

**THE REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**SOLAR PHOTOVOLTAIC SYSTEM INSTALLATION TECHNOLOGY**

**KNQF LEVEL 4**

**PROGRAMME ISCED CODE: 0713 354A**

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# FOREWORD

Provision of quality education and training is fundamental to the Government’s overall strategy for socio-economic development. Quality education and training contribute to achievement focused on Kenya’s development blueprint and sustainable development goals.

Reforms in the education and training sector are necessary for achievement of Kenya Vision 2030 and meeting the provisions the Constitution of Kenya. The education sector had to be aligned to the Constitution and this resulted in formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 1 of 2019). A key feature of this policy is the change in the design and delivery of TVET training. This policy document requires that training in TVET be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery that allows for multiple entry and exit in TVET programs.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that this Curriculum has been developed.

It is my conviction that this curriculum will play a great role towards development of competent human resource for the Electrical Engineering sector’s growth and sustainable development.

**PRINCIPAL SECRETARY**

**STATE DEPARTMENT FOR TVET**

**MINISTRY OF EDUCATION**

**PREFACE**

Kenya Vision 2030 aims to transform the country into a newly industrializing, middle-income country providing high quality life to all its citizens by the year 2030. Kenya intends to create a globally competitive and adaptive human resource base to meet requirements of a rapidly industrializing economy through life-long education and training. TVET has a responsibility of facilitating the process of inculcating knowledge, skills and worker behaviour necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency Based Education and Training (CBET).

The Technical and Vocational Education and Training Act No. 29 of 2013 and the Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya, emphasized the need toreform curriculum development, assessment and certification. This called for a shift to CBET to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labour force.

This curriculum has been developed in adherence to the Kenya National Qualification Framework and CBETA standards and guidelines. The curriculum is designed and organized into Units of Learning with Learning Outcomes; suggested delivery methods, training/learning resources and methods of assessing the trainee’s achievement. The curriculum is competency-based and allows multiple entry and exit to the course.

I am grateful to the Council Members, Council Secretariat, NSSC, expert workers and all those who participated in the development of this curriculum.

# ACKNOWLEDGEMENT

This curriculum has been designed for competency-based training and has independent units of learning that allow the trainee flexibility in entry and exit. In developing the curriculum, significant involvement and support was received from industry and various organizations.

I appreciate National Electrical Engineering Sector Skills Committee who enabled the development of this curriculum. I recognize with appreciation the role of the SSC in ensuring that competencies required by the industry are addressed in this curriculum.

I also thank all stakeholders in the Electricity and Energy sector for their valuable input and all those who participated in the process of developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that workers in construction sector will acquire competencies that will enable them perform their work more efficiently.

**TABLE OF CONTENTS**

Contents

[FOREWORD 2](#_Toc194745161)

[ACKNOWLEDGEMENT 5](#_Toc194745162)

[ABBREVIATIONS AND ACRONYMS 7](#_Toc194745163)

[COURSE OVERVIEW 9](#_Toc194745164)

[Industrial attachment 9](#_Toc194745165)

[Entry Requirements 9](#_Toc194745166)

[MODULE ONE 11](#_Toc194745167)

[ELECTRICAL INSTALLATION 13](#_Toc194745168)

[DC SOLAR PV SYSTEMS 17](#_Toc194745169)

[SOLAR WATER PUMP SYSTEM INSTALLATION 22](#_Toc194745170)

[MODULE TWO 28](#_Toc194745171)

[ELECTRICAL INSTALLATION 29](#_Toc194745172)

[SOLAR PV SYSTEMS INSTALLATION 37](#_Toc194745173)

[SOLAR WATER PUMP SYSTEM INSTALLATION 44](#_Toc194745174)

