COMPETENCY STANDARD

SOLAR (PV) SYSTEM INSTALLATION AND MAINTENANCE LEVEL-I

CONSTRUCTION SECTOR

ISEC Improving Skills and Economic Opportunities in Cox's Bazar

In collaboration with

In partnership with Canada

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Foreword

UN High Commissioner for Refugees (UNHCR), in collaboration with International Organization for Migration (IOM), BRAC, Center for Natural Resource Studies (CNRS), and NGO Forum for Public Health, is implementing a skills development project as part of a joint Initiative by International Labour Organization (ILO), UNHCR and BRAC with financial support from Global Affairs Canada (GAC) in the refugee camps of Cox's Bazar and on Bhasan Char.

The project has a target to reach a total of 8,000 refugee youth (18-24) participants for accredited vocational skills training which will be selected across the camps considering the demand of the refugee youths and labour market needs of Rakhine state of Myanmar so that the acquired skills can be utilised after their repatriation. To assess the skills needs of the refugee youths, UNHCR, in collaboration with UCEP Bangladesh, a national pioneer organisation in the vocational skills sector in Bangladesh, commissioned a Skills Needs Assessment in all refugee camps in Cox's Bazar and on Bhasan Char. In alignment with the Skills Needs Assessment findings and commitment, the project developed Competency Standards by adopting Myanmar National Qualification Framework (MNQF) or ASEAN Qualification Reference Framework (AQRF).

Following the requirement of the Myanmar National Qualification Framework (MNQF) or ASEAN Qualification Framework (AQRF), analysing the context of the camps, compatible aptitude and utilisation opportunities for the refugee youth and their educational qualifications, the pool of TVET experts of UCEP Bangladesh has developed course outline of the following ten occupations. Consequently, those ten course outlines have been translated into Competency Standards.

1. Sewing Machine Operation
2. Community Health Worker
3. Concreter
4. Small Engine Mechanic
5. Caregiving
6. Solar (PV) System Installation and Maintenance
7. Electrician (Building)
8. Plumbing
9. Agricultural Crops Production
10. Bakery and Pastry Staff

The following Competency Standard for ***Solar (PV) System Installation and Maintenance Level-I*** is adapted from the "Training Regulations - PV Systems Installation NC II – Construction Sector" developed by the Technical Education and Skills Development Authority of the Philippines, and “Competency Standards for Electrical Installation and Maintenance NTVQF Level – II & III” developed by Bangladesh Technical Education Board. Competency standards are benchmarks defining the skills, knowledge and attributes people need to perform a work role.

Qualification Framework Description (Certification System)

To attain the Solar (PV) System Installation and Maintenance Level-I, the candidate must demonstrate competence through assessment covering all the units listed in Section 1. Successful candidates shall be awarded a Certificate of Participation issued jointly by UNHCR and ILO. The qualification of Solar (PV) System Installation and Maintenance Level-I may be attained through the accumulation of Certificates of Competency (COCs) in the following areas:

1. Apply basic electrical concept and circuits
2. Check Solar System (PV) Components/ Materials Compliance
3. Install Solar System (PV)
4. Perform Solar System (PV) Testing and Commissioning
5. Make trouble shooting Solar (PV) System

Successful candidates shall be awarded a Certificate of Participation. Accumulating and submitting all COCs acquired for the relevant units of competency comprising a qualification, an individual shall be issued a Certificate of Participation jointly by UNHCR and ILO to demonstrate the accumulated competencies. The Certificate of Participation may help the person attain the Recognition of Prior Learning (RPL) test in the country of origin or any other third country. Assessment shall focus on the core units of competency. The basic and common units shall be integrated or assessed concurrently with the core units.

General Guidelines for the Assessment

In general, for the competency standard

Method of Assessment:	1. Interviews/questioning 2. Observation 3. Demonstration 4. Oral/written examination
Context of Assessment:	1. Training is delivered from camp-based non-registered training centre 2. Training materials and the curriculum modules are adopted from MNQF or AQRF 3. Training programs are endorsed by the *Government of Bangladesh – United Nations Framework on Skills Development for Rohingya Refugee/FDMNs and Host Communities*
Information about development and characteristics of the Standard	Course Title: Solar (PV) System Installation and Maintenance Level-I Level: I Nominal Training Duration: 360 Hours This course is designed to enhance the knowledge, desirable skills and attitudes of Solar (PV) System Installation and Maintenance Level-I in accordance with industry standards. It covers Basic, Common and Core Competencies.

Course Structure

Solar (PV) System Installation and Maintenance Level-I

Code	Unit of Competencies	Total Guided Hours		
		Th.	**Pr.**	**Total**
Basic Competencies (2 UoCs Required)				
ISEC-CON-SM-01-B	Receive and respond to workplace communication	06	14	20
ISEC-CON-SM-02-B	Follow basic housekeeping procedures	08	22	30
Total in Basic Competencies		**14**	**36**	**50**
Industry Competencies (3 UoCs Required)				
ISEC-CON-SM-01-I	Follow the safety and health procedure	06	24	30
ISEC-CON-SM-02-I	Work in the Construction Sector	06	24	30
ISEC-CON-SM-03-I	Use Hand and Power Tools for Electrical Works	03	12	15
Total in Industry Competencies		**15**	**60**	**75**
Technical Competencies (5 UoCs Required)				
ISEC-CON-SM-01-T	Apply basic electrical concept and circuits	10	50	60
ISEC-CON-SM-02-T	Check Solar (PV) System Components/ Materials Compliance	05	25	30
ISEC-CON-SM-03-T	Install Solar (PV) System	10	50	60
ISEC-CON-SM-04-T	Perform Solar (PV) System Testing and Commissioning	05	25	30
ISEC-CON-SM-05-T	Make trouble shooting Solar (PV) System	10	45	55
Total in Technical Competencies		**40**	**195**	**235**
Total Nominal Hours		**69**	**291**	**360**

BASIC COMPETENCIES

UNIT OF COMPETENCY : **Receive and respond to workplace communication**

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes required to receive, respond and act on verbal and written communication.

