array and string
	  ○ Types
	  ○ Mounting location and orientation (pitch, azimuth angle and optimum direction)
	  ○ Installation and connection
			• Read and interpret manufacturer's instruction/specification
			• Read and interpret block diagram of solar PV system
			• Read and interpret singe line diagram
			• Read and interpret wiring diagram

	• Grid-tied inverter
	  ○ Introduction
	  ○ Types
	  ○ Functions
	• Islanding/anti-islanding features
	• Importance of site assessment
	• Factors of site assessment (Roof orientation, direction, shading, wiring requirement and energy needs)
	• Roof preparation and mounting techniques
	• Fundamental concept of electricity
	• Electrical parameters (current, resistance, voltage, continuity, power, ampacity)
	• Electrical wiring, circuit and connection
	• Cables/wires
	• Earthing and lightning arrestor
	  ○ Introduction
	  ○ Types
	  ○ Components and their function
	  ○ Installation technique
	• Protection devices
	  ○ Introduction		

	○ Types ○ Function • NEA Smart meter • Testing and commissioning of solar PV system • Dismantling and assembling process • Types and importance of maintenance • Servicing technique ○ Visual inspection ○ Cleaning ○ Checking ○ Leak detection ○ Terminal greasing ○ Performance testing • Testing and fault diagnose • Repair and maintenance of electrical and mechanical components • Recent trends in photovoltaic and solar system • Cleaning and waste management • Record keeping and documentation • Importance of first aid and first aid kit • Occupational health and safety rules and regulations		

9	Assessment of Competency					
	Unit: 2 **Unit Title: Install and troubleshoot single/three phase on-grid solar PV system upto 10 kWp**					
	Candidate Details			**Assessors Detail**		
	Candidate's Name: Registration Number: Symbol No: Test Centre: Test Date:			Assessors' Name 1. 2. 3.		ID/License No:

Element of competency	Performance Standards	Standard Met	Standard Not Met	Evidence Type	Comments
2.1 Prepare tool, equipment and materials	2.1.1 ***Personal Protective Equipment (PPE)*** used in accordance with task requirement. 2.1.2 Tools, equipment and materials collected as per task requirement. 2.1.3 Working condition of tools and equipment checked and fault tagged.				
2.2 Perform site assessment	2.2.1 Solar installation area determined in consultation with client or as per drawing. 2.2.2 ***Site assessment*** conducted at peak sun hours for solar installation.				

	2.2.3 Solar installation area verified as per the drawing and marked/layout for installation. 2.2.4 Feedback is provided to client based on-site assessment.				
2.3 Install PV module/array/string	2.3.1 ***Mounting structure*** installed firmly in line and level ensuring to withstand wind pressure and wind circulation. 2.3.2 ***Components*** of solar PV system verified and checked for physical damage. 2.3.3 Open circuit voltage and short circuit current measured of each module and verified with manufacturer's specification. 2.3.4 Solar PV module(s)/array/string installed firmly on mounting structure in required direction and inclination as per drawing. 2.3.5 PV module (s) connected in series or parallel as per system design to junction/combiner box through protection devices along with wire conduit. 2.3.6 Conduit installed and cables laid from junction/combiner box to grid-tied inverter through protection devices.				
2.4 Install solar grid-tied inverter	2.4.1 Grid-tied inverter firmly fixed on identified location.				

	2.4.2 Positive and negative terminals from junction/combiner box connected to corresponding terminals of grid-tied inverter through protection devices. 2.4.3 Grid-tied inverter connected through smart meter to NEA national grid as per NEA regulation.				
2.5 Perform electrical wiring	2.5.1 Conduit fixed along marked route. 2.5.2 DC/AC cables laid through conduit as per specification. 2.5.3 Junction box mounted at shortest distance between solar PV modules and grid-tied inverter.				
2.6 Install earthing and protection devices	2.6.1 Earthing components checked and assembled as per manufacturer's instruction. 2.6.2 Earthing with lightning arrestor installed as per drawing. 2.6.3 Earthing system connected with solar PV system as per drawing. 2.6.4 ***Protection devices*** fixed in line and level in designated area. 2.6.5 Protection devices connected with solar PV system as per wiring diagram.				
2.7 Test solar PV system	2.7.1 Solar PV system and individual components functionality checked as per system design. 2.7.2 ***Issues*** faced during installation rectified.				