# 

# ABBREVIATIONS AND ACRONYMS

BOQ Bill of Quantities

EHS Environment, Health and Safety

IET Institute of Electrical and electronics Engineers

KP Kenya Power

SOP Standard operating procedure

NCA National Construction Authority

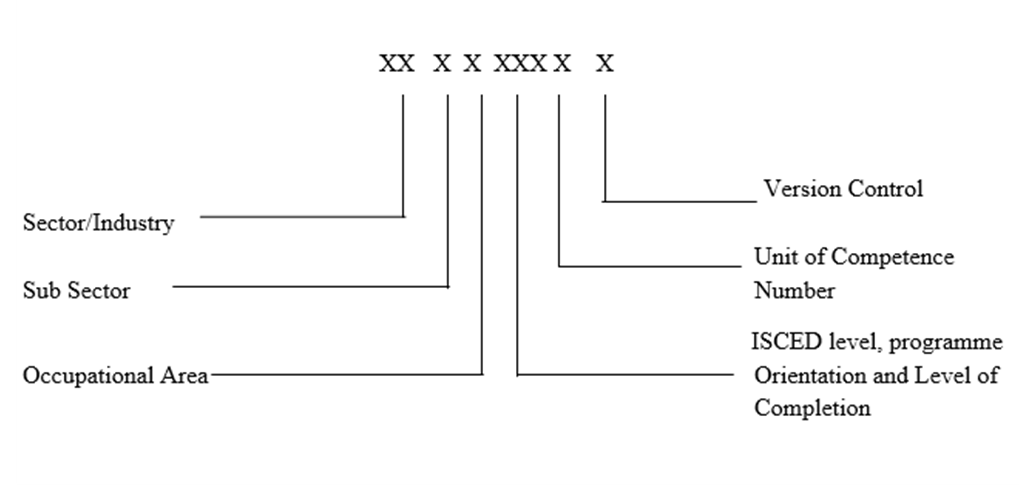
OSHA Occupational Safety and Health Act

PPE Personal Protective Equipment

PV Photo Voltaic

TVET Technical and Vocational Education and Training

**KEY TO UNIT CODE**



# COURSE OVERVIEW

Solar PV Installer Level 4 qualifications consist of competencies that an individual must achieve to perform solar installation activities. It involves performing Electrical installation, DC Solar PV Systems Installation, Solar Water Pump System Installation, Electrical installation, Solar PV systems, and Solar water pump system

**SUMMARY OF UNITS OF** **LEARNING**

|  |  |  |  |
| --- | --- | --- | --- |
| **MODULE ONE** | | | |
| **Unit Code** | **Units Title** | **Unit Duration (Hours)** | **Credit Factor** |
| 0713 251 01A | Electrical installation | 70 | 7.0 |
| 0713 251 02A | DC Solar PV Systems Installation | 70 | 7.0 |
| 0713 251 03 A | Solar Water Pump System Installation | 60 | 6.0 |
| **MODULE TWO** | | | |
| 0713 351 04A | Electrical installation | 140 | 14.0 |
| 0713 351 05A | Solar PV systems | 140 | 14.0 |
| 0713 351 06A | Solar water pump system | 120 | 12.0 |
| Industrial Attachment | | 320 | 32.0 |
| **GRAND TOTALS** | | **910** | **91.0** |

The core units of learning are independent of each other and may be taken independently.

The total duration of the **course is 910 hours** (30 weeks at 30 hours per week) inclusive of industrial attachment.

## Industrial attachment

An individual enrolled in this course will be required to undergo an industrial attachment in an Industry or Solar firm for a minimum period of 320 hours.

## Entry Requirements

An individual entering this course should have any of the following minimum requirements:

1. Kenya Certificate of Primary Education (KCPE)

**Or**

1. Equivalent qualifications as determined by relevant regulatory body

**Trainer Qualification**

Qualifications of a trainer for this course include:

1. Possession of at least Solar PV system installation level 5 or in related trade area;
2. License by TVETA; and
3. License by EBK/KETRB

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 320 hours in Solar PV sector. The industrial training may be taken after completion of all units for those pursuing the full qualification or be distributed equally in each unit for those pursuing part qualification. In the case of dual training model, industrial training shall be as guided by the dual training policy.

