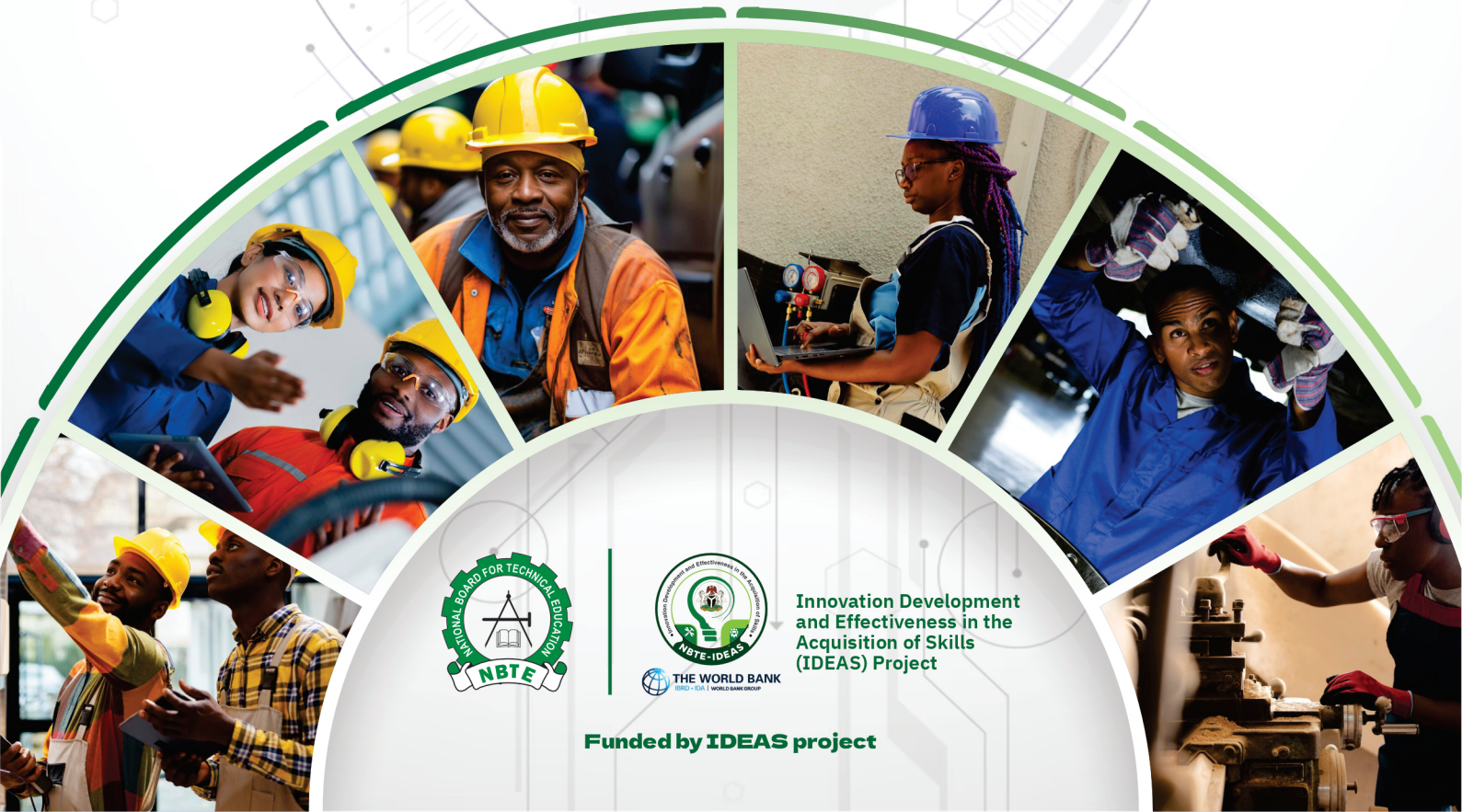
FEDERAL MINISTRY OF EDUCATION

National Skills Qualifications FOR SOLAR PHOTOVOLTAIC SYSTEM INSTALLATION AND MAINTENANCE

LEVEL 1, 2 & 3

February, 2025



NATIONAL BOARD FOR TECHNICAL EDUCATION
NBTE

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National Board for Technical Education
Plot B, Bida Road, P.M.B. 2239, Kaduna, Nigeria

NATIONAL SKILLS QUALIFICATION (NSQ)

LEVEL 1, 2 & 3

SOLAR PHOTOVOLTAIC SYSTEM INSTALLATION AND MAINTENANCE

2025

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NATIONAL SKILLS QUALIFICATION (NSQ)

LEVEL 1

SOLAR PHOTOVOLTAIC SYSTEM INSTALLATION AND MAINTENANCE

2025

GENERAL INFORMATION

OVERVIEW

This qualification is designed for individuals who are interested in pursuing a career in the Solar Photovoltaic (PV) Systems for the award of National Skills Qualifications (NSQ).

Aims: It is aimed at producing Semi Skill Worker or Assistant in Solar PV System Installation and Maintenance, (NSQ) Level 1 with the competence necessary to support in renewable energy industries.
This qualification is subject to review as and when necessary.

QUALIFICATION PURPOSE

Purpose: This qualification is targeted at developing competence and assistance in Solar PV System Installation and Maintenance.

QUALIFICATION REQUIREMENTS

All candidates must:

a. Be medically fit
b. Be physically fit
c. Be mentally fit (Mental alertness)
d. Have achieved all the mandatory units in the qualification
e. Be vetted
f. Basic acknowledge of how to read and write

QUALIFICATION OBJECTIVES

Objectives: To achieve this qualification, the learner should at the end, have the following competencies:

1. Apply occupational health, safety, and environmental guidelines in the Solar Photovoltaic Systems Installation and Maintenance.
2. Communicate appropriate in working environment with team members in Solar Photovoltaic Systems Installation and Maintenance.
3. Work in a Solar Photovoltaic Systems Installation and Maintenance environment as team member.
4. Explain Solar PV System.
5. Operate tools and equipment used in Solar Photovoltaic Systems installation and Maintenance.
6. Identify materials used in Solar Photovoltaic Systems Installation and Maintenance.
7. Identify components used in Solar Photovoltaic Systems Installation and Maintenance.

NATIONAL SKILLS QUALIFICATION (NSQ) TABLE

LEVEL 1
SOLAR PHOTOVOLTAIC SYSTEMS INSTALLATION AND MAINTENANCE

MANDATORY UNITS

Unit	Unit Reference Number	Unit Title	Credit Value	Guided Learning Hours
1	PWR/SPV/001/L1	Occupational Health, Safety and Environmental Guidelines in the Solar PV System Installation and Maintenance	3	30
2	PWR/SPV/002/L1	Teamwork in Solar Photovoltaic SystemsInstallation and Maintenance	1	10
3	PWR/SPV/003/L1	Communication in Solar PV SystemsInstallation and Maintenance	2	20
4	PWR/SPV/004/L1	Introduction to Solar Photovoltaic Systems	2	20
5	PWR/SPV/005/L1	Tools and Equipment used in Solar Systems Installation and Maintenance	3	30
6	PWR/SPV/006/L1	Materials Used in Solar Photovoltaic Systems Installation and Maintenance	4	40
7	PWR/SPV/007/L1	Basic Components used in Solar Photovoltaic Systems Installation and Maintenance	4	40
TOTAL			**19**	190

GENERAL GUIDE

Unit Title	Provides a clear explanation of the content of the unit.
Unit Number	The unique number assigned to the unit.
Unit Reference	The unique reference number given to each unit at qualification approval by NBTE
Unit Level	Denotes the level of the unit within the National Skills Qualification Framework NSQF.
Unit Credit Value	The value that has been given to the unit based on the expected learning time for an average learner. 1 credit = 10 learning hours
Unit Aim	Provides a brief outline of the unit content.
Learning Outcome	A statement of what a learner will know, understand or be able to do, as a result of a process of learning.
Assessment Criteria	A description of the requirements a learner must achieve to demonstrate that the learning outcome has been met.
Unit Assessment Guidance	Any additional guidance provided to support the assessment of the unit.
Unit Guided Learning Hours	The average number of hours of supervised or directed study time or assessment required in achieving the qualification or unit of the qualification.

Unit 001:	**Occupational Health, Safety and Environmental Guidelines in the Solar Photovoltaic Systems Installation and Maintenance**
Unit Reference Number:	PWR/SPV/001/L1C
NSQ Level:	1
Credit Value:	3
Guided Learning Hours:	30

Unit Purpose: This unit standard specifies the competencies required to use Personal Protective Equipment (PPE) to prevent Health, Safety and Environmental hazards in Solar Photovoltaic Systems Installation and Maintenance.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Questions and Answers (Q&A).
3. Witness Statement (WS).
4. Personal Statements (PS)

UNIT 001: Occupational Health, Safety and Environmental Guidelines in the Installation of Solar Photovoltaic Systems Installation and Maintenance