	2.7.3 Solar PV system activated as per commissioning procedures. 2.7.4 Client oriented on operation, maintenance and cleaning of solar PV system.				
2.8 Troubleshoot solar PV system	2.8.1 Fault history collected from clients and recorded as per industry norms. 2.8.2 Solar PV system inspected visually for physical damage and abnormal condition. 2.8.3 Components of solar PV system cleaned and foreign materials removed. 2.8.4 Electrical parameters measured and verified against specification. 2.8.5 Monitoring tools/display analyzed for system performance. 2.8.6 Function/performance of major components and overall system output checked as per block diagram or specification. 2.8.7 Fault and cause of fault identified based on visual inspection and test result and recorded as per industry norms.				

	2.8.8 Materials and cost required for repair is calculated as per industry norms. 2.8.9 Wiring fault and electrical problems fixed as per circuit diagram. 2.8.10 Defective components replaced with new components of correct specification. 2.8.11 Post repair testing carried out as per checklist and commissioned solar PV system.				
2.9 Clean workplace	2.9.1 Tools and equipment cleaned and stored in designated location. 2.9.2 Unused and leftover materials collected and stored in designated location. 2.9.3 Workplace cleaned and waste disposed as per ***3R's principle*** at designated location.				

WT- Written Test **OQ**- Oral Question **PT-** Practical Test **DO** – Direct Observation **SR**- Supervisor's report **SN**–Simulation
RP- Role Play **PG** –Photographs **VD**- Video **CT** – Certificates **TS** – Testimonials (Reward) **PP** – Product Produced
CS – Case Study

Range Statement

Variable	Range
Personal protective equipment	*May include but not limited to:* • Mask • Apron • Gloves • Safety shoes • Safety belt • Helmet
Site assessment	*May include but not limited to:* • Roof/ground orientation/direction/solar geometry • Shading • Available space for other components • Wiring requirement
Mounting structure	*May include but not limited to:* • Frame • Pole
Components	*May include but not limited to:* • PV modules/array/string • Grid-tied inverter • Protection devices

Protection devices	*May include but not limited to:* • Surge Protection Device (SPD) • Transient Voltage Suppressor (TVS) • Miniature Circuit Breaker (MCB) • Moulded Case Circuit Breaker (MCCB) • AC/DC fuse • High Rupturing Capacity (HRC) fuse
Issues	*May include but not limited to:* • Electrical connection problem • Malfunctioning of components • Mechanical fixtures • Islanding/Anti-islanding
Physical damage and abnormal condition	*May include but are not limited to:* • Leak • Wear and tear • Crack • Loose support • Position, direction and inclination of panel • Array orientation and tilt • Disconnection • Broken or damaged wiring • Broken wires and dirty connection • Blown fuse or tripped • Loose connection

	• Potential Induced Degradation (PID) • Soiling • Hotspots • Micro cracks • Electrical system • Shading
Electrical parameters	*May include but not limited to:* • Voltage • Resistance • Continuity • Current • Capacitance • Voltage drop • Short circuit • Open circuit • System output (Power/energy)
Wiring fault	*May include but not limited to:* • Broken wires • Loose connection • Short circuit • Earth fault
3R's principle	*May include but not limited to:* • Reduce • Reuse • Recycle

5	**Unit No: 3** **Unit Title: Install and troubleshoot solar water pump upto 10 kW**	**Unit code:**
	Elements of competency	**Performance standards**
	3.1 Prepare tool, equipment and materials	3.1.1 ***Personal Protective Equipment (PPE) used in accordance with task requirement.*** 3.1.2 Tools, equipment and materials collected as per task requirement. 3.1.3 Working condition of tools and equipment checked and fault tagged.
	3.2 Perform site assessment	3.2.1 Solar installation area determined in consultation with client or as per drawing. 3.2.2 ***Site assessment*** conducted at peak sun hours for solar installation. 3.2.3 Draw down level of ***PV pump*** verified. 3.2.4 Solar PV and pump components installation area verified as per the drawing and marked/layout for installation. 3.2.5 Feedback is provided to client based on-site assessment.
	3.3 Install PV module/array/string	3.3.1 ***Mounting structure*** installed firmly in line and level ensuring to withstand wind pressure and wind circulation. 3.3.2 ***Components*** of solar PV system verified and checked for physical damage. 3.3.3 Open circuit voltage and short circuit current measured of each module and verified with manufacturer's specification. 3.3.4 Solar PV module(s)/array/string installed firmly on mounting structure in required direction and inclination as per drawing. 3.3.5 PV module (s) connected in series or parallel as per system design to junction/combiner box along with wire conduit through protection devices.