NOMINAL DURATION : **20 Hours**

ELEMENT	**PERFORMANCE CRITERIA** ***Italicized terms*** are elaborated in the Range of Variables
1. Follow routine spoken messages	1.1 Required information is gathered by listening attentively and correctly interpreting or understanding information/instructions 1.2 Instructions/information are properly recorded 1.3 Instructions are acted upon immediately in accordance with information received 1.4 Clarification is sought from workplace supervisor on all occasions when any instruction/information is not clear
2. Perform workplace duties following written notices	2.1 ***Written notices and instructions*** are read and interpreted correctly in accordance with ***organizational guidelines*** 2.2 Routine written instruction are followed in sequence 2.3 Feedback is given to workplace supervisor based on the instructions/information received

RANGE OF VARIABLES

Variable	**Range** (*May include but not limited to*)
1. Written notices and instructions	1.1. Handwritten and printed material 1.2. Internal memos 1.3. External communications 1.4. Briefing notes 1.5. General correspondence 1.6. Marketing materials 1.7. Journal articles
2. Organizational Guidelines	2.1 Information documentation procedures 2.2 Company policies and procedures 2.3 Organization manuals 2.4 Service manual

Underpinning Knowledge (To be used as training content in the information sheet of CBLM)	**Underpinning Skills** (to be used as job in the job sheet of CBLM)
• Knowledge of organizational policies/guidelines in regard to processing internal/external information • Ethical work practices in handling communications • Communication process	1. Conciseness in receiving and clarifying messages/information/communication 2. Accuracy in recording messages/information
Required major tools and equipment for the UoC: 1. Pens 2. Note pads	

UNIT OF COMPETENCY : Follow basic housekeeping procedures
UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes required to apply the basic housekeeping procedures.
NOMINAL DURATION : 30 Hours

ELEMENT	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Sort and remove unnecessary items	1.1 Reusable, recyclable materials are sorted in accordance with company/office procedures 1.2 ***Unnecessary items*** are removed and disposed of in accordance with company or office procedures
2. Arrange items	2.1 Items are arranged in accordance with company/office housekeeping procedures 2.2 Work area is arranged according to job requirements 2.3 Activities are prioritized based on instructions 2.4 Items are provided with clear and visible ***identification marks*** based on procedure 2.5 Safety equipment and evacuation passages are kept clear and accessible based on instructions
3. Maintain work area, tools and equipment	3.1 Cleanliness and orderliness of work area is maintained in accordance with company/office procedures 3.2 Tools and equipment are cleaned in accordance with manufacturer's instructions/manual 3.3 ***Minor repairs*** are performed on tools and equipment in accordance with manufacturer's instruction/manual 3.4 Defective tools and equipment are reported to immediate supervisor
4. Follow standardized work process and procedures	4.1 Materials for common use are maintained in designated area based on procedures 4.2 Work is performed according to standard work procedures 4.3 Abnormal incidents are reported to immediate supervisor
5. Follow occupational health, safety and environmental requirements	5.1 Work is performed as per instruction 5.2 Company and office ***decorum*** are followed and complied with 5.3 Work is performed in accordance with occupational health and safety (OHS) requirements

RANGE OF VARIABLES

Variable	**Range** (*May include but not limited to*)
1. Unnecessary items	1.1. Non-recyclable materials 1.2. Unserviceable tools and equipment 1.3. Pictures, posters and other materials not related to work activity 1.4. Waste materials
2. Identification marks	2.1 Labels 2.2 Tags 2.3 Colour coding
3. Decorum	3.1 Company/ office rules and regulations 3.2 Company/ office uniform 3.3 Behaviour
4. Minor repair	4.1 Replacement of parts 4.2 Application of lubricants 4.3 Sharpening of tools 4.4 Tightening of nuts, bolts and screws

Underpinning Knowledge (To be used as training content in the information sheet of CBLM)	**Underpinning Skills** (to be used as job in the job sheet of CBLM)
• Principles of 5S • Work process and procedures • Safety signs and symbols • General OHS principles and legislation • Environmental requirements relative to work safety • Accident/Hazard reporting procedures	1. Basic communication skills 2. Interpersonal skills 3. Reading skills required to interpret instructions 4. Reporting/recording accidents and potential hazards
Required major tools and equipment for the UoC: 1. Pens 2. Note pads 3. Marker 4. Colour pens	

INDUSTRY COMPETENCIES

UNIT OF COMPETENCY	**:**	**Follow the safety and health procedure**
UNIT DESCRIPTOR	**:**	This unit covers the knowledge, skills and attitudes required to perform safety measures effectively and efficiently. It includes identifying areas, tools, materials, time and place in performing safety measures.
NOMINAL DURATION	**:**	**30 Hours**