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Know the health, safety and environmental hazards in Solar Photovoltaic Systems Installation and Maintenance***	1.1	Explain Safety in a workplace									
	1.2	Explain Hazard in a workplace									
	1.3	Explain the importance of working in a healthy, safe and secure environment									
	1.4	List common health, safety and environmental hazards in Solar Photovoltaic Systems Installation and Maintenance									
	1.5	Explain how to report accident or near accident quickly and accurately to appropriate personnel									
	1.6	Select appropriate safety gadgets									
	1.7	Apply safety and environmental standards in accordance with the laid down procedures									
LO 2: ***Understand Personal Protective Equipment (PPE) used in Solar PV and Power backup***	2.1	Explain the meaning of PPE									
	2.2	Identify the types of PPE									
	2.3	Explain the importance of PPE in Solar Photovoltaic Systems Installation and Maintenance									
	2.4	Outline the importance of complying with the PPE regulations									
	2.5	Explain own responsibility under the (Occupational Health and Safety Act. of 2012) as it relates to Solar Photovoltaic Systems Installation and Maintenance									
	2.6	Select appropriate PPEs in accordance with the work guidelines									
	2.7	Demonstrate the use of PPEs									
	2.8	Demonstrate maintenance and storage of PPE in accordance with the specifications									
LO 3: ***Know the safety precautions to be considered in Solar Photovoltaic Systems installation and maintenance.***	3.1	Explain basic safety measures to consider while carrying out work in high voltage/high current Solar Photovoltaic Systems Installation and Maintenance									
	3.2	State the safety measures to consider while working at height (carrying panels on rooftops) in									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
		Solar Photovoltaic Systems Installation and Maintenance.									
	3.3	Explain the importance of earthing in Solar PV Installations									
	3.4	Explain the possible effect of lightening on solar PV installations									
	3.5	Use safety measures to consider when moving heavy batteries in Solar PV Installations									
	3.6	Use laid down procedures to safeguard self, others and the environment.									
LO 4: Know First Aid responsibilities in Solar Photovoltaic Systems Installation and Maintenance	4.1	State the meaning of first aid									
	4.2	State the importance of first aid in Solar Photovoltaic Systems Installation and Maintenance									
	4.3	List first aid tools and materials									
	4.4	Identify own responsibilities in case of an emergency that has to do with electric shock such as: • Identify and switch off power supply sources									
	4.5	State the situations that require artificial resuscitation									
	4.6	Describe how to carry out resuscitation in case of an accident									
	4.7	Explain how to report accident to immediate superior									
	4.8	Explain first aid regulations									
	4.9	Locate first aid box									
	4.10	Treat minor injuries during emergencies									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 002: Teamwork in Solar Photovoltaic Systems Installation and Maintenance

Unit Reference Number: PWR/SPV/002/L1
NSQ Level: 1
Credit Value: 1
Guided Learning Hours: 10

Unit Purpose:
This unit is aimed to impart to the learner the necessary knowledge and skills required to develop team spirit and positive working relationships with fellow workers in the work environment.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out. **Simulations are allowed** in this unit and level.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Questions and Answers (Q&A).
3. Witness Statement (WS).
4. Personal Statements (PS)

Unit 002: Teamwork in Solar Photovoltaic Systems Installation and Maintenance

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Know how to develop positive working relationships with Colleagues in the work environment***	1.1	State the need for developing positive working relationships with colleagues in the work environment.									
	1.2	Explain the importance of relating with others in a way that makes them feel valued and respected.									
	1.3	Assist team members when needed.									
	1.4	Explain the importance of seeking permission from superiors when request is made for assistance falling outside one's area of responsibility.									
	1.5	Communicate information to colleagues about own work that might affect performance of others									
	1.6	Explain the importance of tolerating divergent opinions and perspectives									
LO 2: ***Know how to take responsibilities within the team***	2.1	Recognize own role and responsibilities within the team for a given group assignment									
	2.2	Perform individual tasks in a given group assignment in line with the team's rules and regulations									
	2.3	Participate effectively in a given team work									
	2.4	Prepare and submit task reports promptly									
LO 3: ***Comply with Policies and Regulations of the Organization***	3.1	Work in line with organizational rules and operational standards									
	3.2	Align your operations to the interest of the organization									
	3.3	Access organizational code of conduct for own and team work									
	3.4	Explain organizational code of conduct for own and team work									
	3.5	Report activities of the team work that may negatively affect organizational code of conduct or vision and mission, to the higher authority									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

UNIT 003: Communication in Solar Photovoltaic Systems Installation and Maintenance

Unit reference number: PWR/SPV/003/L1
NSQ Level: 1
Credit value: 2
Guided learning hours: 20

Unit Purpose:

This unit is designed to provide learners with knowledge and skills to establish an effective communication system that is responsive and subject to change in meeting workers, employers and customers need, in work environment

Unit Assessment Requirements/Evidence Requirement

Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment method will include

1. Direct Observations (DO).
2. Questions and Answers (Q&A).
3. Witness Statement (WS).
4. Personal Statements (PS)

Unit 003: Communication in Solar Photovoltaic Systems Installation and Maintenance

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Know non-complex communication system in a work environment***	1.1	Use verbal means to pass on necessary information									
	1.2	Use non-verbal means to convey necessary information e.g. body language, signs, etc.									
	1.3	Distinguish symbols and signs appropriately									
	1.4	Use appropriate terminologies in all technical communications									
LO 2: ***Know the sources of information in a work environment***	2.1	Identify the sources of information in the work environment e.g.: • Upward • Downward • Horizontal									
	2.2	Communicate effectively with the source of information									
	2.3	Use the different information flow systems in a work environment e.g. • Fill in work permit									
	2.4	Use information gathered to overcome challenges in a work situation									
	2.5	Report findings appropriately in accordance with laid down procedures in the work environment e.g. • Fill reporting template									
LO 3: ***Know the various means of communication in a work environment***	3.1	Identify the various communication equipment in the work environment e.g.: • Base Radio • Phones • Walkie Talkie									
	3.2	Use effectively the various communication equipment in a work environment as identified in 3.1 above									
	3.3	Pass information effectively to the appropriate personnel									
	3.4	Explain how to carryout instructions in line with the ethics of work environment									
	3.5	Effectively listen to understand messages in communication									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 004: Introduction to Solar Photovoltaic Systems

Unit Reference Number: PWR/SPV/004/L1
NSQ Level: 1
Credit Value: 2
Guided Learning Hours: 20

Unit Purpose:
This unit standard specifies the competencies required in understanding the history, career opportunities and basic terminologies used in Solar Photovoltaic (PV) System installations in Nigeria. It is intended for those who wish to work as Solar Photovoltaic Systems or Assistant Installers/Operators/Repairers.

Unit Assessment Requirements/Evidence Requirement
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:
1. Direct Observations (DO).
2. Questions and Answers (Q&A).
3. Witness Statement (WS).
4. Personal Statements (PS)

Unit 004: Introduction to Solar Photovoltaic Systems

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Know the background of solar energy.***	1.1	Define renewable energy									
	1.2	List applications of renewable energy • Power generation • Heating and cooling • Transportation									
	1.3	Identify types of renewable energy: • Solar PV • Solar Thermal • Wind Turbine • Geo Thermal • Biomass/Biogas									
	1.4	Mention two type of solar energy technology. • Solar PV • Solar Thermal									
	1.5	Explain the history of Solar PV applications in Nigeria									
	1.6	Identify the impact of Solar PV systems on economic development									
	1.7	Explain the impact of Solar PV on the environment									
LO 2: ***Understand career opportunities in Solar PV Systems***	2.1	Recognize the career value chain of solar PV Installation and Maintenance e.g.: • Solar Installers • Solar component vendors • Battery Chargers • Inverter Maintenance • Solar Accessories Vendor									
	2.2	Explain career opportunities in solar PV Systems									
	2.3	Explain the prospects of solar system industry									
	2.4	Explain the economic advantage of Solar PV Systems									
LO 3: ***Understand the basic terminologies used in Solar PV Systems***	3.1	List the basic terms used in Solar PV System									
	3.2	Define basic terms used in Solar PV Systems e.g.: • kVA / kW/ kWh									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
		• MPPT/ Voc / Isc • Mono/Polycrystalline/ Thin-film etc.									
	3.3	Explain the common terminologies found in manufacturers' manuals									
	3.4	Explain the significance of understanding terminologies in interpreting wiring diagrams									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 005: Tools and Equipment used in Solar Systems Installation and Maintenance

Unit Reference Number: PWR/SPV/005/L1
NSQ Level: 1
Credit Value: 3
Guided Learning Hours: 30

Unit Purpose:
This unit standard specifies the competencies required to demonstrate the use of tools and equipment in Solar PV Systems installations.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Questions and Answers (Q&A).
3. Witness Statement (WS).
4. Personal Statements (PS)

Unit 005: Tools and Equipment used in Solar Photovoltaic and Back-up Installations

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Know the tools and equipment used in Solar Photovoltaic Systems installation and Maintenance.***	1.1	Identify the tools and equipment used in Solar Photovoltaic Systems installation and Maintenance									
	1.2	Explain the uses of tools and equipment in Solar Photovoltaic Systems Installation and Maintenance									
	1.3	Select standard tools and equipment in accordance with a given task									
	1.4	Carry out tools and equipment maintenance in accordance with manufacturers' specifications									
	1.5	Demonstrate the proper storage of tools and equipment									
LO 2: ***Know safe work practices in the handling and operation of tools and equipment.***	2.1	Use standard operating Procedures (SOP) when using tools and equipment									
	2.2	Wear appropriate Personal Protective Equipment (PPE) required for safe work in accordance with the regulatory and workplace requirement									
	2.3	State handling of heavy equipment.									
	2.4	Demonstrate appropriate way of handing tools and equipment according to manufacturer specification									
	2.5	List safety requirements for particular work.									
	2.6	Describe safety procedures in transportation of tools and equipment to sites									
LO 3: ***Know the working condition of tools and equipment.***	3.1	Identify functional tools and equipment, label according to classification									
	3.2	Identify non-functional tools and equipment and label according to classification									
	3.3	Check the tools and equipment									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
		for defects or wear before and after use.									
	3.4	Observe safe working conditions of tools and equipment in accordance with manufacturer's instructions									
	3.5	Select materials, tools and equipment according to classification and job requirements									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 006: Materials used in Solar Photovoltaic Systems Installations and Maintenance

Unit Reference Number: PWR/SPV/006/L1
NSQ Level: 1
Credit Value: 4
Guided Learning Hours: 40

Unit Purpose:
This unit standard specifies the competencies required to demonstrate knowledge and skills of materials used in Solar Photovoltaic Systems Installation and Maintenance.
The unit standard is intended for those interested in working as installers and/or repairers of Solar Photovoltaic Systems installation and Maintenance.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:
1. Direct Observations (DO).
2. Questions and Answers (Q&A).
3. Witness Statement (WS).
4. Personal Statements (PS)

Unit 006: Materials Used in Solar Photovoltaic Systems Installation and Maintenance.