		3.3.6 Conduit installed and cables laid from junction/combiner box to variable frequency drive (VFD)/controller unit through protection devices.
	3.4 Install VFD and controller unit	3.4.1 Location for VFD/controller unit identified in consultation with client. 3.4.2 VFD/controller unit fixed firmly on designated area. 3.4.3 Positive and negative terminals of solar PV module(s)/array/string connected to corresponding terminals of VFD/controller unit through protection devices.
	3.5 Install PV water pump	3.5.1 AC/DC PV pump and components verified as per specification. 3.5.2 PV pump installed as per drawing. 3.5.3 Terminals of pump connected to corresponding terminals of VFD/controller unit through protection devices as per drawing.
	3.6 Perform electrical wiring	3.6.1 Conduit fixed along marked route. 3.6.2 AC/DC cables laid through conduit as per specification. 3.6.3 Junction box mounted at shortest distance between VFD/controller unit to pump.
	3.7 Install earthing and protection devices	3.7.1 Earthing components checked and assembled as per manufacturer's instruction. 3.7.2 Earthing with lightning arrestor installed as per drawing. 3.7.3 Earthing system connected with solar PV water pump system as per drawing. 3.7.4 ***Protection devices*** fixed in line and level in designated area. 3.7.5 Protection devices connected with solar PV water pump system as per wiring diagram.
	3.8 Test solar PV water pump system	3.8.1 Solar PV water pump system and individual components functionality checked as per system design. 3.8.2 ***Issues*** faced during installation rectified.

		3.8.3 Solar PV water pump system activated as per commissioning procedures. 3.8.4 Client oriented on operation, maintenance and cleaning of solar PV water pump system.
	3.9 Troubleshoot solar PV water pump system	3.9.1 Fault history collected from clients and recorded as per industry norms. 3.9.2 Solar PV system inspected visually for ***physical damage and abnormal condition***. 3.9.3 Components of solar PV system cleaned and foreign materials removed. 3.9.4 ***Electrical parameters*** measured and verified against specification. 3.9.5 Monitoring tools/display analyzed for system performance. 3.9.6 Function/performance of major components and overall system output checked as per block diagram or specification. 3.9.7 Fault and cause of fault identified based on visual inspection and test result and recorded as per industry norms. 3.9.8 Materials and cost required for repair is calculated as per industry norms. 3.9.9 ***Wiring fault*** and electrical problems fixed as per circuit diagram. 3.9.10 Defective components replaced with new components of correct specification. 3.9.11 Post repair testing carried out as per checklist and commissioned solar PV system.
	3.10 Clean workplace	3.10.1 Tools and equipment cleaned and stored in designated location. 3.10.2 Unused and left over materials collected and stored in designated location. 3.10.3 Workplace cleaned and waste disposed as per ***3R's principle*** at designated location.

6	**Task Performance Requirements (Tools, Equipment and Materials):** • Solar PV module(s), connecting cables (UV Protective), support structure, VFD, controller unit, water pump, check valve, Pyranometer, magnetic compass, MC connector, waterproof inline cable connectors, hammer, screw drivers, pliers, chisel, adjustable wrench, spanners, hacksaw, knife, wire cutter, crimping tools, wire strippers, angle meter/set square, measuring tape, level meter, drill machine, battery operated drill machine, hot air gun blower, IR thermometer, multimeter, clamp on meter, megger, cables/wires, thermocouple, cable clips, galvanized/stainless steel nuts and bolts, cable lug, heat shrink tube, drift, funnel, plumb bob, elbow, T-jointer, power socket, switches, junction box, bus bar, marker, connectors, screws, clips, rack, cable tie, conduit, corrugated conduit, PVC tape, Teflon tape, petroleum jelly/grease, lightning arrestor, Earth Electrodes, Earthing Strip, Earth pit, back fill compound, tool for drilling hole in the ground, protection devices, dust bin, dust pan, broom, first aid kit and Personal protective equipment (PPE).
7	**Safety and Hygiene (Occupational Health and Safety):** • Use personal protective equipment. • Safe handling of tools, equipment and materials. • Prevent from chemical and electrical hazards.