**Assessment**

The course shall be assessed formatively and summatively:

1. During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
2. Number of formative assessments shall minimally be equal to the number of elements in a unit of competency.
3. For qualification packs that commence at levels 3 or 4, assessments of modules 1 and 2 shall be in accordance with assessment guidelines for levels 3 and 4.
4. Theoretical and practical weighting for each unit of learning shall be 10 :90 for units in module 1 and module 2
5. Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score
6. For a candidate to be declared competent in a unit of competency, the candidate must meet the following conditions:
7. Obtained at least 40% in theory assessment in formative and summative assessments.
8. Obtained at least 60% in practical assessment in formative and summative assessment where applicable.
9. Obtained at least 50% in the weighted results between formative assessment and summative assessment where the former constitutes 60% and the latter 40% of the overall score.
10. Assessment performance rating for each unit of competency shall be as follows:

|  |  |
| --- | --- |
| **MARKS** | **COMPETENCE RATING** |
| 80 -100 | Attained Mastery |
| 65 - 79 | Proficient |
| 50 - 64 | Competent |
| 49 and below | Not Yet Competent |
| Y | Assessment Malpractice/irregularities |

1. Assessment for Recognition of Prior Learning (RPL) may lead to award of part and/or full qualification.

**Certification**

A candidate will be issued with a Certificate of Competency upon demonstration of competence in a core Unit of Competency. To attain the Kenya National TVET Certificate in Solar Photovoltaic System Installation TechnologyLevel 4, the candidate must demonstrate competence in all the Units of Competency as given in the qualification pack. Statement of Attainment certificate may be awarded upon demonstration of competence in certifiable element within a unit.

These certificates will be issued by ……… (QAI)

# MODULE ONE

**ELECTRICAL INSTALLATION**

**UNIT CODE: 0713 251 01A**

**UNIT DURATION: 70 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: performing electrical installation

**Unit Description**

This unit specifies competences required for performing electrical installation. The competences include identifying electrical installation components, installing electrical system and maintaining electrical installation.

**Summary of Learning Outcomes**

By the end of this unit of learning the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Identify electrical installation components | **20** |
|  | Install electrical system | **40** |
|  | Maintain electrical installation | **10** |
|  | **TOTAL** | **70** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify electrical installation components | * 1. Electrical symbols   2. Electrical Materials   3. Electrical routes | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 1. Install electrical system | * 1. Safety measures      1. PPE      2. Electrical hazards   2. Tools and equipment      1. Fixing tools      2. Cutting tools      3. Measuring tools e.g. Tape measure, Tri-square, Steel rule, Spirit level      4. Holding tools      5. Power tools      6. Multimeter   3. Materials      1. Cables      2. Lighting Accessories      3. Power accessories   4. Cable management system      1. Sheath/surface      2. PVC Conduits      3. Mini-Trunking   5. Protection devices      1. Circuit breakers      2. Fuses   6. Electrical circuits      1. Lighting circuit      2. Ring and radial circuits   7. Testing      1. Continuity      2. Polarity   8. Housekeeping practice      1. Waste disposal      2. Recycle      3. Reuse      4. Reduce | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 3. Maintain electrical installation | * 1. Electrical equipment and system Inspection   2. Materials and tools assembly   3. Maintenance   4. Maintenance reports | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |

**Suggested Methods of Instruction**

Practical

Projects

Demonstrations

Group discussion

Direct instructions

Field trips

On-job-training

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | * B. Scaddan Electrical installation work * J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | * IEEE regulation * BS3939 * NEMA regulations * OSHA * Occupational Safety and Health Act (OSHA) * National Environmental Management Authority (NEMA) regulations * IEEE regulations * EPRA regulation | 5 pcs | 1:5 |
|  | Charts | * Single line diagram * Circuit diagrams * Colour codes | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical cables | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Conduits and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Earth resistance meter |  | 5 pcs | 1:5 |
|  | Steel conduit bending machine |  | 2 pcs | 1:13 |
|  | Stocks & Dies |  | 5 pcs | 1:5 |
|  | Vices |  | 5 pcs | 1:5 |
|  | Bending spring |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Crocodile clips |  | 50 pcs | 2:1 |
|  | Mc4 clips |  | 50 pcs | 2:1 |
|  | Clamp clips |  | 50 pcs | 2:1 |
|  | Cable ties |  | 1250 pcs | 50:1 |
|  | Bolt and nuts |  | 150 pcs | 6:1 |
|  | Wall plug |  | 150 pcs | 6:1 |
|  | Work stations |  | 25 | 1:1 |
|  | Installation boards | 1.2 by 1m | 13 pcs | 1:2 |

## 

## DC SOLAR PV SYSTEMS

**UNIT CODE: 0713 251 02A**

**UNIT DURATION: 70 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: install DC solar PV systems

**Unit Description**

This unit covers competences required in installing solar PV systems. The competences include constructing DC solar PV support structures, installing DC solar PV system components and maintaining DC solar PV system