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Know the electrical cables used in Solar Photovoltaic Systems Installation and Maintenance***	1.1	Explain the types of cables used in Solar PV Systems									
	1.2	State the application of cables according to their sizes									
	1.3	Explain the techniques of cable termination									
	1.4	Explain the techniques of cable jointing									
	1.5	Explain the IEEE regulations governing cable termination/joint									
	1.6	Select the correct type of cable for appropriate load specifications									
	1.7	Select the correct size of cable for appropriate load specifications									
	1.8	Perform cable termination in accordance with specifications and laid down procedures									
	1.9	Perform cable jointing in accordance with specifications and laid down procedures									
	10.10	Apply safety measures in cable termination									
	10.11	Apply safety measures in cable jointing and ensure environmental protection guidelines.									
LO 2: ***Understand the cable insulation materials used in Solar PV Installations and Maintenance.***	2.1	Explain the types of insulation material in cables									
	2.2	State the application of insulation materials according to their types									
	2.3	Explain the techniques of insulation material pilling.									
	2.4	Explain the IEEE regulations governing insulation material									
	2.5	Select correct type of insulation for appropriate voltage for a									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
		given task									
	2.6	Select correct size of insulation for appropriate voltage for a given task									
	2.7	Apply safety measures in insulation material use in accordance with the environmental protection guidelines									
LO 3: ***Know the accessories in Solar PV Systems***	3.1	List the various Solar PV Accessories									
	3.2	Explain the various Solar PV Accessories: • PV Mounting rails • Battery rack • Trunking Pipes • Clips and Fishing tapes • Screws, bolts and nuts • Flexible pipes • Combiner box • Cable lugs • Connectors • Crimping tools									
	3.3	Apply safety and environmental standard in assembling and mounting the appropriate Solar PV accessories									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 007: Basic Components used in Solar Photovoltaic Systems Installation and Maintenance.
Unit Reference Number: PWR/SPV/007/1
NSQ Level: 1
Credit Value: 4
Guided Learning Hours: 40

Unit Purpose:
This unit standard specifies the competencies required in identifying and installing basic components used in Solar Photovoltaic Systems Installation and Maintenance. The unit standard is intended for those who want to work as solar PV Installers.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO)
2. Questions and answers (Q&A)
3. Witness Statement (WS)
4. Personal Statement (PS)

Unit 007: Basic Components used in Solar Photovoltaic Systems Installation and Maintenance.

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Know the basic components for solar-PV system.	1.1	List basic components of Solar PV systems									
	1.2	Explain the basic components of Solar PV systems									
	1.3	Explain the application of basic components of Solar PV systems									
	1.4	Describe the function of Charge controllers									
	1.5	Describe the function of solar panels									
	1.6	Describe the function of DC Breakers									
	1.7	Describe the function of AC Breakers									
	1.8	State the function of Inverters									
	1.9	State the function of Batteries									
	1.10	Describe the function of battery equalizer									
	1.11	Select appropriate components in accordance with designers'/ manufacturers' specification and guidelines									
	1.12	Identify necessary safety and environmental standards in selecting appropriate components									
LO 2: ***Understand the types of Solar Batteries***	2.1	Explain the various batteries used in Solar PV systems.									
	2.2	Explain the advantages and disadvantages of each type of batteries.									
	2.3	Describe safety and environmental standard in handling batteries.									
	2.4	Explain maintenance of types of batteries									
LO 3: Understand the protection of DC side	3.1	List the DC protective devices used in Solar PV systems									
	3.2	Describe the function of DC Breakers									
	3.3	Describe the function of DC fuse									
LO 4:	4.1	State the function of AC circuit									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
Know AC protective device in Solar PV Systems		breaker									
	4.2	Describe the function of distribution board									
	4.3	Identify the function of AC fuse									
	4.4	Describe the function of lightning arrestor and earthing system									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

NATIONAL SKILLS QUALIFICATION (NSQ)

LEVEL 2

SOLAR PHOTOVOLTAIC SYSTEM INSTALLATION AND MAINTENANCE

2025

NATIONAL SKILLS QUALIFICATION

GENERAL INFORMATION

OVERVIEW

This qualification is designed for individuals who are interested in pursuing a career in the solar photovoltaic (PV) systems sector for the award of National Skills Qualifications (NSQ).

It is aimed at producing skilled worker or craft person in solar PV system installation and maintenance, NSQ Level II with the competencies necessary to support in renewable energy industries.
This qualification is subject to review as and when the need arises.

QUALIFICATION PURPOSE

This qualification is targeted at developing competence in Solar PV system installation and maintenance.

QUALIFICATION REQUIREMENTS

All Candidates must:

a. Be medically fit
b. Be physically fit
c. Be mentally fit (Mental alertness)
d. Have achieved all the mandatory units in the qualification
e. Be vetted

QUALIFICATION OBJECTIVES

To achieve this qualification, the learner should at the end have the following competencies:

1. Apply occupational health, safety, and environmental guidelines in the installation of Solar Photovoltaic Systems installation and Maintenance.
2. Communicate appropriately in working environment with team members in Solar Photovoltaic Systems installation and Maintenance.
3. Work in a Solar Photovoltaic Systems installation and Maintenance environment in team.
4. Perform basic electrical calculations as part of Solar PV Systems.
5. Install Solar Panels Rack as part of Solar PV Systems.
6. Install Solar PV modules as part of Solar PV systems.
7. Install Charge Controllers as part of Solar PV Systems.
8. Install Batteries in Solar PV Systems.
9. Install Inverters used in Solar PV Systems.
10. Perform load connections in Solar PV Systems.
11. Assemble Solar PV Panels.

NATIONAL SKILLS QUALIFICATION (NSQ) TABLE
LEVEL 2
SOLAR PV SYSTEMS INSTALLATION AND MAINTANANCE

MANDATORY UNITS

Unit	Unit Reference Number	Unit Title	Credit Value	Guided Learning Hours
1	PWR/SPV/001/L2	Occupational Health and Safety	2	20
2	PWR/SPV/002/L2	Communication Skills	2	20
3	PWR/SPV/003/L2	Teamwork	1	10
4	PWR/SPV/004/L2	Basic electrical calculations of Solar PV	4	40
5	PWR/SPV/005/L2	Solar Panel Rack Installation	3	30
6	PWR/SPV/006/L2	Solar Photovoltaic Panel Installation	3	30
7	PWR/SPV/007/L2	Solar PV Charge Controller	3	30
8	PWR/SPV/008/L2	Solar Photovoltaic Battery Installation	4	40
9	PWR/SPV/009/L2	Solar PV Inverter Installation	4	40
10	PWR/SPV/010/L2	Load Connection	3	30
Optional Unit				
11	PWR/SPV/011/L2	Solar Panel Assembly	5	50
TOTAL			34	**340**

GENERAL GUIDE

Unit Title	Provides a clear explanation of the content of the unit.
Unit Number	The unique number assigned to the unit.
Unit Reference	The unique reference number given to each unit at qualification approval by NBTE
Unit Level	Denotes the level of the unit within the National Vocational Qualification framework NSQF.
Unit Credit Value	The value that has been given to the unit based on the expected learning time for an average learner. 1 credit = 10 learning hours
Unit Aim	Provides a brief outline of the unit content.
Learning Outcome	A statement of what a learner will know, understand or be able to do, as a result of a process of learning.
Assessment Criteria	A description of the requirements a learner must achieve to demonstrate that the learning outcome has been met.
Unit Assessment Guidance	Any additional guidance provided to support the assessment of the unit
Unit Guided Learning Hours	The average number of hours of supervised or directed study time or assessment required in achieving a qualification or unit of a qualification.

Unit 001: Occupational Health and Safety

Unit Reference Number:	**PWR/SPV/001/L2**
NSQ Level:	**2**
Credit Value:	**2**
Guided Learning Hours:	**20**

Unit Purpose:

This unit specifies the competencies required to carry out safe work practices.
It involves learning about workplace safety, correct use of signs, symbols, identifying and reducing risks of hazards in the work environment.