8	Required Knowledge		
	Technical Knowledge	**Applied Calculation**	**Graphical Information**

	• Tools, equipment and materials
	  ○ Types
	  ○ Uses
	  ○ Safe handling
	  ○ Storage
	• Introduction of solar energy and photovoltaic
	• Solar PV system
	  ○ Introduction
	  ○ Components and their uses
	  ○ Configuration
	• Solar panels
	  ○ Introduction
	  ○ PV modules, array and string
	  ○ Types
	  ○ Mounting position, direction and angle
	  ○ Installation and connection
	• Variable frequency drive and controller unit
	  ○ Introduction
	  ○ Types
			• Read and interpret manufacturer's instruction/specification
			• Read and interpret block diagram of solar PV system
			• Read and interpret singe line diagram
			• Read and interpret wiring diagram

	○ Functions • Solar water pump ○ Introduction ○ Surface and submersible water pump ○ Functions ○ Water volume, head discharge and suction ○ Draw down level/static and dynamic level • Importance of site assessment • Factors of site assessment • Fundamental concept of electricity • Electrical parameters (current, resistance, voltage, continuity, power, ampacity) • Electrical wiring, circuit and connection • Cables/wires • Earthing and lightning arrestor ○ Introduction ○ Types ○ Components and their function ○ Installation technique • Protection devices ○ Introduction		

	○ Types ○ Function • Testing and commissioning of solar PV water pump system • Dismantling and assembling process • Types and importance of maintenance • Servicing technique ○ Visual inspection ○ Cleaning ○ Checking ○ Leak detection ○ Terminal greasing ○ Performance testing • Testing and fault diagnose • Repair and maintenance of electrical and mechanical components • Recent trends in photovoltaic and solar system • Cleaning and waste management • Record keeping and documentation • Importance of first aid • Occupational health and safety rules and regulations		

9	Assessment of Competency					
	Unit: 3 **Unit Title: Install and troubleshoot solar water pump upto 10 kW**					
	Candidate Details			**Assessors Detail**		
	Candidate's Name: Registration Number: Symbol No: Test Centre: Test Date:			Assessors' Name 1. 2. 3.		ID/License No:

Element of competency	Performance Standards	Standard Met	Standard Not Met	Evidence Type	Comments
3.1 Prepare tool, equipment and materials	3.1.1 ***Personal Protective Equipment (PPE) used in accordance with task requirement.*** 3.1.2 Tools, equipment and materials collected as per task requirement. 3.1.3 Working condition of tools and equipment checked and fault tagged.				
3.2 Perform site assessment	3.2.1 Solar installation area determined in consultation with client or as per drawing. 3.2.2 ***Site assessment*** conducted at peak sun hours for solar installation. 3.2.3 Draw down level of PV pump verified.				

	3.2.4 Solar PV and pump components installation area verified as per the drawing and marked/layout for installation. 3.2.5 Feedback is provided to client based on-site assessment.				
3.3 Install PV module/array/string	3.3.1 ***Mounting structure*** installed firmly in line and level ensuring to withstand wind pressure and wind circulation. 3.3.2 ***Components*** of solar PV system verified and checked for physical damage. 3.3.3 Open circuit voltage and short circuit current measured of each module and verified with manufacturer's specification. 3.3.4 Solar PV module(s)/array/string installed firmly on mounting structure in required direction and inclination as per drawing. 3.3.5 PV module (s) connected in series or parallel as per system design to junction/combiner box along with wire conduit through protection devices. 3.3.6 Conduit installed and cables laid from junction/combiner box to variable frequency drive (VFD)/controller unit through protection devices.				
3.4 Install VFD and controller unit	3.4.1 Location for VFD/controller unit identified in consultation with client.				