**Summary of Learning Outcomes**

By the end of this unit of learning the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Construct DC Solar PV support structures | **10** |
|  | Install DC Solar PV system components | **42** |
|  | Maintain DC Solar PV System | **10** |
|  | **TOTAL** | **62** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Construct DC Solar PV support structures | * 1. Safety procedures   2. Types of mounting structures      1. Solar roof system      2. Steel ground racks      3. Pole mounting   3. Solar PV batteries structures | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 2. Install DC Solar PV system components | * 1. Solar PV module      1. Mono crystalline      2. Poly crystalline      3. Amorphous      4. Single module up to 300 Wp.   2. Components of solar system mounting and installation      1. Charger controller      2. Solar batteries      3. Cables   3. Solar PV batteries      1. Maintenance free      2. Flooded type      3. Single battery 12V   4. Lay Electrical cables   5. Lightening arrestors installation      1. Earth Rod      2. Surge arrestor (SPD)   6. Housekeeping practice      1. Waste disposal      2. Recycle      3. Reuse      4. Reduce | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 3. Maintain solar PV system | * 1. Maintenance materials preparation   2. Maintenance      1. Cleaning the modules      2. Cleaning battery terminals      3. Applying jelly/grease on battery terminals      4. Checking states of electrolytes   3. Maintenance reports | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |

**Suggested Methods of Instruction**

Practical

Projects

Demonstrations

Group discussion

Direct instructions

Field trips

On-job-training

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | * B. Scaddan Electrical installation work * J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | * IEEE regulation * BS3939 * NEMA regulations * OSHA * Occupational Safety and Health Act (OSHA) * National Environmental Management Authority (NEMA) regulations * IEEE regulations * EPRA regulation | 5 pcs | 1:5 |
|  | Charts | * Single line diagram * Circuit diagrams * Colour codes | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical cables | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Conduits and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Earth resistance meter |  | 5 pcs | 1:5 |
|  | Steel conduit bending machine |  | 2 pcs | 1:13 |
|  | Stocks & Dies |  | 5 pcs | 1:5 |
|  | Vices |  | 5 pcs | 1:5 |
|  | Bending spring |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Crocodile clips |  | 50 pcs | 2:1 |
|  | Mc4 clips |  | 50 pcs | 2:1 |
|  | Clamp clips |  | 50 pcs | 2:1 |
|  | Cable ties |  | 1250 pcs | 50:1 |
|  | Bolt and nuts |  | 150 pcs | 6:1 |
|  | Wall plug |  | 150 pcs | 6:1 |
|  | Work stations |  | 25 | 1:1 |
|  | Installation boards | 1.2 by 1m | 13 pcs | 1:2 |

**SOLAR WATER PUMP SYSTEM INSTALLATION**

**UNIT CODE: 0713 251 03A**

**UNIT DURATION: 62 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: install solar PV water pump systems

**Unit Description**

This unit covers competences required in install solar water pump system. The competences include constructing solar PV module system support structures, installing solar water pump system components and maintaining solar water pump system.

**Summary of Learning Outcomes**

By the end of this unit of learning the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Construct Solar PV module system support structures | **10** |
|  | Install Solar PV water pump system components | **42** |
|  | Maintain solar PV water pump system | **10** |
|  | **TOTAL** | **62** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Construct Solar PV water pump system support structures | * 1. Safety procedures   2. Types of solar PV mounting structures  1. Solar roof system 2. Steel ground racks 3. Pole mounting    1. Solar PV water pump mounting structures design interpretation. | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 2. Install Solar water pump system component | * 1. Solar PV module mounting      1. Mono crystalline      2. Poly crystalline      3. Amorphous   2. Single panel up to 300 Wp   3. Solar PV water pump installation      1. Surface/submersible DC water pump   4. Cables joints   5. Lightening arrestor   6. Housekeeping practice      1. Waste disposal      2. Recycle      3. Reuse      4. Reduce | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 3. Maintain solar water pump system | * 1. Solar water pump Materials preparation      1. Cables      2. Cable ties      3. Accessories      4. Grease   2. Solar PV water pump system testing   3. Maintenance activities      1. Cleaning module      2. Removal of silt   4. Maintenance report preparation | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |

**Suggested Methods of Instruction**

Practical

Projects

Demonstrations

Group discussion

Direct instructions

Field trips

On-job-training

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | * B. Scaddan Electrical installation work * J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | * IEEE regulations * BS3939 * NEMA regulations * Occupational Safety and Health Act (OSHA) * National Environmental Management Authority (NEMA) regulations * EPRA regulation * PV system requirement refer KEBS Standards of 1673-1:2004 | 5 pcs | 1:5 |
|  | Charts | * Single line diagram * Circuit diagrams * Colour codes | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical wires | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Conduits and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Inclinometer |  | 5 pcs | 1:5 |
|  | Spanner |  | 5 pcs | 1:5 |
|  | cable lugs |  | 150 pcs | 6:1 |
|  | racks |  | 13 | 1:2 |
|  | solar spacer |  | 25 | 1:1 |
|  | mounting spacer |  | 25 | 1:1 |
|  | ground mount pipe caps |  | 50 pcs | 2:1 |
|  | solar panel cleaning kit |  | 13 | 1:2 |
|  | Locking tool clip |  | 13 | 1:2 |
|  | Permanent roof anchor |  | 13 | 1:2 |
|  | Mounting brackets |  | 13 | 1:2 |
|  | Crocodile clips |  | 50 pcs | 2:1 |
|  | Mc4 clips |  | 50 pcs | 2:1 |
|  | MC4 Climping tool |  | 5 pcs | 1:5 |
|  | Clamp clips |  | 50 pcs | 2:1 |
|  | Cable ties |  | 1250 pcs | 50:1 |
|  | Bolt and nuts |  | 150 pcs | 6:1 |
|  | Wall plug |  | 150 pcs | 6:1 |
|  | Ladder |  | 5 | 1:5 |
|  | Module mover |  | 5 | 1:5 |
|  | ballast block carrier |  | 5 | 1:5 |
|  | Thermal camera |  | 5 | 1:5 |
|  | Irradiance meter |  | 5 | 1:5 |
|  | Insulation resistance tester |  | 5 | 1:5 |
|  | Vent pipe cutter |  | 5 | 1:5 |
|  | Work stations |  | 25 | 1:1 |
|  | Installation boards | 1.2 by 1m | 13 pcs | 1:2 |

# MODULE TWO

## ELECTRICAL INSTALLATION

**UNIT CODE: 0713 351 04A**

**UNIT DURATION: 140 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform electrical installation

**Unit Description**

This unit specifies competences required for performing electrical installation. The competences include producing electrical drawings, interpreting electrical installation drawing, installing electrical system, testing electrical installation and maintaining electrical installation.