ELEMENT	**PERFORMANCE CRITERIA** ***Italicized terms*** are elaborated in the Range of Variables
1. Follow safe work practices	1.1 ***Safety regulations*** and ***workplace*** safety and hazard control practices and procedures based on organization procedures are followed. 1.2 ***Hazards/ risk*** in the workplace and their corresponding indicators are identified to minimize or eliminate risk to co-workers, workplace and environment in accordance with organization procedures 1.3 ***Contingency measures*** during the events of workplace accidents, fire and other emergencies are complied with in accordance with organization procedures
2. Identify hazards and risks	2.1 Maximum tolerable limits of contaminants based on threshold limit values (TLV) which when exceeded will result in harm or damage to health are identified 2.2 Effects of the hazards are determined. 2.3 OHS issues or concerns and identified workplace hazards are reported to designated personnel in accordance with workplace requirements and relevant OHS legislation
3. Follow emergency procedures	3.1 Follow consistently Occupational Health and Safety (OHS) procedures for controlling hazards/risks in workplace are consistently followed. 3.2 Procedures for dealing with workplace accidents, fire and emergencies are followed in accordance with organization OHS policies 3.3 Personal Protective Equipment (PPE) are correctly used in accordance with organization's OHS procedures and.

RANGE OF VARIABLES

Variable	**Range** (*May include but not limited to*)
1. Safety regulations	1.1. Waste Disposable 1.2. Electrical and Fire Safety precaution 1.3. Signs
2. Hazards	2.1. Chemical 2.2. Electrical 2.3. Falls
3. Risks	3.1. Precaution hazards (use sharp tools) 3.2. Lifeline 3.3. Barricade 3.4. PPE (Masks, Gloves, Boots, Apron, Hat, Eye goggles) 3.5. Signs 3.6. Mask
4. Contingency measures	4.1. Location of first aid kit 4.2. Evacuation 4.3. Agencies contract 4.4. Farm emergency procedures

Underpinning Knowledge (To be used as training content in the information sheet of CBLM)	**Underpinning Skills** (to be used as job in the job sheet of CBLM)
Safety Practices • Implementation of regulatory controls and policies relative to treatment of area and application of chemicals • Proper disposal of waste materials **Codes and Regulations** • Hazard identification • Emergency procedures **Tools & Equipment: Uses and Specification** • Masks, gloves, boots, overall coats for health protection **Maintenance** • Regular check-up and repair of tools, materials and outfit before and after use	1. Ability to recognize effective tools, materials, and outfit 2. Ready skills required to read labels, manuals, and other basic safety information
Required major tools and equipment for the UoC: 1. Tools, equipment, and outfits appropriate in applying safety measures	

UNIT OF COMPETENCY : Work in the Construction Sector

UNIT DESCRIPTOR : This unit covers the skills, knowledge, and attitude in working in the construction sector. It includes the following steps: describe the organizational structure within the construction sector, identify processes and procedures, identify tools, equipment, and materials, identify workplace practices, organize own workload, and practice OHS.

NOMINAL DURATION : 30 Hours

ELEMENT	**PERFORMANCE CRITERIA** ***Italicized terms*** are elaborated in the Range of Variables
1. Describe the organizational structure within the sector	1.1 Scope, nature and ***major fields*** of the construction sector are determined 1.2 The profile of the construction sector in relation to Bangladesh ***employment conditions*** is determined 1.3 Trends and technologies relevant to the sector are explained. 1.4 Relevant policies and guidelines are identified and interpreted. 1.5 ***Instructions*** as to procedures in achieving quality are obtained, understood and clarified.
2. Identify processes and procedures	2.1 Construction processes are identified, described and explained. 2.2 Work activities are correctly identified. 2.3 Adjustments are interpreted.
3. Identify tools, equipment and materials	3.1 Appropriate ***manuals*** are accessed to ensure up-to-date specifications of tools, materials, and equipment. 3.2 Construction ***tools, materials and equipment*** are identified. 3.3 Substitutes are identified in case of non-availability.
4. Identify workplace requirements	4.1 ***Workplace requirements*** are identified and clarified. 4.2 Roles and responsibilities of all personnel are described. 4.3 Workplace's practices are identified. 4.4 ***Problem-solving strategies*** are used to address bottlenecks, inconsistencies, and other concerns.
5. Organize own workload	5.1 Own work activities are planned, and progress of work is communicated to relevant staff. 5.2 Work activities are completed. 5.3 Difficulties and bottlenecks are identified, and solutions are put forwarded. 5.4 Own work is monitored against workplace standards and areas for improvement identified and acted upon.

ELEMENT	**PERFORMANCE CRITERIA** ***Italicized terms*** are elaborated in the Range of Variables
6. Follow occupational health, safety (OHS) and environmental requirements	6.1 Relevant ***OHS*** practices are identified. 6.2 Relevant ***OHS*** practices are interpreted and implemented.

