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BUILDING ELECTRICIAN SOLAR PV SYSTEM TECHNICIAN

CBT Curriculum

National Vocational Certificate Level 4

Version 1 - January 2020

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A black and white photograph of a man in a plaid shirt leaning over a workbench, working on two solar panels. The panels are mounted on a stand, and the man is using a tool to work on the wiring or components of the panels. The background is a simple curtain.

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Table of Contents

1. Introduction.....	3
1.1 . Purpose of the Training Program:	4
1.2 . Overall objectives of training program.....	4
1.3 . Competencies to be gained after completion of course	5
1.5. Minimum qualification for teachers	9
1.6. Medium of instruction	9
1.7. Duration of the course:.....	9
1.8. Description and structure of the course	10
2. Overview of the Curriculum for Solar PV System Technician	11
3. Solar PV System Technician	14
Module – 1: Conduct site assessment for Solar PV system installation.....	14
Module – 2: Develop Basic Solar PV system design.....	16
Module – 3: Interpret job document.....	18
Module – 4: Install Solar PV System	20
Module – 5: Perform Wiring of Solar PV System	23
Module – 6: Troubleshoot Solar PV System	26
Module – 7: Maintain Solar PV system	28
Module – 8: Adopt Safety Precautions.....	31
Module – 9: Develop basic professional skills	33



NVQs for Building Electrician - Solar PV System Technician



4. List of Tools and Equipment.....	36
5. Members of the Curriculum Development Committee.	47



1. Introduction

Solar energy has been making headlines across the world for the last few years. The global installed capacity of solar photovoltaic (PV), also termed solar cells, has grown from 5 GW to more than 400 GW. This phenomenal success owes to wide ranging factors; most importantly, conducive policies, technological advancements and economy of scale. Solar PV system is now becoming financially competitive with conventional forms of power generation. Dubai, for example, is currently developing an 800 MW through solar PV project with a power purchase agreement signed at less than three US cents per kW hour.

Solar radiation, or level of sunshine, is the resource or fuel for solar energy systems. Accurate measurement and analysis of this resource are fundamental to achieve the anticipated performance. However, there are other important parameters that also need to be taken into account to predict and evaluate a system's performance and this is often where mistakes are made.

The solar industry of Pakistan has nearly doubled in size every year for the past five years, and this trend is expected to continue in future, so there are opportunities for how to become a Solar PV Technician.

Solar PV System Technician determines the design of the array and performs the installations. The process to become a Solar PV System Technician mostly depends on where an individual want to install residential solar systems. Internationally becoming a solar energy professional sometimes requires a license specific to solar PV instalment. Pakistan regulates its own solar installation and safety processes, it might be different from other world rules and regulations, hence required no license but a certificate in this qualification can provide ample of employment opportunities.

The qualification of Building Electrician – Solar PV System Technician is developed based on solar energy sector's demand on the pattern of competency based training under national vocational qualification framework (NVQF). It carries a learning volume of 700 hours i.e. 6 hours per day and five days a week means 30 weeks which is almost 6 months and four months is recommended as internship.

Solar PV System Technician plays a vital role in the installation and maintenance of Solar PV System and Electrical appliances. The increased use of solar energy has maximized the demand of Solar PV Technician having the skills to install and maintain solar photovoltaic systems, thus, meeting the



NVQs for Building Electrician - Solar PV System Technician



Ever-growing demand of industry. This course has been design and developed to achieve its objectives of providing appropriate skills. The pass out of this course would be able to:

- Work in small & big construction units as Solar PV Technician
- Work as building electrician in an electrical outfit / company / organization.
- Work as building electrician with construction contractor.
- be self employed by having own electrical / wiring workshop

1.1. Purpose of the Training Program:

The purpose of the training is to provide skilled manpower to improve the existing solar PV system related industry. This will improve the quality of solar PV system technician in terms of consumer's acceptability and willingness in Pakistan. The availability of such quality of technician in the local and international markets will ultimately bring economic benefits to the producers and processors.