**Summary of Learning Outcomes**

By the end of this unit of learning the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Produce electrical drawings | **10** |
|  | Interpret electrical installation drawing | **30** |
|  | Install electrical system | **60** |
|  | Test electrical installation | **20** |
|  | Maintain electrical installation | **20** |
|  | **TOTAL** | **140** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Produce electrical drawings | * 1. Electrical symbols and abbreviations   2. Meaning of electrical drawings   3. Drawing of electrical diagrams e.g. block, schematic, circuit, line and wiring | * Practical demonstration * Projects * Written tests * Oral test |
| 1. Interpret electrical installation drawing | * 1. Wiring diagrams      1. Single line diagram         1. Intake point         2. Lighting plan         3. Power circuit   2.1.1.4 Change over switching   * + 1. Schematic diagram     2. Wiring diagram   1. Bill of quantities; | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Install electrical system | * 1. Safety; PPE, handling of equipment   2. Tools, equipment and materials   3.2.1 Cutting tools e.g. Hacksaws, Stripping knives, Side cutters, Pliers   * + 1. Fixing tools e.g. Assorted hammers, Assorted Screw drivers     2. Fastening tools e.g Assorted spanners and wrenches     3. Lifting and tensioning tools     4. Holding tools     5. Power tools     6. Multimeter     7. Cables     8. Accessories   1. Cable management systems      1. Cable duct      2. Steel Conduits      3. Trunking   2. Cable Termination techniques      1. Cable lugs      2. Cable glands      3. Cable joints i.e Tee joint, married joint, end twist, Britannia joint.   3. Earthing and protection systems      1. IT      2. TNC      3. TNS      4. TT      5. TNCS/PME/PEN/CNE      6. Circuit breakers      7. Fuses      8. ELCBs/RCD   4. Installation of final circuits      1. ***Special*** Lighting circuits      2. Power circuits   5. Housekeeping practices      1. Disposal of waste      2. Reusing      3. Recycling      4. Cleaning and storage of tools and equipment | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Test electrical installation | * 1. Definition of terms: inspection      1. Visual inspection:         1. Colour codes         2. Labelling         3. Damages         4. Termination   2. Electrical tests      1. Continuity test      2. Insulation resistance test      3. Polarity test   3. IEE Regulations | * Practical * Demonstration * Projects * Written tests * Oral Questioning |
| 1. Maintain electrical installation | * 1. Definition; maintenance; servicing; repair; fault, diagnosis/troubleshooting   2. Visual inspection:      1. Colour codes      2. Labelling      3. Damages      4. Termination   3. Importance of maintenance   4. Maintenance materials and tools      1. Hacksaws      2. Stripping knives      3. Side cutters      4. Pliers      5. Tape measure      6. Assorted hammers      7. Assorted Screw drivers      8. Assorted spanners and wrenches      9. Digital Multimeter      10. Phase tester   5. Cause of equipment failure   6. Maintenance activities      1. Faulty lamps      2. Faulty accessories      3. Types of Maintenance         1. Preventive Maintenance         2. Corrective Maintenance         3. Predictive Maintenance         4. Condition-Based Maintenance   7. Types of faults      1. Short circuits      2. Loose connections      3. Bad connections      4. Open circuits   8. Electrical tests      1. Continuity test      2. Insulation resistance test      3. Polarity test   9. Maintenance report      1. Repairs      2. Inspection      3. Maintenance task e.g preventive maintenance task      4. Test and maintenance report form | * Practical * Demonstration * Projects * Written tests * Oral Questioning |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions
6. Field trips
7. On-job-training

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | B. Scaddan Electrical installation work  J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | IEEE regulation  BS3939  NEMA regulations  OSHA | 5 pcs | 1:5 |
|  | Charts | Single line diagram  Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Laboratory | 100m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical wires | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Pipes and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Clamp meters |  | 5 pcs | 1:5 |
|  | Insulation resistance meter |  | 5 pcs | 1:5 |
|  | Earth resistance meter |  | 5 pcs | 1:5 |
|  | Stocks & Dies |  | 5 pcs | 1:5 |
|  | Vices |  | 5 pcs | 1:5 |
|  | Oscilloscope |  | 5 pcs | 1:5 |
|  | Pipe bending Machine |  | 5 pcs | 1:5 |
|  | Bending spring |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |
|  | Installation boards | 1.2 by 1m | 13 pcs | 1:2 |

## SOLAR PV SYSTEMS INSTALLATION

**UNIT CODE: 0713 351 05A**

**UNIT DURATION: 140 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: install solar PV systems

**Unit Description**

This unit covers the competences required in Install Solar PV Systems. Competences include; applying electrical concepts, constructing Solar PV support structures, installing Solar PV system components and maintaining solar PV system.