RANGE OF VARIABLES

Variable	**Range** (*May include but not limited to*)
1. Major Fields	1.1. Construction Site Support (Dogging, Rigging, etc.) 1.2. Carpentry and Form Works 1.3. Masonry, Brick/Block Laying and Concreting 1.4. Surface Finishing, Tiling and Painting 1.5. Roofing 1.6. Plumbing 1.7. Residential Electrical Wiring and Cabling 1.8. Solar (PV) system installation and maintenance
2. Employment conditions	2.1. Code of Practice 2.2. Wage System 2.3. Labour Practices 2.4. Gender Issues 2.5. Procedures for Handling Disputes 2.6. Innovations in the Sector
3. Instructions	3.1. Specifications and requirements 3.2. Standard operating procedures 3.3. Manuals of Instruction 3.4. Operations Manual
4. Manuals	4.1. Manual of Instructions 4.2. Manual of Specifications 4.3. Repair Manual 4.4. Quality Manual 4.5. Maintenance Procedure and Troubleshooting
5. Workplace requirements	5.1. Goals and objectives 5.2. Strategic and Operational Plans 5.3. Systems and Processes 5.4. Monitoring and Evaluation 5.5. Reports and Documentation
6. Tools, equipment, and materials	6.1. Refers to all tools, equipment, and materials appropriate for any of the construction fields
7. Problem-solving strategies	7.1. Asking questions 7.2. Feedback and Feed forward system 7.3. Reference to Standard Operating Procedures 7.4. Accessing Information 7.5. Reviews 7.6. Brainstorming
8. OHS	8.1. Reporting hazards, risks, and emergencies 8.2. Arrangement of workplaces 8.3. Standard Operating Procedure 8.4. Workplace environment and safety 8.5. Safe storage of tools and equipment 8.6. Use of PPE

Underpinning Knowledge (To be used as training content in the information sheet of CBLM)	**Underpinning Skills** (to be used as job in the job sheet of CBLM)
• Scope and Major Divisions of the Construction Sector • Relevant Policies and Guidelines in the Construction Sector	1. Describing the organization structure 2. Identifying construction processes and procedures 3. Identifying tools, equipment, and materials

• Manuals used in the Construction Sector • Relevant Terminologies and Acronyms • Types and Uses of Construction Tools and Materials • Workplace Practices • Occupational Health and Safety Practices • Recording and Reporting practices	4. Identifying workplace practices 5. Organizing own workload 6. Practicing OHS
Required major tools and equipment for the UoC: 1. Pens 2. Writing materials 3. Computer 4. Multi-media projector	

UNIT OF COMPETENCY : Use Hand and Power Tools for Electrical Works

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes required to use hand and power tools for electrical works. It specifically includes – inspect hand tools and power tools for usability; use hand tools; operate power tools; and maintain hand tools and power tools after use.

NOMINAL DURATION : 15 Hours

ELEMENT	**PERFORMANCE CRITERIA** ***Italicized terms*** are elaborated in the Range of Variables
1. Inspect hand tools and power tools for usability	1.1 Hand tools are identified 1.2 Application of tools to job requirement is interpreted 1.3 Usability of tools are checked and verified 1.4 ***Hand tools*** and ***power tools*** are prepared 1.5 Sources of power supply for power tools are identified
2. Use hand tools	2.1 Appropriate hand tool for the job is used 2.2 Proper and safe use and operation of hand tools are applied 2.3 ***Safety precautions*** is observed when using hand tools 2.4 Unsafe or faulty tools are identified and marked for repair
3. Operate power tools	3.1 Power supply outlet and electrical cord are inspected and confirmed safe for use in accordance with established workplace safety requirements 3.2 Proper sequence of operation is applied in using power tools 3.3 Power tools are used safely in accordance to manufacturer's operating specification
4. Clean and maintain hand tools and power tools after use	4.1 Dust and foreign matters are removed from power tools in accordance to workplace standard 4.2 Condition of tools is checked after use 4.3 Appropriate lubricant is applied after use and prior to storage 4.4 ***Measuring tools*** are checked and calibrated 4.5 Defective tools, instruments, power tools and accessories are inspected and corrected or replaced

RANGE OF VARIABLES

Variable	**Range** (*May include but not limited to*)
1. Hand tools	1.1. Ball peen hammer 1.2. Cross peen hammer 1.3. Straight peen hammer 1.4. Mallet / soft hammer 1.5. Bench vise 1.6. Soft jaw 1.7. Rough file 1.8. Medium file 1.9. Smooth file 1.10. Punches 1.11. Chisels 1.12. Wrenches 1.13. Pliers 1.14. Scriber 1.15. Scraper 1.16. Screw drivers 1.17. Dividers 1.18. Trammels 1.19. Surface plate 1.20. Marking table 1.21. Height gauge 1.22. Layout tools 1.23. Tap sets 1.24. Die sets 1.25. Tap handle 1.26. Die handle 1.27. Hacksaw 1.28. Paint brushes 1.29. Drill bits 1.30. Tap extruder 1.31. Screw Extruder 1.32. Hacksaw frame 1.33. Hacksaw blade 1.34. Rivet Gun 1.35. Sledgehammers 1.36. Sockets 1.37. Spanners 1.38. Vice grip 1.39. Wire Cutters 1.40. Wood Planners 1.41. Hand drill machine 1.42. Hand grinding machine 1.43. Pedestal drill 1.44. Powered screwdriver 1.45. Hand shear 1.46. Clamps 1.47. Jacks 1.48. Soldering iron 1.49. Allen wrenches 1.50. Draft punches
2. Power Tools	2.1. Power drills 2.2. Power rivet gun