	3.4.2 VFD/controller unit fixed firmly on designated area. 3.4.3 Positive and negative terminals of solar PV module(s)/array/string connected to corresponding terminals of VFD/controller unit through protection devices.				
3.5 Install PV water pump	3.5.1 AC/DC ***PV pump*** and components verified as per specification. 3.5.2 PV pump installed as per drawing. 3.5.3 Terminals of pump connected to corresponding terminals of VFD/controller unit through protection devices as per drawing.				
3.6 Perform electrical wiring	3.6.1 Conduit fixed along marked route. 3.6.2 AC/DC cables laid through conduit as per specification. 3.6.3 Junction box mounted at shortest distance between VFD/controller unit to pump.				
3.7 Install earthing and protection devices	3.7.1 Earthing components checked and assembled as per manufacturer's instruction. 3.7.2 Earthing with lightning arrestor installed as per drawing. 3.7.3 Earthing system connected with solar PV water pump system as per drawing.				

	3.7.4 ***Protection devices*** fixed in line and level in designated area. 3.7.5 Protection devices connected with solar PV water pump system as per wiring diagram.				
3.8 Test solar PV water pump system	3.8.1 Solar PV water pump system and individual components functionality checked as per system design. 3.8.2 ***Issues*** faced during installation rectified. 3.8.3 Solar PV water pump system activated as per commissioning procedures. 3.8.1 Client oriented on operation, maintenance and cleaning of solar PV water pump system.				
3.9 Troubleshoot solar PV water pump system	3.9.1 Fault history collected from clients and recorded as per industry norms. 3.9.2 Solar PV system inspected visually for ***physical damage and abnormal condition***. 3.9.3 Components of solar PV system cleaned and foreign materials removed. 3.9.4 ***Electrical parameters*** measured and verified against specification. 3.9.5 Monitoring tools/display analyzed for system performance.				

	3.9.6 Function/performance of major components and overall system output checked as per block diagram or specification. 3.9.7 Fault and cause of fault identified based on visual inspection and test result and recorded as per industry norms. 3.9.8 Materials and cost required for repair is calculated as per industry norms. 3.9.9 ***Wiring fault*** and electrical problems fixed as per circuit diagram. 3.9.10 Defective components replaced with new components of correct specification. 3.9.11 Post repair testing carried out as per checklist and commissioned solar PV system.				
3.10 Clean workplace	3.10.1 Tools and equipment cleaned and stored in designated location. 3.10.2 Unused and left over materials collected and stored in designated location. 3.10.3 Workplace cleaned and waste disposed as per ***3R's principle*** at designated location.				

WT- Written Test **OQ**- Oral Question **PT-** Practical Test **DO** – Direct Observation **SR**- Supervisor's report **SN**–Simulation

RP- Role Play **PG –**Photographs **VD**- Video **CT** – Certificates **TS** – Testimonials (Reward) **PP** – Product Produced

CS – Case Study

Range Statement

Variable	Range
Personal protective equipment	*May include but not limited to:* • Mask • Apron • Gloves • Safety shoes • Safety belt • Helmet
Site assessment	*May include but not limited to:* • Roof/ground orientation/direction/solar geometry • Shading • Available space for other components • Wiring requirement
PV pump	*May include but not limited to:* • Surface • Submersible
Mounting structure	*May include but not limited to:* • Frame • Pole
Components	*May include but not limited to:* • PV modules/array/string

	• Solar inverter • VFD • Controller unit • Protection devices
Protection devices	*May include but not limited to:* • Surge Protection Device (SPD) • Transient Voltage Suppressor (TVS) • Miniature Circuit Breaker (MCB) • Moulded Case Circuit Breaker (MCCB) • AC/DC fuse
Issues	*May include but not limited to:* • Electrical connection problem • Malfunctioning of components • Mechanical fixtures • Water discharge
Physical damage and abnormal condition	*May include but are not limited to:* • Leak • Wear and tear • Crack • Loose support • Position, direction and inclination of panel • Array orientation and tilt • Disconnection • Broken or damaged wiring