**Summary of Learning Outcomes**

By the end of this unit of learning the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Apply basic electrical concepts | **20** |
|  | Construct Solar PV support structures | **40** |
|  | Install Solar PV system component | **60** |
|  | Maintain solar PV system | **20** |
|  | **TOTAL** | **140** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply basic electrical concepts | * 1. The meaning of SI unit   2. SI unit of various types of Electrical parameters      1. Power – Watts (W)      2. Current – Amperes (A)      3. Resistance – Ohms(Ω)      4. Voltage – Volts (V)   3. Identification of Quantities of Charge, force, work and power   4. Ohm’s law   5. Calculations involving parallel and series circuits   6. Calculations involving various Electrical parameters e.g. Power, Current, Voltage, Resistance | * Practical demonstration * Projects * Written tests   Oral test |
| 1. Construct Solar PV support structures | * 1. Safety Procedures   2. Tools and equipment      1. Hydrometer      2. Inclinometer      3. Compass   3. Types of mounting structures      1. Rooftop      2. Ground      3. Solar roof system      4. Steel ground racks      5. Pole mounting   4. Solar PV Battery structures | * Practical * demonstration * Projects * Written tests * Oral Questioning |
| 1. Install Solar PV system components | * 1. Planning to install   2. Pre-installation checks   3. Solar Panel Mounting positioning   4. security of the panels   5. Methods of solar panel connection      1. Parallel and series   6. Components of solar system mounting and installation      1. Charger controller      2. Inverters      3. Solar batteries e.g Maintenance free, Flooded type, Series connection up to 24v/1000wp, Parallel connection up to 24v/1000wp, Series-parallel connection up to 24v/1000wp   7. Cables   8. Lay Electrical cables      1. Cable laying tools      2. Cable segregation      3. Cable labelling   9. Mount Solar panel      1. Installation of Solar panel         1. Slanting angle/tilt angle         2. Panel Ratings   10. Terminate solar Electrical cables       1. Meaning of terms       2. Cable lugging       3. Solar Cable connectors   11. Lightening arrestors base installation       1. Rod gap arrester       2. Earth Rod       3. Surge arrestor (SPD)   12. Housekeeping       1. Waste disposal       2. Recycle       3. Reuse       4. Reduce | * Practical * demonstration * Projects * Written tests * Oral Questioning |
| 1. Maintain solar PV system | * 1. Materials e.g pure water, soft bristle brushes, microfiber cloths or sponges, calcium, grease   2. Tests      1. Continuity test      2. Insulation resistance test      3. Polarity test      4. Short circuit systems (Isc)      5. Open circuit voltage (Voc)      6. Battery voltage and current   3. Maintenance of;      1. Solar modules      2. Solar batteries maintenance      3. Inverter maintenance      4. Charge controller maintenance   4. Maintenance records      1. Maintenance checklist      2. Maintenance reports | * Practical * demonstration * Projects * Written tests * Oral Questioning |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions
6. Field trips
7. On-job-training

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Solar Electric Handbook by Solar energy International  B. Scaddan Electrical installation work  J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | Solar PV manuals | 5 pcs | 1:5 |
|  | Charts | Single line diagram  Solar PV layout  Circuit diagrams  Colour codes | 1 pc for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Laboratory | 100m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical wires | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Solar Panels |  | 10 | 1:3 |
|  | Charge controller |  | 10 | 1:3 |
|  | Batteries |  | 10 | 1:3 |
|  | Inverter |  | 10 | 1:3 |
|  | Mounting racks |  | 10 | 1:3 |
|  | Pipes and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
|  | Materials and supplies | Clamp clips,Cable ties, Conduits, Bolt and nuts, Wall plug, Mounting brackets, cable lugs, racks, solar spacer, mounting spacer, ground mount pipe caps, cleaning kit, Locking tool clip, Permanent roof anchor | 10 | 1:3 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | MC4 Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Irradiance meter |  | 5 pcs | 1:5 |
|  | Insulation resistance tester |  | 5 pcs | 1:5 |
|  | Polarity tester |  | 5 pcs | 1:5 |
|  | Clamp meter |  | 5 pcs | 1:5 |
|  | Thermal camera |  | 5 pcs | 1:5 |
|  | Inclinometer |  | 5 pcs | 1:5 |
|  | Ladder |  | 5 pcs | 1:5 |
|  | ballast block carrier |  | 5 pcs | 1:5 |
|  | Module mover |  | 5 pcs | 1:5 |
|  | Vent pipe cutter |  | 5 pcs | 1:5 |
|  | Flat pry bar |  | 5 pcs | 1:5 |
|  | Battery operated drill |  | 5 pcs | 1:5 |
|  | Safety harness |  | 25 pcs | 1:1 |

## SOLAR WATER PUMP SYSTEM INSTALLATION

**UNIT CODE: 0713 351 06A**

**UNIT DURATION: 120 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: install solar water pump systems

**Unit Description**

This unit covers the competences required in Install Solar Water Pump System. Competences include; managing electrical workshop, constructing Solar PV module system support structures, installing Solar water pump system components, maintaining solar water pump system.