	2.3. Hand grinders 2.4. Pneumatic wrenches 2.5. Press machine 2.6. Jack hammer 2.7. Planers 2.8. Pedestal drills
3. Safety precautions	3.1. Use of appropriate PPEs 3.2. Proper hand, feet and eye coordination 3.3. Safe condition of electrical outlets, cords and lamps 3.4. Working environment 3.5. Safe operating condition of hand tools and power tools 3.6. Awareness to OHS requirements
4. Measuring Tools	4.1. Measuring tape 4.2. Steel rule 4.3. Meter rule 4.4. Outside & inside caliper 4.5. Protractors' 4.6. Tri-square 4.7. Sprit level 4.8. Vernier clliper 4.9. Micrometre 4.10. Simple protractor 4.11. Vernier protractor 4.12. Limit gauges 4.13. Snap gauges

Underpinning Knowledge (To be used as training content in the information sheet of CBLM)	**Underpinning Skills** (to be used as job in the job sheet of CBLM)
• Types of hand tools and their proper uses • Types of power tools, their uses and safe handling method • Procedures in the use of hand tools and power tools • Policies and procedures for occupational health and safety • Use of PPE • Reporting and documentation • Preventive maintenance methods and techniques • Storage procedures	1. Using hand tools 2. Maintaining tools 3. Maintaining safety precaution for using hand & power tools 4. Maintaining operation procedure of power tools 5. Applying proper sequence of operation
Required major tools and equipment for the UoC: 1. Workplace (simulated or actual) 2. Different types of hand tools and power tools 3. Workbooks 4. Hand tools and power tools operating and maintenance manuals	

TECHNICAL COMPETENCIES

UNIT OF COMPETENCY : **Apply basic electrical concept and circuits**

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitude required to electrical concepts and circuits. It includes current types, tools and equipment, source of electricity, conductors, and circuits.

NOMINAL DURATION : **60 Hours**

ELEMENT	**PERFORMANCE CRITERIA** ***Italicized terms*** are elaborated in the Range of Variables
1. Select and prepare necessary materials	1.1 ***PPE*** is selected and used 1.2 PPE is used as per workplace requirements
2. Apply electrical concept and working principle	2.1 ***Source of electricity*** is explained 2.2 Use of ***electricity*** is demonstrated 2.3 Differences between AC and DC are explained 2.4 Use of electrical measuring units is explained 2.5 Measurement of voltage, current, and resistance are demonstrated with ***measuring tools and instrument*** 2.6 Power and energy of a particular load is explained 2.7 Power and energy of a particular load is calculated
3. Explain the principle of electricity generation	3.1 Electricity is generated by generator and battery 3.2 Differences between AC and DC are explained 3.3 Flow of electrical current is explained 3.4 Renewable and non-renewable energy sources are identified 3.5 Working principle of conversion of solar energy to electrical energy is demonstrated
4. Use electrical conductor, semiconductor, and non-conductor	4.1 Different types of electrical ***conductors*** are identified and used 4.2 Different types of semiconductors are identified 4.3 Different types of non-conductors are identified
5. Perform wiring and circuits	5.1 ***Electrical circuit*** is explained 5.2 Series, parallel, and mixed circuits are demonstrated 5.3 Connection of a series circuit is performed by two lamps controlled by a switch 5.4 Connection of a parallel circuit is performed by two lamps controlled by a switch 5.5 Connection of a series-parallel circuit is performed by three lamps controlled by a switch

RANGE OF VARIABLES

Variable	**Range** (*May include but not limited to*)
1. Personal protective equipment (PPE)	1.1. Goggles 1.2. Rubber gloves 1.3. Safety shoes 1.4. Leather/ rubber apron 1.5. Hard hat
2. Source of electricity	2.1. National grid 2.2. Generator 2.3. Battery
3. Electricity	3.1. AC 3.2. DC
4. Tools and equipment	4.1. Tools 4.1.1. Screwdrivers 4.1.2. Pliers 4.1.3. Wrenches 4.1.4. Hammer 4.1.5. Electrician's knife 4.1.6. Hacksaw 4.1.7. Cross cut saw 4.1.8. Hand drill 4.2. Measuring instruments 4.2.1. Clamp meter 4.2.2. Ammeter 4.2.3. Voltmeter 4.2.4. Multi-meter 4.2.5. Hydrometer
5. Conductors	4.1. Conductor 4.2. Sem-conductor 4.3. Non-conductor
6. Electrical circuit	5.1. Series circuit 5.2. Parallel circuit 5.3. Mixed circuit

Underpinning Knowledge (To be used as training content in the information sheet of CBLM)	**Underpinning Skills** (to be used as job in the job sheet of CBLM)
• Basic principles of electricity • Electrical measuring instruments • Basic mathematics	1. Use of hand tools and equipment 2. Splicing, Dressing and Terminating wires 3. Soldering Techniques 4. Tracing circuits
Required major tools and equipment for the UoC: 1. Tools and equipment appropriate for installation of PV components 2. Personal Protective Equipment (PPE)	

UNIT OF COMPETENCY : **Check Solar (PV) System Components/ Materials Compliance**

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes in checking PV components/materials compliance prior to installation.