Unit Assessment Requirements/ Evidence Requirement:

Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO)
2. Questions and answers (Q&A)
3. Witness Statement (WS)
4. Personal Statement (PS)

Unit 001: Occupational Health and Safety

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.				
LO 1: ***Know safe working Practices and Instructions***	1.1	Describe safe work practice and instructions										
	1.2	Recognize safety signs and symbols										
	1.3	Interpret safety signs and symbols correctly.										
	1.4	Observe safe work practices on given tasks										
	1.5	Work in accordance with health and safety best practices										
LO 2: ***Know Safety, Hazards and risks in work place***	2.1	Identify types of hazards in the work environment										
	2.2	Describe ways to avoid common hazards in the work place										
	2.3	State methods of how to reduce the risk of hazards in the work place										
	2.4	Describe how to report potential hazards in the work place										
LO 3: ***Know the appropriate actions to take during accident/injuries***	3.1	Identify basic first aid equipment.										
	3.2	Explain the benefits of first aid equipment										
	3.3	State types of injuries commonly found in the workplace.										
	3.4	Identify serious injuries that require emergency response in the work place.										
	3.5	State the steps to be taken following an accident										
	3.6	Identify own responsibilities in case of an emergency such as: • Identifying and switching off power supply sources • Carrying out artificial resuscitation methods • Calling for medical attention • Transferring patient to the nearest medical facility										
	3.7	Identify muster point										
	3.8	Identify locations of fire										

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
		extinguishers in case of fire outbreak									
	3.9	Describe methods of fire fighting									
	3.10	Describe the Pull Aim Squeeze and Sweep (PASS) of fire extinguishers									
	3.11	Describe how to treat minor injuries and burns									
LO 4: Know safe work practices and clean work environment	4.1	Identify safe access and exit routes in the work environment									
	4.2	Describe safe work practices and clean work environment									
	4.3	Dispose all wastes appropriately in designated waste facilities									
	4.4	State the advantages of using appropriate PPE while carrying out a task in work environment									
	4.5	Select appropriate working tools for a given task to avoid hazards									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 002:	**Communication Skills**
Unit Reference Number:	**PWR/SPV/002/L2**
NSQ Level:	**2**
Credit Value:	**2**
Guided Learning Hours:	**20**

Unit Purpose:
This unit specifies the competencies required to demonstrate good communication and interpersonal skills.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations/Oral Questions (DO).
2. Questions and Answers (QA).
3. Personal Statement (PS).
4. Witness Testimony (WT).
5. Assignments

Unit 002: Communication Skills

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Understand the importance of good communication skills***	1.1	State reasons why good communication skills is important in Solar PV Systems.									
	1.2	List ways to communicate effectively: • Upward • Downward • Horizontal									
	1.3	Explain the significance of patience and a mild demeanor while communicating with colleagues and clients									
	1.4	Describe how to communicate in a professional manner.									
	1.5	State the need for respectful body language even when in a bad mood or while under pressure.									
LO 2: ***Know how to follow documented instructions***	2.1	Read and accurately follow steps in installation manuals.									
	2.2	Explain mobile app documentation.									
	2.3	Read the information displayed on various solar devices.									
LO 3: ***Know how to document information after commissioning of solar system***	3.1	Determine parameters to be documented									
	3.2	Describe the scope of information needed to be documented.									
	3.3	Explain the importance of the documented information.									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 003:	**Team Work**
Unit Reference Number:	**PWR/SPV/003/L2**
NSQ Level:	**2**
Credit Value:	**1**
Guided Learning Hours:	**10**

Unit Purpose:
This unit is aimed to impart into the learner, the necessary knowledge and skills required to develop team spirit and positive working relationship with the fellow workers in the work environment.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out. **Simulations are allowed** in this unit and level.

Assessment methods to be used include:
1. Direct Observations/Oral Questions (DO)
2. Questions and Answers (QA)
3. Witness Testimony (WT)
4. Work Product (WP)
5. Recognition of Prior Learning (RPL)

Unit 003: Team Work

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Know Positive working relationship with colleagues in the work environment***	1.1	Explain the need for developing positive working relationship with colleagues in the work environment.									
	1.2	Explain the importance of relating with other people in a way that makes them feel valued and respected.									
	1.3	Assist team members when one's services are requested.									
	1.4	Report to the authorized personnel when request is made for assistance falling outside one's area of responsibility.									
	1.5	Communicate information to colleagues about own work that might affect performance of others									
LO 2: ***Know the responsibilities within the team***	2.1	Explain own role and responsibilities within the team for a group work.									
	2.2	Carry out individual tasks in a given group assignment in line with the team's rules and regulations.									
	2.3	Participate actively in a given team work.									
	2.4	Give own report of task carried out in a team.									
LO 3: ***Know policies and regulations of organization***	3.1	Carry out assigned tasks in a team in line with organizational standards									
	3.2	Use organizational code of practice for assigned job within a team.									
	3.3	Obtain organizational code of conduct for own and team jobs.									
	3.4	Explain the importance of using organizational code of conduct for own and team jobs									
	3.5	List rules that guide the activities of the team									
	3.6	Report activities of the team work that may affect organizational code of conduct to the higher authority.									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 004: Basic Electrical Calculations of Solar PV

Unit Reference Number: PWR/SPV/004/L2
NSQ Level: 2
Credit Value: 4
Guided Learning Hours: 40

Unit Purpose:
This unit standard specifies the competencies required to calculate the flow of electricity in a simple circuit and identify instruments used in measuring electrical quantities according to specifications.

Unit: Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations/Oral Questions (DO).
2. Questions and Answers (QA).
3. Personal Statement (PS).
4. Work Products (WP).

Unit 004: Basic Electrical Calculations of Solar PV

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Know the calculations used in Solar PV Systems	1.1	Explain types of circuits connections									
	1.2	Explain electrical current parameters use in Solar PV									
	1.3	Define the Ohm's Law formulae									
	1.4	Calculate the total voltage in a parallel, series and combination of circuits.									
	1.5	Calculate the total current in a parallel, series and combination of circuits.									
	1.6	Calculate the total resistance in a parallel, series and combination of circuits.									
	1.7	Determine the total power in a parallel, series and combination of circuits									
	1.8	Determine the total energy in a parallel, series and combination of circuits									
	1.9	Record calculations in accordance with laid down procedures.									
LO 2: Know the appropriate measuring Instruments in solar PV system installation and maintenance.	2.1	List the measuring instruments used in Solar PV Systems									
	2.2	Explain the uses of different measuring instruments used in Solar PV Systems									
	2.3	Select appropriate measuring instruments for a given task									
	2.4	Use appropriate instruments to measure electric current in a circuit									
	2.5	Use appropriate instruments to measure voltage in a circuit									
	2.6	Use appropriate instruments to measure resistance in a circuit									
	2.7	Use appropriate instruments to measure electric energy in a circuit									
	2.8	Determine the state of charge of a battery using appropriate instruments									
LO 3: Know geometrical measurement and	3.1	Explain measurements requirements in preparation for a specific task.									

LEARNING OBJECTIVE (LO) **The learner will:**		**PERFORMANCE CRITERIA** **The learner can:**	**Evidence Type**					**Evidence Ref. Page No.**			
calculations in preparation for installation	3.2	Determine space requirement for installation of Solar panels									
	3.3	Explain how to calculate number of panels required for a particular Solar project									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 005: Solar Panel Rack Installation

Unit Reference Number: PWR/SPV/005/2
NSQ Level: 2
Credit Value: 3
Guided Learning Hours: 30

Unit Purpose:
This unit standard specifies the competencies required in installation of solar panel rack. The unit standard is intended for those who want to work as solar PV Installers.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out. Simulations are not acceptable

Assessment methods to be used include:

1. Direct Observations/Oral Questions (DO).
2. Questions and Answers (QA).
3. Personal Statement (PS).
4. Work Product (WP).

Unit 005: Solar Panel Rack Installation.

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Know the Pre-installation of Solar panel racks	1.1	Describe the structural condition of the mounting area									
	1.2	Identify the mounting system to be deployed									
	1.3	Select mounting system compatible to the rack									
	1.4	Select appropriate tools, equipment and materials used in mounting solar panel rack according to specifications and guidelines									
	1.5	Identify and select appropriate PPE for the installation of solar panel racks									
LO 2: Know how to Position and Install Solar Panel Rack	2.1	Identify the location of a panel rack									
	2.2	Identify "true south" and find optimum tilt angle of the rack									
	2.3	Identify jacking points and safety measures used in solar rack installation									
	2.4	Perform rack installation according to standard specifications									
	2.5	Apply safety and environmental standards in selecting and installation of solar panel racks									
LO 3: Know how to review the completion of solar PV installation rack	3.1	Carry out checks to ensure work is following plans/drawings /instructions and requirements									
	3.2	Notify Supervisor upon completion of work									
	3.3	Clean tools, equipment and as well any excess materials and return to storage in accordance with established safety procedures									
	3.4	Clean the work area									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 006:	**Solar Photovoltaic Panel Installation**
Unit Reference Number:	**PWR/SPV/006/L2**
NSQ Level:	**2**
Credit Value:	**3**
Guided Learning Hours:	**30**

Unit Purpose:
This unit standard specifies the competencies required in the preparation and installation of solar module.
The unit standard is intended for those who want to work as solar PV Installers.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out. Simulation is not allowed

Assessment methods to be used include:

1. Direct Observations/Oral Questions (DO).
2. Questions and Answers (QA).
3. Personal Statement (PS).
4. Work Product (WP).

Unit 006: Solar Photovoltaic Panel Installation

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Know how to Prepare to install Solar PV modules	1.1	Explain the difference between monocrystalline, poly crystalline and thin-film Solar PV module									
	1.2	Select the appropriate Solar PV modules									
	1.3	Select appropriate tools, equipment and materials according to specifications and guidelines									
	1.4	Select appropriate PPE for the installation of solar PV modules									
LO 2: Know the installation of solar PV modules	2.1	Determine the appropriate orientation for installation of solar PV modules									
	2.2	Perform PV modules installation according to specifications and guidelines									
	2.3	Apply safety and environmental standards in installation of solar PV module									
LO 3: Know how to Communicate information regarding the panel installation	3.1	Identify specific information on installed solar PV panels									
	3.2	Apply appropriate medium in transfer of information									
	3.3	Convey information clearly and concisely									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 007: **Solar PV Charge Controller**
Unit Reference Number: **PWR/SPV/007/L2**
NSQ Level: **2**
Credit Value: **3**
Guided Learning Hours: **30**

Unit Purpose:
The unit standard specifies the competencies required in preparing and installing charge controllers in Solar PV systems.

The unit standard is intended for those who want to work as Solar PV Installers.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out. Simulations are not allowed.

Assessment methods to be used include:

1. Direct Observations/Oral Questions (DO).
2. Questions and Answers (QA).
3. Personal Statement (PS).
4. Work Product (WP).