**Summary of Learning Outcomes**

By the end of this unit of learning the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Manage electrical workshop | **10** |
|  | Construct Solar PV module system support structures | **40** |
|  | Install Solar water pump system components | **60** |
|  | Maintain solar water pump system | **10** |
|  | **TOTAL** | **120** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Manage electrical workshop | 1.1. Health and safety procedures   * + 1. Safety measures.     2. Relevant clauses in appropriate Acts e.g.     3. Occupational safety and health act (OSHA)     4. Work injury benefits act (WIBA)     5. Safety Regulations and procedures     6. PPEs     7. First Aid     8. Relevant regulations e.g. IEE regulations     9. Common hazards and sources of danger e.g. burns, cuts, electric shock, falling from heights, falling objects, noise, dust, chemicals   1. Electrical workshop records e.g.      1. Inventory      2. Duty schedule      3. Maintenance schedule, etc.   2. Storage of Tools, equipment and materials | * Practical demonstration * Projects * Written tests * Oral test |
| 1. Construct Solar PV module system support structures | * 1. Solar PV modules e.g Mono crystalline, Poly crystalline, Amorphous      1. Solar PV connections e.g Series connection up to 1000 wp      2. Parallel connection up to 1000 wp      3. Series-parallel connection up to 1000 wp   2. Types of mounting structures      1. Rooftop      2. Ground      3. Solar roof system      4. Steel ground racks      5. Pole mounting   3. Solar PV water pump mounting structures e.g ground mount systems, top of pull mount, scalable ground mount | * Practical * demonstration * Projects * Written tests * Oral Questioning |
| 1. Install Solar PV pump system components | * 1. Solar PV module mounting      1. Flat roof mounting      2. roof hook      3. Water proof carport      4. Packing canopy      5. Ground mounting   2. Solar pumping system      1. Module      2. PV pump inverter      3. Pumps and motors; ac and dc   3. Types of single-phase pump systems      1. Submersible pump      2. Floating pumps      3. Surface pumps   4. Lightening arrestor; components of lightening arrestors, importance of lightening arrestors   5. Housekeeping      1. Waste disposal      2. Recycle      3. Reuse      4. Reduce | * Practical * demonstration * Projects * Written tests * Oral Questioning |
| 1. Maintain solar water pump system | * 1. Tests      1. Continuity test      2. Insulation resistance test      3. Polarity test      4. Short circuit systems (Isc)      5. Open circuit voltage (Voc)      6. Irradiance meter   2. Maintenance is carried out as per IET regulations   3. Maintenance records      1. Maintenance checklist      2. Maintenance reports | * Practical demonstration * Projects * Written tests * Oral Questioning |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions
6. Field trips
7. On-job-training

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Solar Electric Handbook by Solar energy International  B. Scaddan Electrical installation work  J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | Solar PV manuals | 5 pcs | 1:5 |
|  | Charts | Single line diagram  Solar PV layout  Circuit diagrams  Colour codes | 1 pc for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Laboratory | 100m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical wires | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Solar Panels |  | 10 | 1:3 |
|  | Charge controller |  | 10 | 1:3 |
|  | Batteries |  | 10 | 1:3 |
|  | Inverter |  | 10 | 1:3 |
|  | Mounting racks |  | 10 | 1:3 |
|  | Pipes and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
|  | Materials and supplies | Clamp clips,Cable ties, Conduits, Bolt and nuts, Wall plug, Mounting brackets, cable lugs, racks, solar spacer, mounting spacer, ground mount pipe caps, cleaning kit, Locking tool clip, Permanent roof anchor | 10 | 1:3 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | MC4 Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Irradiance meter |  | 5 pcs | 1:5 |
|  | Insulation resistance tester |  | 5 pcs | 1:5 |
|  | Polarity tester |  | 5 pcs | 1:5 |
|  | Clamp meter |  | 5 pcs | 1:5 |
|  | Thermal camera |  | 5 pcs | 1:5 |
|  | Inclinometer |  | 5 pcs | 1:5 |
|  | Ladder |  | 5 pcs | 1:5 |
|  | ballast block carrier |  | 5 pcs | 1:5 |
|  | Module mover |  | 5 pcs | 1:5 |
|  | Vent pipe cutter |  | 5 pcs | 1:5 |
|  | Flat pry bar |  | 5 pcs | 1:5 |
|  | Battery operated drill |  | 5 pcs | 1:5 |
|  | Safety harness |  | 25 pcs | 1:1 |