NOMINAL DURATION : **30 Hours**

ELEMENT	PERFORMANCE CRITERIA ***Italicized terms*** are elaborated in the Range of Variables
1. Identify components/materials and specifications for inspection/testing	1.1 ***Components/Materials*** are listed as per job requirements 1.2 Component/Material ***specifications*** are listed for inspection/testing 1.3 Components/materials are identified in line with job order requirements 1.4 Components/materials are inspected for damage in line with enterprise requirements 1.5 Damaged component/materials and accessories are recorded/noted and reported to supervisor
2. Interpret manuals	2.1 Relevant sections and chapters of specifications/manuals are located in relation to the work to be conducted 2.2 Information and procedure in the manual are interpreted in accordance with the job requirement 2.3 Testing procedures are prepared according to the manufacturers' specifications 2.4 Manuals of components/materials and accessories are interpreted in line manufacturer/supplier/specification
3. Identify and prepare test instruments	3.1 ***Test instruments*** are listed as per job order requirement 3.2 Test instrument specifications are complied with in accordance with the test procedure requirement
4. Inspect/test components and materials	4.1 ***Testing procedures*** are identified in accordance with the manufacturer's specifications 4.2 Tests results are recorded in material testing forms 4.3 Inspection/Testing is accomplished without causing damage to components and materials and injury to self and others 4.4 Task is performed using ***personal protective equipment (PPE)***
5. Report test results	5.1 Test results are evaluated against the manufacturer's specifications 5.2 Report is made on the compliance or non-compliance of the material according to manufacturer's specifications

6. Notify completion of work	6.1 Final checks are made to ensure that work conforms with instructions and job requirements 6.2 Supervisor is notified upon completion of work 6.3 Tools, equipment and any surplus resources and materials are, where appropriate, cleaned, checked, and returned to storage in accordance with established procedures 6.4 Work area is cleaned up and made safe according to occupational health and safety (OHS) regulation

RANGE OF VARIABLES

Variable	**Range** (*May include but not limited to*)
1. Components materials	1.1. PV Module/array 1.2. Support structures 1.3. Charge Controller/regulator 1.4. Battery/battery bank 1.5. Inverter/converter 1.6. Lighting fixtures and accessories 1.7. Convenience outlets for appliances and devices 1.8. Wires and cables 1.9. Fastening fixtures
2. Specifications	2.1. Voltage 2.2. Current 2.3. Voltage settings 2.4. Specific gravity 2.5. Illumination of lights 2.6. International Electro-technical Commission (IEC) and other certifying bodies 2.7. Dimension (length, diameter/size, thickness) 2.8. IP/NEMA outdoor ratings (tropicalized, sunlight-resistant)
3. Test instruments	3.1. Voltmeter 3.2. Ammeter 3.3. Variable Power Supply 3.4. Lux meter 3.5. Multi-meter 3.6. Hydrometer 3.7. Clamp meter
4. Test procedures	4.1. Measurement of terminal voltage 4.2. Measurement of current flow 4.3. Measurement of voltage settings of charge controller/regulator 4.4. Measurement of specific gravity of battery electrolyte solution 4.5. Measurement of illumination output of lights
5. Personal protective equipment (PPE)	5.1. Goggles 5.2. Rubber gloves 5.3. Safety shoes 5.4. Leather/ rubber apron 5.5. Hard hat

Underpinning Knowledge (To be used as training content in the information sheet of CBLM)	**Underpinning Skills** (to be used as job in the job sheet of CBLM)
• Electrical measuring instruments • Basic mathematics • IEC and other certifying body standards • IP/NEMA standards • Product Standards (PS) • Selection and usage of tools • Personal Protective Equipment (PPE) • Types and uses of PV components/materials	1. Visual assessment of components/materials 2. Preparing materials/tools/tests 3. Using test instruments, tools, and equipment 4. 5S Skills 5. Reading and interpreting manufacturer's specifications and manuals

• Different forms • Requisition procedure • Types of PV specifications and tools • Common materials • Common damage to PV components/materials/ accessories • Safety Conscious • Observant/Attentive to details • Safety conscious	6. Mathematical skills 7. Proper handling of PV components/materials 8. Following instructions
Required major tools and equipment for the UoC: 1. Workplace location 2. Tools and equipment appropriate for the activity 3. Manufacturer's manual 4. Personal Protective Equipment (PPE) 5. Inspection/testing instruments 6. PV Components/materials appropriate for electrical installation lay-out	

UNIT OF COMPETENCY : **Install Solar (PV) System**
UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitude in installing standalone PV system 1 KW or less.
NOMINAL DURATION : **60 Hours**

ELEMENT	**PERFORMANCE CRITERIA** ***Italicized terms*** are elaborated in the Range of Variables
1. Plan and prepare work	1.1 Electrical drawings are read and interpreted to determine job order requirements 1.2 Type and quantity of ***system components*** and other materials are identified in line with job order requirements 1.3 ***Tools and equipment*** are selected in line with job order requirements 1.4 ***Personal protective equipment (PPE)*** are identified and selected in line with safety requirements 1.5 Instructions in preparation for work activity are communicated clearly and confirmed to ensure that the instructions are understood 1.6 Procedure for planning and preparation of work is checked to ensure that it is done correctly and in accordance to established company standards procedure to ensure safety 1.7 All components/materials needed to the work are obtained and estimated according to established procedures and plans
2. Install PV components	2.1 Pre-installation procedures are performed as per manufacturer's recommendation 2.2 Procedures for installation of PV components are performed in line with job order requirements 2.3 Schedule of work is followed based on agreed time and quality standards 2.4 Consultations/ instructions are sought with supervisor/end user if unplanned events or conditions occur 2.5 Ongoing checking of quality of work is undertaken in accordance with instructions and requirements 2.6 Conductors/wires are terminated/splice in accordance with existing PV component standards 2.7 Installation of PV system is accomplished without causing damage to components, materials, supplies and minimum wastage, and injury to self/others 2.8 Safety procedures are followed based on ***regulations***