Unit 007: Solar PV Charge Controller

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Know how to prepare and install charge controllers in Solar PV Systems.	1.1	Explain the difference between MPPT and PWM charge controllers									
	1.2	State the appropriate ratings of charge controllers to battery size and PV module power output design to be installed									
	1.3	Distinguish between rating of charge controllers									
	1.4	Interpret rating of charge controller									
	1.5	Explain the connection sequence of charge controllers.									
	1.6	State precautionary measures to be taken in installing charge controllers									
	1.7	List the steps involved in the connection of charge controller									
LO 2: Install charge controller in Solar PV Systems.	2.1	Use appropriate tools, equipment, and materials to install charge controllers									
	2.2	Identify the best location to mount charge controller									
	2.3	Install charge controller according to specifications and connection sequence									
	2.4	Apply safe working procedures in the selection and installation of charge controllers									
LO 3: Configure installed Charge Controller	3.1	Configure charge controller to suit solar PV size according to specifications and manufacturer's guidelines.									
	3.2	Configure Charge Controller to suite battery type, capacity and technology according to specifications and manufacturer's guidelines.									
	3.3	Operate the charge controller according to specifications and manufacturer's guidelines									
	3.4	Observe and take readings on the charge controller									
	3.5	Document the various readings taken									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 008:	**Solar Photovoltaic Battery installation**
Unit Reference Number:	**PWR/SPV/008/L2**
NSQ Level:	**2**
Credit Value:	**4**
Guided Learning Hours:	**40**

Unit Purpose:

The unit specifies the competencies required to install battery in solar PV system. It involves learning about the battery type, battery size, battery polarities, battery configurations and battery installation.

Unit Assessment Requirements/Evidence Requirement

Assessment must be carried out in real workplace environment in which learning and human development is carried out. Simulation is not allowed

Assessment methods to be used include:

1. Direct Observations/Oral Questions (DO).
2. Questions and Answers (QA).
3. Personal Statement (PS).
4. Work Product (WP).

Unit 008: Solar Photovoltaic Battery Installation

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Install batteries in solar PV System.	1.1	Describe the working principles of batteries									
	1.2	Explain the types and sizes of batteries and their applications in Solar PV installations									
	1.3	State the application of types of batteries									
	1.4	Discuss Solar PV batteries life span									
	1.5	Explain the importance of warranties in the installation of batteries									
	1.6	Select appropriate tools, equipment and materials used in the installation of batteries									
	1.7	Select appropriate PPE for the installation of batteries									
LO 2: Know battery installation in solar PV	2.1	Identify battery polarities before installation									
	2.2	Explain how to handle batteries safely and appropriately									
	2.3	Carry out voltage measurements on batteries to confirm their status									
	2.4	Know how to install the battery according to: • Battery racks • Appropriate positioning in line with health and safety measures									
	2.5	Connect batteries in series/parallel in accordance with the voltage requirement of the inverter.									
	2.6	Install batteries to charge controller in accordance with specifications									
	2.7	Perform cable termination using cable lugs and torque in battery installation									
	2.8	Ensure appropriate temperature control environment									
LO 3: Understand Configuration of	3.1	Explain the need for series battery configuration									
	3.2	Explain the need for parallel									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
Solar PV battery		battery configuration									
	3.3	Explain the need for series/ parallel combined battery configuration									
LO 4: Know the Protection in Solar PV battery installation	4.1	Define Battery voltage Equalizer									
	4.2	State the importance of Battery voltage equalizer									
	4.3	Explain types of battery protection									
	4.4	Install battery fuses									
	4.5	Install battery circuit breaker									
	4.6	Ensure regular battery checks and maintenance									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 009:	**Solar PV Inverter Installation**
Unit Reference Number:	**PWR/SPV/009/L2**
NSQ Level:	**2**
Credit Value:	**4**
Guided Learning Hours:	**40**

Unit Purpose:

The unit standard specifies the competencies required in the preparation and installation of inverters in solar PV system.

The unit standard is intended for those who want to work as solar PV installers.

Unit Assessment Requirements/Evidence Requirement

Assessment must be carried out in real workplace environment in which learning and human development is carried out. Simulations are not allowed.

Assessment methods to be used include:

1. Direct Observations/Oral Questions (DO).
2. Questions and Answers (QA).
3. Personal Statement (PS).
4. Work Product (WP).

Unit 009: Solar PV Inverter Installation

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Understand Inverter in Solar PV Systems***	1.1	Define what is an Inverter									
	1.2	State types of inverters									
	1.3	Explain the principles of operation of an inverter									
	1.4	Sketch the inverter output wave form									
LO 2: ***Know Inverter size***	2.1	Carry out basic load analysis									
	2.2	Determine appropriate size and type of inverter									
	2.3	State safe working practices in the installation of inverters									
LO 3: ***Install inverters***	3.1	Apply safe working practices in the installation of inverters									
	3.2	Carry out inspection on suitable locations to install inverter									
	3.3	Determine appropriate location to install the inverter									
	3.4	Select appropriate tools, equipment and materials in the installation of inverter according to electrical load specifications									
	3.5	Select appropriate PPE for installing inverters in solar PV									
	3.6	Explain types of mounting • Wall mounting • Rack mounting									
	3.7	Prepare installation for wall mounting according to: • Determine suitable point on the wall • Mark out hole positions according to Inverter design • Drill holes on the Wall with suitable size bits • Select appropriate fisher and screws • Mount the inverter and fasten the screws to appropriate torque									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
	3.8	Prepare installation for rack mounting to: • Ensure the rack is suitable for the PV system • Assemble the rack • Place the rack at appropriate position • Mount batteries at appropriate position • Connect batteries according to connection type • Confirm total battery voltage output is appropriate • Mount Inverter in appropriate position • Connect an Inverter DC terminals to battery terminals • Connect inverter AC side to load and mains supply • Ensure all fuses and circuit breakers are connected appropriately • Carry out appropriate test before switching • Switch on the inverter • Perform no-load test • Perform on-load test • Observe performance of the system									
	3.9	Apply safety and environmental standards in accordance with the manufacturer's specifications and guidelines									
LO 4: ***Install Uninterruptible Power Supply (UPS)***	4.1	Apply safety and environmental standards in accordance with the manufacturer's specifications									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
		and guidelines									
	4.2	Identify UPS terminals, ratings and settings									
	4.3	Carry out inspection on suitable locations on how to install UPS									
	4.4	Select appropriate tools, equipment and materials in the installation of UPS systems according to the electrical load specifications									
	4.5	Select appropriate location to install the UPS									
	4.6	Install UPS in accordance with the electrical load specifications									
	4.7	Prepare UPS installation according to specifications: • Carryout battery installation where applicable • Ensure all fuses and circuit breakers are connected appropriately • Carry out appropriate tests before switching • Switch on the UPS • Perform no-load test • Perform on-load test • Observe performance of the system									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 010: Load Connections

Unit Reference Number: PWR/SPV/010/L2
NSQ Level: 2
Credit Value: 3
Guided Learning Hours: 30

Unit Purpose:
The unit standard specifies the competencies required to demonstrate skills of electrical load distribution of a building, connection of inverter output power to the load and the charging system. The unit is intended for those who want to work as Solar PV Installers/Operators/Repairers.

Requirements/Evidence Requirement
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations/oral questions (DO).
2. Questions and Answers (QA).
3. Personal Statement (PS).
4. Work Product (WP).

UNIT 010: Load Connection

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.				
LO 1: Distribute electrical load in a building	1.1	Apply safety and environmental standards according to the laid down procedures										
	1.2	Explain the domestic / commercial/industrial electrical distribution systems: • Distribution board • Final circuits (socket, lighting, cooker, air conditioners etc.) • Earthing • Lightening arrestor										
	1.3	Identify final circuit (sub-circuits) to be connected to the inverter and or mains.										
	1.4	Explain the importance of electrical protective devices (EPDs) on loads in a building										
	1.5	Select appropriate distribution and protective devices in accordance with load specifications and regulations.										
	1.6	Carry out appropriate inspections and test										
LO 2: Know various electrical loads	2.1	Identify DC loads										
	2.2	Identify AC resistive loads										
	2.3	Identify AC reactive loads										
	2.4	Ensure appropriate Inverter sizing for reactive loads										
	2.5	Determine the safe operating power for all electrical loads										
LO 3: Know the sources of battery charging and output power supply	3.1	Apply safety measures in connection of inverter to the load and charging										
	3.2	Identify sources of battery charging to the PV system: • AC mains/Generator (through the inverter) • Solar PV Mains stand-alone charger										
	3.3	Locate power source point to feed the Inverter										
	3.4	Select appropriate miniature										

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
		circuit breaker (MCB) to protect and feed the Inverter									
	3.5	Explain the importance of electrical protective devices (EPDs) on Inverter charging									
	3.6	Connect appropriate MCB to the Inverter output									
	3.7	Perform load and charging connections in accordance withthe guidelines and specifications									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 011: Solar Panel Assembly.
Unit Reference Number: PWR/SPV/011/L2
NSQ Level: 2
Credit Value: 5
Guided Learning Hours: 50

Unit Purpose:
The unit standard specifies the competencies required in Solar Panel Assembly.
This unit standard is intended for those who want to work as Solar Panel Assemblers.

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations/Oral Questions (DO).
2. Questions and Answers (QA).
3. Personal Statement (PS).
4. Work Product (WP).