	• Open circuit • Blown fuse or tripped • Loose connection • Potential Induced Degradation (PID) • Soiling • Hotspots • Micro cracks • Electrical system • Shading
Electrical parameters	*May include but not limited to:* • Voltage • Resistance • Continuity • Current • Capacitance • Voltage drop • Short circuit • Open circuit • System output (Power/energy)
Wiring fault	*May include but not limited to:* • Broken wires • Loose connection • Short circuit • Earth fault

3R's principle	*May include but not limited to:* • Reduce • Reuse • Recycle

5	**Unit No: 4** **Unit Title: Install and troubleshoot standalone/centralized solar street light**	**Unit code:**
	Elements of competency	**Performance standards**
	4.1 Prepare tool, equipment and materials	4.1.1 ***Personal Protective Equipment (PPE)*** used in accordance with task requirement. 4.1.2 Tools, equipment and materials collected as per task requirement. 4.1.3 Working condition of tools and equipment checked and fault tagged.
	4.2 Perform site assessment	4.2.1 Solar installation area determined in consultation with client or as per drawing. 4.2.2 ***Site assessment*** conducted at peak sun hours for solar installation. 4.2.3 Solar installation area verified as per the drawing and layout for installation. 4.2.4 Feedback is provided client based on-site assessment.
	4.3 Install PV module/array/string for centralized system	4.3.1 ***Mounting structure*** installed firmly in line and level ensuring to withstand wind pressure and wind circulation. 4.3.2 ***Components*** of solar PV system verified and checked for physical damage. 4.3.3 Open circuit voltage and short circuit current measured of each module and verified with manufacturer's specification. 4.3.4 Solar PV module(s)/array/string installed firmly on mounting structure in required direction and inclination as per drawing. 4.3.5 PV module (s) connected in series or parallel as per system design to junction/combiner box along with wire conduit through protection devices. 4.3.6 Solar street light installed in designated location as per drawing. 4.3.7 AC cables laid through poles along the route and connected as per wiring diagram.

	4.4 Install standalone solar street light	4.4.1 Mounting structure and light installed firmly on pole in line and level ensuring to withstand wind pressure. 4.4.2 Components of solar PV system verified and checked for physical damage. 4.4.3 Open circuit voltage and short circuit current measured of each module and verified with manufacturer's specification. 4.4.4 Solar PV module(s) installed firmly on mounting frame in required direction and inclination as per drawing. 4.4.5 PV module (s) connected as per system design along with wire conduit.
	4.5 Install charge controller unit and battery unit	4.5.1 Charge controller unit and battery unit fixed firmly on designated area. 4.5.2 Voltage of battery measured and verified as per manufacturer's specification. 4.5.3 Positive and negative terminals of charge controller connected to corresponding terminals of battery unit. 4.5.4 Positive and negative terminals of solar PV module(s) connected to charge controller. 4.5.5 Positive and negative terminals of charge controller connected to corresponding terminals of street light.
	4.6 Test solar street light	4.6.1 Functionality of street light, battery and charge controller checked as per system design. 4.6.2 ***Issues*** faced during installation rectified. 4.6.3 Street light activated and illumination tested as per manufacturer's specification.
	4.7 Troubleshoot solar street light	4.7.1 Fault history collected from clients and recorded as per industry norms. 4.7.2 Solar PV system inspected visually for ***physical damage and abnormal condition***.

		4.7.3 Components of solar PV system cleaned and foreign materials removed. 4.7.4 ***Electrical parameters*** measured and verified against specification. 4.7.5 Monitoring tools/display analyzed for system performance. 4.7.6 Function/performance of major components checked as per block diagram or specification. 4.7.7 Fault and cause of fault identified based on visual inspection and test result and recorded as per industry norms. 4.7.8 Materials and cost required for repair is calculated as per industry norms. 4.7.9 ***Wiring fault*** and electrical problems fixed as per circuit diagram. 4.7.10 Defective components replaced with new components of correct specification. 4.7.11 Post repair testing carried out as per checklist and commissioned solar PV system.
	4.8 Clean workplace	4.8.1 Tools and equipment cleaned and stored in designated location. 4.8.2 Unused and left over materials collected and stored in designated location. 4.8.3 Workplace cleaned and waste disposed as per ***3R's principle*** at designated location.
6	**Task Performance Requirements (Tools, Equipment and Materials):** • Solar PV module(s), connecting cables (UV Protective), support structure, charge controller unit, battery, street light, pole, Pyranometer, magnetic compass, inline connectors, MC connector, hammer, wrenches sets, screw drivers, pliers, chisel, adjustable wrench, spanners, hacksaw, knife, cutting pliers, crimping tools, wire strippers, angle meter/set square, measuring tape, level meter, drill machine, battery operated drill machine, hot air gun blower, IR thermometer, multimeter, clamp on meter, megger, cables/wires, lux meter, cable clips, galvanized/stainless steel nuts and bolts, cable lug, heat shrink tube, switches, junction box, adjustable staircase, marker, connectors, screws,	