3. Notify completion of work	3.1 Final checks are made to ensure that work conforms with plans/ drawings/instructions and requirements 3.2 Supervisor is notified upon completion of work 3.3 Tools, equipment, and any excess materials, where appropriate, are cleaned, checked and returned to storage in accordance with established safety procedures 3.4 Work area is cleaned and made safe
4. Obtain and convey information	4.1 Specific and relevant information about the system installed is accessed from ***appropriate sources*** 4.2 Effective questioning and speaking skills are used to gather and convey information 4.3 Appropriate ***medium*** is used to transfer information 4.4 Conduct of conveying information is carried out clearly and concisely 4.5 Conveying information is conducted in a courteous manner appropriate to the cultural background of the costumer/s
5. Complete relevant work-related documents	5.1 ***Forms*** relating to the conduct of job are completed accurately 5.2 Reporting requirements are completed according to the guidelines

RANGE OF VARIABLES

Variable	**Range** (*May include but not limited to*)
1. System components	1.1. Solar Module(s) 1.2. Support structures 1.3. Charge Controller/regulator 1.4. Battery/battery bank 1.5. Inverter 1.6. Wires and accessories 1.7. Protective devices such as: 1.7.1. Disconnect switch 1.7.2. Fuse 1.7.3. Breakers 1.7.4. Diodes 1.7.5. Low-voltage disconnect 1.8. DC – DC converters 1.9. Grounding system 1.10. Lighting fixtures and accessories 1.11. Convenience outlets for appliances and devices 1.12. Loads (AC and DC lights, water pumps, and/or appliances)
2. Tools and equipment	2.1. Tools: 2.1.1. Screwdrivers 2.1.2. Pliers 2.1.3. Wrenches 2.1.4. Hammer 2.1.5. Electrician's knife 2.1.6. Hacksaw 2.1.7. Cross cut saw 2.1.8. Hand drill 2.2. Measuring instruments 2.2.1. Clamp meter 2.2.2. Ammeter 2.2.3. Voltmeter 2.2.4. Multi-meter 2.2.5. Hydrometer 2.3. Ladder/scaffolding
3. Personal protective equipment (PPE)	3.1. Rubber gloves 3.2. Safety shoes 3.3. Hard hat 3.4. Goggles 3.5. Electrician's holster 3.6. Safety belts 3.7. Safety clothes/pants
4. Regulations	4.1. International Electro-technical Commission (IEC) Regulation 4.2. Electrical safety 4.3. Mechanical safety 4.4. Civil safety
5. Appropriate sources	5.1. Components Specification and Manual 5.2. Suppliers 5.3. Dealers 5.4. Trade personnel 5.5. Industry bodies

	5.6. Distributors
6. Medium	6.1. Information discussion 6.2. One on one communication 6.3. Group interaction 6.4. Vernacular speaking
7. Forms	7.1. Customer manual 7.2. Warranty documents 7.3. Product procedures 7.4. Product specifications 7.5. Product features 7.6. Product instruction

Underpinning Knowledge (To be used as training content in the information sheet of CBLM)	**Underpinning Skills** (to be used as job in the job sheet of CBLM)
• PV system operation • PEC requirements • Installation procedures for PV components • Safety practices • Electrical Installation Drawing and Specification • Tools/Materials uses and specification	1. Reading and interpretation of codes, symbols and diagrams 2. Interpreting plan and details 3. Preparing materials 4. Interpreting product and technical brochures 5. Use of hand tools and equipment 6. Splicing, Dressing and Terminating wires 7. Soldering Techniques 8. Tracing circuits 9. Interpreting product and technical brochures
Required major tools and equipment for the UoC: 1. Workplace location 2. Drawings and specifications relevant to the task 3. Complete system components and accessories 4. Tools and equipment appropriate for installation of PV components 5. Personal Protective Equipment (PPE) 6. IEC materials	

UNIT OF COMPETENCY : **Perform Solar (PV) System Testing and Commissioning**

UNIT DESCRIPTOR : This unit covers the knowledge, skills, and attitude in testing and commissioning installed PV systems.

NOMINAL DURATION : **30 Hours**

ELEMENT	**PERFORMANCE CRITERIA** ***Italicized terms*** are elaborated in the Range of Variables
1. Prepare to commission PV system	1.1 Work instructions are validated to ensure clear understanding of job requirements 1.2 ***Commissioning procedures*** are planned according to manufacturer's instructions and job order requirements 1.3 ***Personal protective equipment (PPE)*** needed to complete job order requirements are obtained according to established procedures 1.4 ***Tools, measuring instruments and materials*** needed for commissioning are obtained according to established procedures
2. Commission PV system	2.1 Each component and the whole system are checked if operational and are installed according to established procedures and job order requirements 2.2 Corrective measures or rectifications on the installation are made in line with established procedures 2.3 PV systems is activated according to commissioning procedures 2.4 Occupational health and safety procedures are followed during commissioning
3. Inspect and notify completion of work	3.1 Final inspection is undertaken to ensure that commissioning of PV system meets job requirements 3.2 ***Commissioning document*** is accomplished, and written report is prepared using the prescribed format and submitted to the supervisor 3.3 Work completed is notified to a supervisor and customer according to established procedure 3.4 Proper housekeeping is observed and practiced in accordance with occupational health and safety standards 3.5 Customer is oriented on the use of the installed system according to company procedures and manufacturer's instruction