Unit 011: Solar Panel Assembly

LEARNING OBJECTIVE (LO) **The learner will:**		**PERFORMANCE CRITERIA** **The learner can:**	**Evidence Type**					**Evidence Ref. Page No.**			
LO 1: Understand Solar Panel Technology	1.1	Explain the term Solar Panel									
	1.2	Identify the components, materials, and tools required to produce a Solar Panel									
	1.3	State the importance of Solar Panels									
	1.4	Explain the working principles of Solar Panels									
	1.5	State the advantages and disadvantages of producing Solar Panels at local levels									
LO 2: Understand Solar Cells and Photovoltaic Technology	2.1	Explain types of cells used to produce Solar Panels									
	2.2	Describe how the Solar cells generate energy									
	2.3	Perform cells handling procedures									
LO3: Know tools and materials used in Solar Panel Assembly.	3.1	Describe material used in Solar Panel Assembly									
	3.2	List materials used in Solar Panel Assembly									
	3.3	Identify tools used in Solar Panel Assembly									
LO 4: Know Planning and Design of Solar Cells.	4.1	Examine available sunlight used for energy generation									
	4.2	Perform calibration and dummy cell arrangements for final outlooks									
	4.3	Determine the kind of voltage connections for optimal power tapping									
LO5: Know Soldering Techniques	5.1	Explain the term soldering									
	5.2	Explain types of soldering techniques									
	5.3	List soldering materials									
	5.4	Identify soldering techniques									
LO 6: Know the procedure of Solar Panel Assembly	6.1	Carry out Solar cells by padding									
	6.2	Perform trimming, cleaning, and aligning of cells prior to laying									
	6.3	Carry out soldering									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
	6.4	Perform series and parallel cells connections									
	6.5	Assemble cells between protective calibrated layers									
	6.6	Test connected cells for optimal energy and power supply									
	6.7	Carryout termination of series connected cells into junction box									
	6.8	Perform connected cells lamination and encapsulation									
	6.9	Couple cell layered board with tempered glass and frame									
	6.10	Use durable of framed boards with water proof & weather proof sealing materials									
LO 7: Know testing and troubleshooting	7.1	Carry out final test of functional connection and rate output									
	7.2	Perform quality inspection of cables connection to the bus outlet									
	7.3	Carry out check for electrical consistency and structural integrity									
LO 8: Know how to carryout post-assembly activities of Solar modules for optimal efficiency	8.1	Document all procedures with detailed descriptions									
	8.2	Carry out planning for acquisition of tools and materials for continuous improvement									
	8.3	Communicate constant production and product quality assurance									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

NATIONAL SKILLS QUALIFICATION (NSQ)

LEVEL 3

SOLAR PHOTOVOLTAIC SYSTEM INSTALLATION AND MAINTENANCE

2025

NATIONAL SKILLS QUALIFICATION
GENERAL INFORMATION

OVERVIEW

This qualification is designed for individuals who are interested in pursuing a career in the Solar Photovoltaic (PV) Systems sector for the award of National Skills Qualifications (NSQ).

It is aimed at producing skilled worker in Solar PV System Installation and Maintenance, NSQ Level III with the competencies necessary to support in renewable energy industry.
This qualification is subject to review as when necessary.

QUALIFICATION PURPOSE

This qualification is targeted at developing competence in skilled Solar PV System Installation and Maintenance.

QUALIFICATION REQUIREMENTS

All Candidates must:

a. Be medically fit
b. Be physically fit
c. Be mentally fit (Mental alertness)
d. Have achieved all the mandatory units in the qualification
e. Be vetted.
f. Basic acknowledge of how to read and write

QUALIFICATION OBJECTIVES

To achieve this qualification, the learner should at the end have the following competencies:

1. Apply occupational health, safety, and environmental guidelines in the installation of Solar Photovoltaic Systems installation and Maintenance.
2. Communicate appropriately in working environment with team members in Solar Photovoltaic Systems installation and Maintenance.
3. Work in a Solar Photovoltaic Systems installation and Maintenance environment in team.
4. Explain the Components of Solar PV Systems Installation
5. Carryout Solar PV System Design
6. Carry out Cost Estimate for Installing Solar Photovoltaic.
7. Testing and Commissioning of Solar PV Installation
8. Operate and maintain installed Solar PV system.
9. Troubleshoot Solar PV system
10. Manage a Solar PV Business

National Skills Qualification (NSQ)
LEVEL III
SOLAR PHOTOVOLTAIC SYSTEM INSTALLATION AND MAINTENANCE

MANDATORY UNITS

Unit	Unit Reference Number	Unit Title	Credit Value	Guided Learning Hours
1	PWR/SPV/001/L3	Occupational Health, Safety and Environmental Guidelines in the Solar PV System Installation and Maintenance	3	30
2	PWR/SPV/002/L3	Communication in Solar PV System Installation and Maintenance	2	20
	PWR/SPV/003/L3	Teamwork in Solar Photovoltaic and Power Back-up Systems	1	10
4	PWR/SPV/004/L3	Components of Solar PV System Installation	3	30
5	PWR/SPV/005/L3	Solar PV System Design and Installation	4	40
6	PWR/SPV/006/L3	Cost Estimate for Installing Solar Photovoltaic	4	40
	PWR/SPV/007/L3	Operation and Maintenance of installed Solar PV System	4	40
8	PWR/SPV/008/L3	Testing and Commissioning of Solar PV Installation	4	40
9	PWR/SPV/009/L3	Troubleshooting Techniques in Solar PV System Installation	4	40
Optional Unit				
11	PWR/SPV/010/L3	Entrepreneurship Installation	5	50
TOTAL			**36**	**360**

GENERAL GUIDE

Unit Title	Provides a clear explanation of the content of the unit.
Unit Number	The unique number assigned to the unit.
Unit Reference	The unique reference number given to each unit at qualification approval by NBTE
Unit Level	Denotes the level of the unit within the National Vocational Qualification Framework (NSQF).
Unit Credit Value	The value that has been given to the unit based on the expected learning time for an average learner. 1 credit = 10 learning hours
Unit Aim	Provides a brief outline of the unit content.
Learning Outcome	A statement of what a learner will know, understand or be able to do, as a result of a process of learning.
Assessment Criteria	A description of the requirements a learner must achieve to demonstrate that a learning outcome has been met.
Unit Assessment Guidance	Any additional guidance provided to support the assessment of the unit.
Unit Guided Learning Hours	The average number of hours of supervised or directed study time or assessment required in achieving a qualification or unit of a qualification.

Unit 001:	**Occupational Health and Safety**
Unit Reference Number:	**PWR/SPV/001/L3**
NSQ Level:	**3**
Credit Value:	**2**
Guided Learning Hours:	**20**

Unit Purpose:
This unit specifies the competencies required to carry out safe work practices.

It involves learning about workplace safety, correct use of signs, symbols, identifying and reducing risks of hazards in the work environment.

Unit Assessment Requirements/Evidence Requirement:
Assessment must be carried out in real work place environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Written/Oral Questions and Answers (QA).
3. Personal Statement
4. Work Product (WP)
5. Professional Discussions (PD)
6. Simulations

Unit 001: Occupational Health and Safety

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: *Know safe working Practices and Instructions*	1.1	Describe safe work practice and instructions.									
	1.2	Recognize safety signs and symbols.									
	1.3	Interpret safety signs and symbols correctly.									
	1.4	Observe safe work practices on given tasks.									
	1.5	Work in accordance with health and safety best practices.									
LO 2: *Understand Safety, Hazards and Risks in Work Place*	2.1	State types of hazards in the work environment.									
	2.2	Describe ways to avoid common hazards in the work place									
	2.3	State methods to reduce the risk of hazards in a work place									
	2.4	Describe how to report potential hazards in a work place									
LO 3: Know appropriate actions to take during accident/injuries	3.1	Identify basic first aid equipment									
	3.2	Explain the benefits of first aid equipment									
	3.3	State types of injuries commonly found in a workplace									
	3.4	Identify serious injuries that require emergency response in a work place									
	3.5	State the steps to be taken when an accident occurs									
	3.6	Identify own responsibilities in case of an emergency such as: • Identifying and switching off power supply sources • Carrying out artificial resuscitation methods • Calling for medical attention • Transferring patient to the nearest medical facility									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
	3.7	Identifying muster point									
	3.8	Identify locations of fire extinguishers in case of fire outbreak									
	3.9	Describe methods of fire fighting									
	3.10	Describe the Pull Aim Squeeze and Sweep (PASS) of fire extinguishers									
	3.11	Describe how to treat minor injuries and burns									
LO 4: Know safe work practices and clean work environment	4.1	Identify safe access and exit routes in the work environment									
	4.2	Describe safe work practices and clean work environment									
	4.3	Dispose all wastes appropriately in designated waste facilities									
	4.4	State the advantages and disadvantages of using appropriate PPE while carrying out a task in work environment									
	4.5	Select appropriate working tools for a given task to avoid hazard									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 002:	**Communication Skills**
Unit Reference Number:	**PWR/SPV/002/L3**
NSQ Level:	**3**
Credit Value:	**2**
Guided Learning Hours:	**20**

Unit Purpose:
This unit specifies the competencies required to demonstrate good communication and interpersonal skills.

It involves the ability to read and understand documented instructions and the ability to know how to communicate respectfully when in a bad mood or under pressure.

Unit Assessment Requirements/Evidence Requirement:
Assessment must be carried out in real work place environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Written/Oral Questions and Answers (QA).
3. Personal Statement
4. Work Product (WP)
5. Professional Discussions (PD)

Unit 002: Communication Skills

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Know good Communication Skills***	1.1	State reasons why good communication skills is important in Solar PV System Systems									
	1.2	List ways to communicate effectively: • Upward • Downward • Horizontal									
	1.3	Explain the significance of patience and mild demeanor while communicating with colleagues and clients									
	1.4	Describe how to communicate in a Professional manner									
	1.5	State the need for respectful body language even when in a bad mood or while under pressure									
LO 2: ***Know how to follow Documented Instructions***	2.1	Read and accurately follow steps in Installation manuals									
	2.2	Explain mobile app documentation.									
	2.3	Read the information displayed on various Solar devices.									
LO 3: ***Document information after commissioning of Solar System***	3.1	Determine parameters to be documented									
	3.2	Describe the scope of information needed to be documented									
	3.3	Explain the importance of documented information									
	3.4	Document appropriate information accordingly									
	3.5	Report documented information to appropriate authority									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 003:	**Teamwork**
Unit Reference Number:	**PWR/SPV/003/L3**
NSQ Level:	**3**
Credit Value:	**1**
Guided Learning Hours:	**10**

Unit Purpose:
This unit is aimed to impart into the learner, the necessary knowledge and skills required to develop team spirit and positive working relationship with the fellow workers in the work environment.