	cable tie, corrugated conduit, PVC tape, petroleum jelly/grease, protection devices, dust bin, dust pan, broom, first aid kit and Personal protective equipment (PPE).
7	**Safety and Hygiene (Occupational Health and Safety):** • Use personal protective equipment. • Safe handling of tools, equipment and materials. • Prevent from chemical and electrical hazards.

8	Required Knowledge		
	Technical Knowledge	**Applied Calculation**	**Graphical Information**

	• Tools, equipment and materials
	  ○ Types
	  ○ Uses
	  ○ Safe handling
	  ○ Storage
	• Solar panels
	  ○ Introduction
	  ○ PV modules
	  ○ Types
	  ○ Mounting position, direction and angle
	  ○ Standalone Installation and connection procedure
	  ○ Centralized Installation and connection procedure
	• Charge controller unit
	  ○ Introduction
	  ○ Types
	  ○ Functions
	• Batteries
	  ○ Introduction
	  ○ Types
			• Read and interpret manufacturer's instruction/specification
			• Read and interpret block diagram of solar street light

	○ Functions ○ Electrolyte level and specific gravity ○ State of charge (SoC) and Depth of discharge (DoD) • Street light ○ Introduction ○ Types ○ Functions ○ Standard Illumination required for high ways/subways/lane ○ Cleaning and maintenance • Importance of site assessment • Factors of site assessment • Fundamental concept of electricity • Electrical parameters • Electrical wiring, circuit and connection • Cables/wires • Testing and commissioning of street light • Dismantling and assembling process • Types and importance of maintenance • Servicing technique ○ Visual inspection		

	○ Cleaning ○ Checking ○ Leak detection ○ Terminal greasing ○ Performance testing • Testing and fault diagnose • Repair and maintenance of electrical and mechanical components • Fundamental concept of electricity • Electrical parameters • Electrical wiring, circuit and connection • Cleaning and waste management • Record keeping and documentation • Importance of first aid • Occupational health and safety rules and regulations		

9	**Assessment of Competency**					
	Unit: 4 **Unit Title: Install and troubleshoot standalone/centralized solar street light**					
	Candidate Details		**Assessors Detail**			
	Candidate's Name: Registration Number: Symbol No: Test Centre: Test Date:		Assessors' Name 1. 2. 3.		ID/License No:	

Element of competency	**Performance Standards**	**Standard Met**	**Standard Not Met**	**Evidence Type**	**Comments**
4.1 Prepare tool, equipment and materials	4.1.1 ***Personal Protective Equipment (PPE)*** used in accordance with task requirement. 4.1.2 Tools, equipment and materials collected as per task requirement. 4.1.3 Working condition of tools and equipment checked and fault tagged.				
4.2 Perform site assessment	4.2.1 Solar installation area determined in consultation with client or as per drawing. 4.2.2 ***Site assessment*** conducted at peak sun hours for solar installation.				

	4.2.3 Solar installation area verified as per the drawing and layout for installation. 4.2.4 Feedback is provided client based on-site assessment.				
4.3 Install PV module/array/string for centralized system	4.3.1 ***Mounting structure*** installed firmly in line and level ensuring to withstand wind pressure and wind circulation. 4.3.2 ***Components*** of solar PV system verified and checked for physical damage. 4.3.3 Open circuit voltage and short circuit current measured of each module and verified with manufacturer's specification. 4.3.4 Solar PV module(s)/array/string installed firmly on mounting structure in required direction and inclination as per drawing. 4.3.5 PV module (s) connected in series or parallel as per system design to junction/combiner box along with wire conduit through protection devices. 4.3.6 Solar street light installed in designated location as per drawing. 4.3.7 AC cables laid through poles along the route and connected as per wiring diagram.				