RANGE OF VARIABLES

Variable	**Range** (*May include but not limited to*)
1. Commissioning procedures	1.1. PV module/array functional test 1.2. Charge controller/Regulator functional test 1.3. Battery functional test 1.4. Load Test 1.5. High potential test
2. Personal protective equipment (PPE)	2.1. Mask 2.2. Safety goggles or face shield 2.3. Gloves (rubber/leather) 2.4. Safety harness 2.5. First aid kit 2.6. Hard hat 2.7. Safety shoes 2.8. Rubber apron 2.9. Safety belts 2.10. Electrician holster kit 2.11. Safety clothes/pants 2.12. Insulating mat
3. Tools, measuring instruments, and materials	3.1. Tools 3.1.1. Screwdrivers 3.1.2. Pliers 3.1.3. Wrenches 3.1.4. Ladder/scaffolding 3.1.5. Magnetic compass 3.1.6. Spirit level 3.2. Measuring instrument 3.2.1. Clamp meter 3.2.2. Multi-meter 3.2.3. Hydrometer 3.3. Materials 3.3.1. Wires and cables 3.3.2. Connectors 3.3.3. Clamps 3.3.4. Electrical tape 3.3.5. Oil and grease 3.3.6. Fuse 3.3.7. Diodes 3.3.8. Staple wires, screws and nails 3.3.9. Asphalt/sealant (if needed) 3.3.10. Distilled water 3.3.11. Bolts and nuts
4. Commissioning documents (CD)	4.1. CD for Solar Home System 4.2. CD for Battery Charging Station 4.3. CD for School Electrification

Underpinning Knowledge (To be used as training content in the information sheet of CBLM)	**Underpinning Skills** (to be used as job in the job sheet of CBLM)
• PV system and individual components functionality and standard operating ranges	1. Interpreting electrical drawings 2. Tracing schematic diagrams and circuits

• Common system/equipment malfunctions and basic corrective or techniques • Commissioning procedures for PV systems and parts of a commissioning document • Basic principles of electricity	3. Handling of tools, test instruments, and materials

Required major tools and equipment for the UoC:

1. Actual site or simulated workplace with PV system to be commissioned
2. Tools, measuring instruments, and materials appropriate for PV system commissioning
3. Electrical installation drawings and installation data sheet
4. Forms
    a. Commissioning document
    b. Acceptance document
5. Personal protective equipment (PPE)

UNIT OF COMPETENCY : Make trouble shooting Solar (PV) System

UNIT DESCRIPTOR : This unit covers the knowledge, skills, and attitude in testing and commissioning installed PV systems.

NOMINAL DURATION : 55 Hours

ELEMENT	**PERFORMANCE CRITERIA** ***Italicized terms*** are elaborated in the Range of Variables
1. Diagnose faults in Solar (PV) System units and wiring	1.1 ***Personal protective equipment (PPE)*** needed to complete job order requirements are obtained according to established procedures 1.2 ***Physical faults*** in the inverter, charger, charge controller, panel, battery, and wiring system are checked visually 1.3 ***Operational faults*** in the inverter and charge controller are checked by ***testing instrument*** 1.4 Panel is tested for appropriate functioning 1.5 Battery is checked by meter for appropriate voltage 1.6 Electrolyte of battery is checked by hydrometer 1.7 ***Electrical connections*** are checked throughout the wiring 1.8 Charge controller and inverter are tested
2. Repair the faults in Solar (PV) System unit and wiring	2.1 Burn components are replaced 2.2 Inactive and faulty components are replaced 2.3 Battery water is added if required 2.4 Loose Connections are repaired throughout the wiring
3. Clean and store the tools and materials	3.1 Tools and equipment are cleaned 3.2 Tools, measuring instruments, and access materials are stored as per work place standards

RANGE OF VARIABLES

Variable	**Range** (*May include but not limited to*)
1. Physical faults	1.1. Burn components by high temperature 1.2. Damaged by insect 1.3. Disconnection due to vibration 1.4. Loose connection
2. Operational faults	2.1. Components are inactive by aging 2.2. Components are inactive by transient effects 2.3. Components are inactive due to manufacturing defects 2.4. Components are inactive due to overload
3. Testing instruments	3.1. Voltmeter 3.2. Ammeter 3.3. Multi-meter 3.4. Hydrometer
4. Electrical connections	4.1. Terminal connections of switches, sockets, and light fixtures 4.2. Terminal connection of panel 4.3. Terminal connection of charge controller 4.4. Terminal connection of inverter 4.5. Terminal connection of battery

Underpinning Knowledge (To be used as training content in the information sheet of CBLM)	**Underpinning Skills** (to be used as job in the job sheet of CBLM)
• Personal Protective Equipment (PPE) • Technique of testing solar home system operation • Diagnose faults in solar home system unit and wiring	1. Performing solar home system testing for operation 2. Testing charge controller and inverter 3. Replacing burn component 4. Repairing loose connection through wiring
Required major tools and equipment for the UoC: 1. Actual site or simulated workplace with PV system to be commissioned 2. Tools, measuring instruments, and materials appropriate for PV system commissioning 3. Electrical installation drawings and installation data sheet	