Unit Assessment Requirements/Evidence Requirement:
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Simulations are allowed in this unit and level.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Written/Oral Questions and Answers (QA).
3. Personal Statement
4. Work Product (WP)
5. Professional Discussions (PD)
6. Simulations

Unit 003: Team Work

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Know Positive/Negative working relationships with colleagues in a Work Environment***	1.1	Explain the need for developing positive working relationship with colleagues in a work environment									
	1.2	Explain the importance of relating with others in a way that makes them feel valued and respected									
	1.3	Support team members when one's services are requested									
	1.4	Report to the authorized personnel when request is made for assistance falling outside one's area of responsibility									
	1.5	Communicate information to colleagues about own work that might affect performance of others									
	1.6	Supervise team to ensure roles and responsibilities of the team members are appropriate									
LO 2: ***Know responsibilities within a team work***	2.1	Explain own role and responsibilities within the team for a group work.									
	2.2	Carry out individual tasks in a given group assignment in line with the team's rules and regulations									
	2.3	Participate actively in a given team work									
	2.4	Give own report of task carried out in a team									
	2.5	Give instructions to team members and ensure compliance									
LO 3: ***Comply with Policies and Regulations of Organization***	3.1	Carry out assigned tasks in a team in line with organizational standards									
	3.2	Use organizational code of practice for assigned job done in the team									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
	3.3	Obtain organizational code of conduct for own and team jobs									
	3.4	Explain the importance of using organizational code of conduct for own and team jobs									
	3.5	List rules that guide the activities of the team									
	3.6	Report activities of the team work that may affect organizational code of conduct to the higher authority									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 004: Solar PV System Components

Unit Reference Number: PWR/SPV/004/L3
NSQ Level: 3
Credit Value: 3
Guided Learning Hours: 30

Unit Purpose:
This unit standard specifies the competencies required in identifying Solar PV components
The unit standard is intended for those who want to work as Solar PV Installers

Unit Assessment Requirements/Evidence Requirements:
Assessment must be carried out in real workplace environment in which learning and human development is carried out

Assessment methods to be used include:

1. Direct Observations (DO).
2. Questions and Answers (QA).
3. Personal Statement
4. Work Product (WP)
5. Professional Discussions (PD)

Unit 004: Solar PV System Components

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO1: Know Solar-PV modules	1.1	Interpret the technical specifications and output characteristics of photovoltaic modules									
	1.2	Define the terms: Isc, Voc, Imp, Vmp, Pmax									
	1.3	State the factors which influence the output characteristics of Photovoltaic modules (irradiance, temperature, age)									
	1.4	Compare the advantages and disadvantages of Monocrystalline, Polycrystalline, and amorphous Photovoltaic modules for various applications, considering different installation needs and manufacturers' data.									
	1.5	Explain the effect on array output (current, voltage and power) of connecting modules in series and parallel configurations.									
	1.6	Explain the effects of using dissimilar modules in an array.									
	1.7	Analyze the impact of shading on a PV array.									
LO2: Know Solar-PV Charge Controller	2.1	Explain the operating principles of Pulse Width Modulated (PWM) Solar Charge Controllers.									
	2.2	Explain the operating principles of Maximum Power Point Tracker (MPPT) Solar Charge Controllers									
	2.3	Explain the role of each of the solar charge controller's features (low voltage cut-out, temperature compensation and load disconnect)									
	2.4	Explain the specifications, installation requirements and controls for a range of commercially available PWM and MPPT Solar Charge Controllers.									
LO 3: Know Solar-PV Battery Bank	3.1	Compare different battery technologies, such as lead-acid and lithium-ion; considering internal design, characteristics, reliability,									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
		safety, convenience, lifespan, and cost to make informed decisions on their suitability for various system requirements									
	3.2	Analyze the factors and manufacturers' data that impact the Lead-Acid battery performance									
	3.3	Analyze the factors and manufacturers' data that impact the Lithium-ion battery performance									
	3.4	Demonstrate the different techniques used to measure batteries bank capacity									
	3.5	Observe the battery bank installation requirements for safety and performance									
LO4: Configure Solar-PV Inverters	4.1	Explain the operating principles of Solar PV Inverters									
	4.2	Identify types of Inverters									
	4.3	Carry out Inverter-charger configuration									
	4.4	Describe the specifications, installation requirements and controls for a range of commercially available inverters.									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 005: Solar PV System Design and Installation

Unit Reference Number: PWR/SPV/005/L3
NSQ Level: 3
Credit Value: 4
Guided Learning Hours: 40

Unit Purpose:
The unit standard specifies the competencies required to design and install Solar PV system. The unit is intended for those who want to work as solar PV Installers.

Unit Requirements/Evidence Requirement
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Questions and Answers (QA).
3. Personal Statement
4. Work Product (WP)
5. Professional Discussions (PD)

Unit005: Solar PV System Design

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Know how to conduct a site Survey and Energy Audit	1.1	Conduct a visual inspection of the site to identify potential installation issues.									
	1.2	Verify that the site requirements for a Solar PV installation, including shading, wind loading and roof structural integrity									
	1.3	Conduct a site survey to determine the optimal location and orientation of the Solar PV System									
	1.4	Identify potential safety hazards and develop a plan to mitigate them									
	1.5	Conduct energy demand assessment and or energy audit									
LO 2: Know how to develop a Solar System Design	2.1	Review the Solar PV System design to ensure compliance with relevant regulations and standards									
	2.2	Evaluate customer's energy requirements for optimization of energy production									
	2.3	Investigate that all components design meet energy requirements									
LO 3: Conduct verification of executed System Installation	3.1	Check that the mounting structures are installed correctly and meet the manufacturer's specifications									
	3.2	Inspect the Solar PV systems connections to ensure they are installed correctly and meet the manufacturer's specifications									
	3.3	Verify that the Inverters are installed correctly and meet the manufacturer's specifications									
	3.4	Verify that the charge controllers are installed correctly and meet the manufacturer's specifications									
	3.5	Verify that the battery is installed correctly and meet the manufacturer's specifications									
	3.6	Identify potential component failures and develop a plan to correct them									
LO 4: Know how to review Solar PV	4.1	Conduct performance testing to ensure the solar PV system is									

LEARNING OBJECTIVE (LO) The learner will:		**PERFORMANCE CRITERIA The learner can:**	**Evidence Type**					**Evidence Ref. Page No.**			
Installation System Performance		operating at the expected efficiency									
	4.2	Verify that the system is producing the expected amount of energy									
	4.3	Check that the system is operating efficiently and fulfill safety measures									
	4.4	Identify gaps and/or potential component failures and develop a plan to correct them									
LO 5: Know how to prepare report and document all recommendations.		Generate a comprehensive installation report detailing the findings and identified gaps									
		Provide recommendations for corrective action to address any issues identified									
		Identify opportunities for system optimization and upgrading									
		Provide a plan for implementing the recommended corrective actions and system optimizations									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 006: Cost Estimate for Installing Solar Photovoltaic

Unit Reference Number: PWR/SPV/006/L3
NSQ Level: 3
Credit Value: 4
Guided Learning Hours: 40

Unit Purpose:
The unit standard specifies the competencies required in determining the cost estimate of installing Solar PV to the client.

This unit standard is intended for those who want to work as Solar PV System Installers.

Unit Assessment Requirements/Evidence Requirement:
Assessment must be carried out in real work place environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Questions and Answers (QA).
3. Personal Statement
4. Work Product (WP)
5. Professional Discussions (PD)

Unit 006: Cost estimate for Installing Solar PV

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Carry out site visit, data collection and Load Analysis	1.1	Conduct a site visit to assess the location, terrain, and existing infrastructure.									
	1.2	Collect data on the site's Solar irradiance, temperature and Wind Patterns.									
	1.3	Identify the required loads to be powered in the building									
	1.4	Estimate the total loads: • Resistive • Inductive									
	1.5	Estimate the energy requirement in kWh									
	1.6	Determine the appropriate inverter size									
	1.7	Determine appropriate Panels, Batteries and Charge controller sizes and quantities									
	1.8	Determine cables and accessories									
LO 2: Carry out Cost Estimation of components, accessories and materials	2.1	Carry out market survey on components, accessories and materials									
	2.2	Estimate the cost of materials, including Solar Panels, Inverters, mounting structures, and wiring etc.									
	2.3	Estimate the cost of labour, including the cost of workers, hours, and benefits									
	2.4	Estimate the cost of equipment and tools required for the installation									
	2.5	Estimate the cost of transportation and Logistics									
	2.6	Consider Value Added Tax (VAT)									
	2.7	Determine total cost estimate for the Solar PV System									
	2.8	Prepare budget proposal									
	2.9	Present budget proposal									
LO 3 Prepare project plan for PV Installation	3.1	Define the Project plan									
	3.2	Explain logistics in Project planning scheduling									
	3.3	Explain manpower management in project planning									
	3.4	Explain work scheduling in project planning									
	3.5	Explain time management in projects									

Learners Signature: Date:
Assessors Signature: Date:
IQA Signature (if sampled): Date:

EQA Signature (if sampled): Date:

Unit 007: Operation and Maintenance of Installed Solar Photovoltaic Systems

Unit Reference Number: PWR/SPV/007/L3
NSQ Level: 3
Credit Value: 4
Guided Learning Hours: 40

Unit Purpose:
The unit standard introduces and specifies the competencies required to operate and maintain solar PV Systems.