4.4 Install standalone solar street light	4.4.1 Mounting structure and light installed firmly on pole in line and level ensuring to withstand wind pressure. 4.4.2 Components of solar PV system verified and checked for physical damage. 4.4.3 Open circuit voltage and short circuit current measured of each module and verified with manufacturer's specification. 4.4.4 Solar PV module(s) installed firmly on mounting frame in required direction and inclination as per drawing. 4.4.5 PV module (s) connected as per system design along with wire conduit.				
4.5 Install charge controller unit and battery unit	4.5.1 Charge controller unit and battery unit fixed firmly on designated area. 4.5.2 Voltage of battery measured and verified as per manufacturer's specification. 4.5.3 Positive and negative terminals of charge controller connected to corresponding terminals of battery unit. 4.5.4 Positive and negative terminals of solar PV module(s) connected to charge controller. 4.5.5 Positive and negative terminals of charge controller connected to corresponding terminals of street light.				

4.6 Test solar street light	4.6.1 Functionality of street light, battery and charge controller checked as per system design. 4.6.2 ***Issues*** faced during installation rectified. 4.6.3 Street light activated and illumination tested as per manufacturer's specification.				
4.7 Troubleshoot solar street light	4.7.1 Fault history collected from clients and recorded as per industry norms. 4.7.2 Solar PV system inspected visually for ***physical damage and abnormal condition***. 4.7.3 Components of solar PV system cleaned and foreign materials removed. 4.7.4 ***Electrical parameters*** measured and verified against specification. 4.7.5 Monitoring tools/display analyzed for system performance. 4.7.6 Function/performance of major components checked as per block diagram or specification. 4.7.7 Fault and cause of fault identified based on visual inspection and test result and recorded as per industry norms.				

	4.7.8 Materials and cost required for repair is calculated as per industry norms. 4.7.9 ***Wiring fault*** and electrical problems fixed as per circuit diagram. 4.7.10 Defective components replaced with new components of correct specification. 4.7.11 Post repair testing carried out as per checklist and commissioned solar PV system.				
4.8 Clean workplace	4.8.1 Tools and equipment cleaned and stored in designated location. 4.8.2 Unused and left over materials collected and stored in designated location. 4.8.3 Workplace cleaned and waste disposed as per ***3R's principle*** at designated location.				

WT- Written Test **OQ**- Oral Question **PT-** Practical Test **DO** – Direct Observation **SR**- Supervisor's report **SN**–Simulation
RP- Role Play **PG** –Photographs **VD**- Video **CT** – Certificates **TS** – Testimonials (Reward) **PP** – Product Produced
CS – Case Study

Range Statement

Variable	Range
Personal protective equipment	*May include but not limited to:* • Mask • Apron • Gloves • Safety shoes • Safety belt • Helmet
Site assessment	*May include but not limited to:* • Roof/ground orientation/direction/solar geometry • Shading • Available space for other components • Wiring requirement
Mounting structure	*May include but not limited to:* • Frame • Pole
Components	*May include but not limited to:* • PV modules/array/string • Solar inverter • Charge controller • Battery

	• Protection devices • DC-DC convertors • Street light
Issues	*May include but not limited to:* • Electrical connection problem • Malfunctioning of components • Mechanical fixtures
Physical damage and abnormal condition	*May include but are not limited to:* • Leak • Wear and tear • Crack • Loose support • Position, direction and inclination of panel • Array orientation and tilt • Disconnection • Broken or damaged wiring • Open circuit • Blown fuse or tripped • Loose connection • Potential Induced Degradation (PID) • Soiling • Hotspots • Micro cracks • Electrical system • Shading

Electrical parameters	*May include but not limited to:* • Voltage • Resistance • Continuity • Current • Capacitance • Voltage drop • Short circuit • Open circuit • System output (Power/energy)
Wiring fault	*May include but not limited to:* • Broken wires • Loose connection • Short circuit • Earth fault
3R's principle	*May include but not limited to:* • Reduce • Reuse • Recycle