The core purpose of this qualification is to produce employable Building Electrician with solar PV system, who could provide advanced installation and maintenance services of solar PV system, including off-grid solar photovoltaic (PV) system installation. In addition, this qualification will prepare unemployable youth to employee in construction industry or as an entrepreneur. To prepare and train students through skill training and enabling them to earn their living either through employment in industry or be self-employed as an electrician.

1.2. Overall objectives of training program

Solar PV System Technician qualification consists of theoretical and practical details required for the conduct of assessment survey, PV System installation, troubleshooting and maintenance of solar photovoltaic and UPS systems. The main objectives of the qualification are as follows:



NVQs for Building Electrician - Solar PV System Technician



Conduct site assessment for Solar PV system installation

Develop basic solar PV system design

Interpret job document

Install Solar PV System

Perform Solar PV System Wiring

Troubleshoot Solar PV System

Maintain Solar PV system

Perform Safety measure during electric work

Develop basic Entrepreneurial skills.

1.3. Competencies to be gained after completion of course

The detail of the competency standards included in this qualifications given below:

- **National Vocational Certificate level 1, in (Electrical Technology) “Building Electrician - Solar PV System Technician”**
 - A. Maintain safety, health and cleanliness
 - B. Communicate in different work contexts
 - C. Apply a problem solving method
 - D. Apply basic reading, writing and speaking skills in English in different life contexts
 - E. Apply basic numeracy skills in different life contexts
 - F. Demonstrate positive workplace attitude and behaviors.
 - G. Carry out maintenance procedures as Building Electrician (Helper)
 - H. Produce a plan for career options related to a Building Electrician



NVQs for Building Electrician - Solar PV System Technician



- **National Vocational Certificate level 2, in (Electrical Technology) “Building Electrician - Solar PV System Technician”**
 - A. Maintain workplace safety
 - B. Apply continuing professional development
 - C. Perform preventive maintenance as part of electrical operations
 - D. Perform corrective maintenance as part of electrical operations E.
 - Test electrical and electronic parameters
 - F. Install solar panel
 - G. Assemble electrical appliances
 - H. Perform installation of electrical products and appliances
 - I. Install domestic wiring
 - J. Use and maintain electrical tools and equipment
 - K. Solar PV Fundamentals
 - L. Off-grid Solar PV Systems with battery storage
 - M. Operation and maintenance of off-grid solar PV systems
- **National Vocational Certificate level 3, in (Electrical Technology) “Building Electrician - Solar PV System Technician”.**
 - A. Apply knowledge of entrepreneurial ideas.
 - B. Plan work and calculate cost.
 - C. Install three-phase wiring
 - D. Perform distribution of electrical supply
 - E. Perform corrective maintenance as part of electrical operations
 - F. Designing and installation of off-grid solar PV systems.



NVQs for Building Electrician - Solar PV System Technician



- **National Vocational Certificate level 4, in (Electrical Technology) “Building Electrician - Solar PV System Technician”**
 - A. Conduct site assessment for solar PV installation
 - B. Develop basic solar PV system design
 - C. Interpret job document
 - D. Install solar PV system
 - E. Perform PV system wiring
 - F. Troubleshoot Solar PV system
 - G. Maintain solar PV system
 - H. Adopt safety precautions
 - I. Develop basic entrepreneurial skills



NVQs for Building Electrician - Solar PV System Technician



1.4. Entry level of trainees

The entry for National Vocational Certificate level 1-4, in (Electrical Technology) “Building Electrician - Solar PV System Technician” are given below:

Title	Entry requirements
National Vocational Certificate level 1, in (Electrical Technology) “Building Electrician - Solar PV System Technician”	Entry for assessment for this qualification is open. However, entry into formal training institutes, based on this qualification may require skills and knowledge equivalent to matric (Grade 10) with some working knowledge of this field.
National Vocational Certificate level 2, in (Electrical Technology) “Building Electrician - Solar PV System Technician”	Entry for assessment for this qualification is open. However entry into formal training institute for this qualification is person having National Vocational Certificate level 1, in (Electrical Technology) “Building Electrician - Solar PV System Technician”.
National Vocational Certificate level 3, in (Electrical Technology) “Building Electrician - Solar PV System Technician”	Entry for assessment for this qualification is open. However, entry into formal training institute for this qualification is person having National Vocational Certificate level 2, in (Electrical Technology) “Building Electrician - Solar PV System Technician”. In addition to this the person must have matriculation with fundamental knowledge of electricity and electronics can also apply. In addition to this he/she must be computer literate and have knowledge of basic concepts of electricity and electronics.
National Vocational Certificate level 4, in (Electrical Technology) “Building Electrician - Solar PV System Technician”	Entry for assessment for this qualification is open. However, entry into formal training institute for this qualification is person having National Vocational Certificate level 3, in (Electrical Technology) “Building Electrician - Solar PV System Technician”. In addition to this the person must have matriculation with fundamental knowledge of electricity and electronics can also apply. In addition to this he/she must be computer literate and have knowledge of basic concepts of solar PV system.



