

**THE REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**SOLAR PV SYSTEM INSTALLATION**

**KNQF LEVEL 3**

**PROGRAMME ISCED CODE: 0713 254 A**

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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.

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# 

# ABBREVIATIONS AND ACRONYMS

CAD Computer Aided Design

IEEE Institute of Electrical and electronics Engineers

KEBS Kenya Bureau of Standards

PPE Personal Protective Equipment

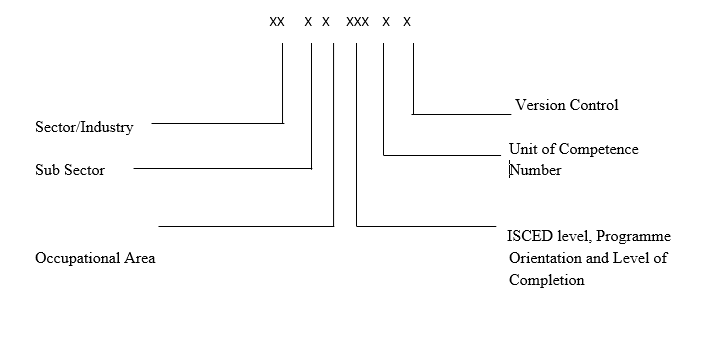
PV Photo Voltaic

TVET Technical and Vocational Education and Training

CV Curriculum Vitae

BS British Standard

**KEY TO UNIT CODE**



# COURSE OVERVIEW

This Solar PV Installer Level 3 curriculum consists of competencies that an individual must achieve to perform solar installation activities. It involves performing Electrical installation, DC Solar PV Systems Installation, and Solar Water Pump System Installation

# Summary of Units of Learning

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Units Title** | **Unit Duration (Hours)** | **Credit Factor** |
| 0713 251 03A | Electrical installation | 70 | 7.0 |
| 0713 251 04A | DC Solar PV Systems Installation | 70 | 7.0 |
| 0713 251 05 A | Solar Water Pump System Installation | 60 | 6.0 |
| **Industrial Attachment** | | 240 | 24 |
| **GRAND TOTAL** | | **440** | **44** |

The total duration of the **course is 440 hours** (14 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 a Solar firm for a period of at least 240 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 TVETA

**Trainer Qualification**

Qualifications of a trainer for this course include:

1. Possession of at least solar PV system. 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 240 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 summative:

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
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 Kenya National TVET Certificate in Solar PV System Installation Level 3 certificate, 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 Qualification Awarding Institution

**ELECTRICAL INSTALLATION**

**UNIT CODE: 0713 251 04A**

**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. Safety measures      1. PPE      2. Electrical hazards   2. Electrical symbols   3. Electrical Materials   4. Electrical routes | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 1. Install electrical system | * 1. Tools and equipment      1. Fixing tools      2. Cutting tools      3. Measuring tools e.g. Tape measure, Tri-square, Steel rule, Spirit level   2. Holding tools      1. Power tools      2. Multimeter   3. Materials      1. Cables   4. Lighting Accessories   5. Power accessories   6. Cable management system      1. Sheath/surface      2. PVC Conduits      3. Mini-Trunking   7. Protection devices      1. Circuit breakers      2. Fuses   8. Electrical circuits      1. Lighting circuit      2. Ring and radial circuits   9. Testing      1. Continuity      2. Polarity   10. 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 of materials and tools 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 05A**

**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 | **20** |
|  | Install DC Solar PV system components | **40** |
|  | Maintain DC Solar PV System | **10** |
|  | **TOTAL** | **70** |

**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 |
| 1. 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 |
| 1. 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 06A**

**UNIT DURATION: 60 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 | **40** |
|  | Maintain solar PV water pump system | **10** |
|  | **TOTAL** | **60** |

**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 |
| 1. 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 |
| 1. 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 |