The unit is intended for those who want to work as Solar PV and power back-up operators and maintenance technicians.

Requirements/Evidence Requirement
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Questions and Answers (QA).
3. Personal Statement
4. Work Product (WP)
5. Professional Discussions (PD)

Unit 007: Operation and Maintenance of Installed Solar Photovoltaic Systems

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Execute operations of different Solar PV Systems	1.1	Apply safety in accordance with laid down procedures									
	1.2	Demonstrate procedure to switch 'ON' and switch 'OFF' a system									
	1.3	Outline the common cleaning procedures for: • Solar panels • Batteries • Inverter • Charge controller									
	1.4	Describe response procedures for the following faults: • Power failure with continuous inverter beeping • Continuous sound alarm/ visual display • Inverter tripping on normal load etc.									
	1.5	Describe the normal operation of the system according to specification and standard guidelines									
	1.6	Report fault findings to the appropriate authority									
	1.7	Select appropriate instrument to detect, isolate and repair faults									
LO 2: Know the maintenance on Solar PV Systems	2.1	Apply safety in accordance with laid down procedures									
	2.2	Analyze maintenance of Solar PV Systems									
	2.3	Discuss types of maintenance: • Predictive maintenance • Preventive maintenance • Corrective maintenance									
	2.4	State the difference between operation and maintenance									
	2.5	Identify ratings and specific locations of all connected loads									
	2.6	Explain components/systems warranties									
	2.7	Perform simple checks on fuse, Distribution Board (DB), MCB according to specifications and guidelines									
	2.8	Apply corrective actions to amend faults found through the checks									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
	2.9	Record findings and corrective actions on appropriate templates									
	2.10	Store records according to workshop policy									
LO 3: Know the tools used in maintenance of Solar PV system.	3.1	Describe tools/instruments used in battery maintenance: • Hydrometer • Battery Analyzer • Voltmeter • DC Clamp meter • Dummy load • Thermometer • Spanners • Screwdrivers • Grease • Distilled/Deionized water • Installation tape • Crimping kit etc.									
	3.2	Identify tools/ instruments used in modules, inverter, and charge controller maintenance: • AC/DC Voltmeter • AC/DC Clamp meter • Spanner • Screwdrivers • Air Blowers • Pliers/cutters • Installation tape • Crimping kit • Wire brush etc.									
	3.3	Describe proper procedures for handling different maintenance tools									
	3.4	Use appropriate tools in carrying out maintenance of Solar PV System									
LO 4: Perform relevant isolation procedure for maintenance	4.1	Carry out PV modules isolation									
	4.2	Carry out AC input/output isolation									
	4.3	Carry out battery bank isolation									
	4.4	Carry out inverter isolation									
	4.5	Carry out charge controller isolation									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 008:	**Testing and Commissioning of Solar PV System Installation**
Unit Reference Number:	**PWR/SPV/008/L3**
NSQ Level:	**3**
Credit Value:	**4**
Guided Learning Hours:	**40**

Unit Purpose:
The unit standard specifies the competencies required to test and commission Solar PV installation in accordance with laid down procedures. The unit is intended for those who want to work as solar PV Installers.

Prerequisite(s):
Level II

Unit Assessment Requirements/Evidence Requirement
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Questions and Answers (QA).
3. Personal Statement (PS)
4. Work Product (WP)
5. Professional Discussions (PD)

Unit 008: Testing and Commissioning of Solar PV System Installation

LEARNING OBJECTIVE (LO)The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Carryout testing of solar PV system	1.1	Apply safety measures in testing all parameters in accordance with laid down procedures									
	1.2	Explain the Importance of ground (Earth) connection									
	1.3	Explain the polarity test, continuity test, earth resistance test and insulation test									
	1.4	Select appropriate test instruments in accordance with specifications									
	1.5	Locate the position and condition of ground (Earth) connection									
	1.6	Locate the position and condition of lightening arrestor									
	1.7	Perform the following tests according to specifications and guidelines: • Polarity test • Continuity test • Earth resistance test • Insulation test									
LO 2: Record test results in accordance with laid down procedures	2.1	Apply safety and environmental measures in recording according to laid down procedures									
	2.2	Explain the importance of documentation in Solar PV installation									
	2.3	Outline the procedure for keeping records									
	2.4	Record and store test results as appropriate (in writing, pictorials, videos, analogue or digital)									
LO 3: Know the laid down procedures in project commissioning	3.1	Apply safety and environmental measures in commissioning a project according to laid down procedures									
	3.3	Outline the various types of project commissioning: • Check Specifications • Check Components compliance • Check performance compliance • Check installation • Check documentation • Maintain user Education									
	3.4	Explain the process of commissioning a Solar PV									
	3.5	Carry out safe and orderly handover of the project to the client									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 009:	**Troubleshooting Techniques in Solar Photovoltaic Systems**
Unit Reference Number:	**PWR/SPV/009/L3**
Level:	**3**
Credit Value:	**4**
Guided Learning Hours:	**40**

Unit Purpose:
The unit standard specifies the competencies required to identify faults and appropriate troubleshooting techniques used in solar PV Systems.

The unit is intended for those who want to work as solar PV System repairers.

Unit Assessment Requirements/Evidence Requirement
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Questions and Answers (QA).
3. Personal Statement
4. Work Product (WP)
5. Professional Discussions (PD)

Unit 009: Troubleshooting Techniques in Solar Photovoltaic Installation

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: Understand different types of troubleshooting techniques used in Solar PV	1.1	Differentiate between 'fault' and 'troubleshooting'									
	1.2	Explain the common faults/issues associated with Solar PV systems: • Battery Failure • Shading • Charge controller failure • Partial Contacts etc.									
	1.3	Discuss the effects of various faults on system performance as mentioned in 1.2 above									
	1.4	Explain the short circuit fault, open circuit fault and overload									
LO 2: Carry out relevant tests to detect faults in PV systems	2.1	Apply safety while locating faults in accordance with laid down procedures									
	2.2	Explain the importance of Interacting with clients to determine the nature of faults									
	2.3	Perform open circuit fault test, short circuit fault test, and overload test according to specifications and guidelines									
	2.4	Select appropriate instruments used for tracing faults in PV systems									
	2.5	Carry out tests to determine battery status									
	2.6	Carry out test on AC output voltage of the Inverter									
LO 3: Interpret System information	3.1	Discuss system information									
	3.2	Interpret symbols & their usefulness									
	3.3	Interpret manuals									
	3.4	Interpret system diagrams									
LO 4: Apply safe work habit and clean work environment	4.1	Identify safe access routes in the work environment									
	4.2	Ensure clean work environment at all time									
	4.3	Explain how to observe own safety and others in the work environment									
	4.4	Dispose all wastes appropriately to designated waste facilities									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

Unit 010: Entrepreneurship in Solar PV Installation

Unit Reference Number: PWR/SPV/010/L3
NSQ Level: 3
Credit Value: 5
Guided Learning Hours: 50

Unit Purpose:
The unit standard specifies the competencies required to demonstrate skills of entrepreneurship in solar PV installation.

The unit is intended for those who want to work as Solar PV Installers/Operators/Repairers/Vendors.

Unit Assessment/Evidence requirement
Assessment must be carried out in real workplace environment in which learning and human development is carried out.

Assessment methods to be used include:

1. Direct Observations (DO).
2. Questions and Answers (QA).
3. Personal Statement
4. Professional Discussions (PD)

UNIT 010: Entrepreneurship in Solar PV Installation

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
LO 1: ***Know the Fundamentals of Solar Market Opportunities***	1.1	Define Entrepreneurship									
	1.2	Analyze market trends, demand, and opportunities for Solar energy solutions in different sectors.									
	1.3	Identify key competitors with their different business models in the Solar industry.									
	1.4	Analyze policy frameworks, regulations and incentives affecting solar business									
LO 2: ***Develop a Sustainable Business Model for a Solar Energy Venture***	2.1	Explain a unique value proposition and target customer segments for a Solar business.									
	2.2	Identify key stakeholders, including suppliers, investors, Government agencies and develop partnerships									
	2.3	Develop a pricing strategy, financial plan, and revenue model for a Solar startup.									
	2.4	Create a business plan outlining operational, marketing, and sales strategies.									
	2.5	Develop an advertisement strategy that includes digital, print media and other available means									
LO 3: ***Implement Solar Project Financing and Investment Strategies***	3.1	Evaluate different financing options, including grants, loans, crowd funding and investor funding									
	3.2	Assess market evaluation for best supplier									
	3.3	Carry out risk assessment and mitigation strategies for Solar projects									
	3.4	Communicate solar business proposal to potential investors									
LO 4:	4.1	Develop a customer									

LEARNING OBJECTIVE (LO) The learner will:		PERFORMANCE CRITERIA The learner can:	Evidence Type					Evidence Ref. Page No.			
Manage Operations and Scaling up of Solar Energy Business		acquisition and retention strategy through digital marketing and community engagement									
	4.2	Execute consistent supply chain and logistics management for solar components									
	4.3	Maintain quality control, and after-sales support for customer retainer ship									
	4.4	Identify opportunities for scaling the business through referrers, new markets gateways, partnerships and technological advancements									

Learners Signature:	Date:
Assessors Signature:	Date:
IQA Signature (if sampled):	Date:
EQA Signature (if sampled):	Date:

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National Skills Qualifications

FOR

SOLAR PHOTOVOLTAIC SYSTEM INSTALLATION AND MAINTENANCE

LEVEL 1, 2 & 3

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