1.5. Minimum qualification for teachers

- Should have completed intermediate and equivalent qualifications
- Must be a holder of G II certificate or Three years DAE in Electrical or Electronics Technology.
- Must be able to communicate effectively both orally and in written form.
- Must have at least two (4) years teaching experience.

1.6. Medium of instruction

Urdu, local language

1.7. Duration of the course:

The proposed curriculum is composed of 9 modules that will be covered in **700 hours**. It is proposed that the course may be delivered in 8 months' period.

The distribution of contact hours is given below:

Total	700 hours
Theory	161 hours (23%)
Practical	539 hours (77%)



1.8. Description and structure of the course

Following is the structure of the course:

Module #	Title	Theory (hours)	Practical (hours)	Total (hour)	Credits hours	Level	Category
1	Conduct site assessment for solar PV installation	18	32	50	05	4	Technical
2	Develop basic solar PV system design	20	70	90	09	4	Technical
3	Interpret job document	18	32	50	05	4	Technical
4	Install solar PV system	28	72	100	10	4	Functional
5	Perform PV system wiring	20	60	80	08	4	Technical
6	Troubleshoot Solar PV system	16	54	70	07	4	Technical
7	Maintain solar PV system	13	87	100	10	4	Technical
8	Adopt safety precautions	06	54	60	06	4	Functional
9	Develop basic entrepreneurial skills	22	78	100	10	4	Generic
	TOTAL	161	539	700	70		



2. Overview of the Curriculum for Solar PV System Technician

Module Title and Aim	Learning Units	Theory Days/hours	Workplace Days/hours	Timeframe of modules
Module 1: Conduct site assessment for Solar PV system installation	LU-1: Carryout load assessment LU-2: Perform shadow analysis. LU-3: Estimate wiring requirements LU-4: Identify the south direction for mounting structure.	18	32	50
Module 2: Develop basic Solar PV system design	LU-1: Calculate load for solar PV system design LU-2: Assess working schedule of load LU-3: Select Panels LU-4: Determine backup time. LU-5: Draw basic design of solar PV System	20	70	90
Module 3: Interpret job document	LU-1: Prepare checklist for job LU-2: Interpret schematic diagram LU-3: Record the data LU-4: Prepare log sheet for general maintenance	18	32	50



NVQs for Building Electrician - Solar PV System Technician



Module 4: Install Solar PV System	LU-1: Arrange required tools and equipment LU-2: Perform PV test LU-3: Erect the mounting structure LU-4: Fix PV modules as per circuit design LU-5: Install Battery Bank LU-6: Install inverter/charge controller/variable frequency drive (VFD) LU-7: Install Solar PV Pumps LU-8: Connect the PV modules as per circuit design	28	72	100
Module 5: Perform Solar PV System Wiring	LU-1: Interpret wiring diagram LU-2: Connect the PV modules as per circuit diagram LU-3: Lay Cables LU-4: Perform wiring test LU-5: Carry out battery test LU-6: Interconnect the PV system LU-7: Configure the inverter / charge controller	20	60	80
Module 6: Troubleshoot Solar PV System	LU-1: Diagnose the fault LU-2: Identify solution of the faults LU-3: Rectify the faults LU-4: Carryout post rectification function test LU-5: Perform wiring tests	16	54	70
Module 7: Maintain Solar PV system	LU-1: Prepare check list for maintenance LU-2: Follow routine maintenance log sheet LU-3: Maintain Solar PV modules LU-4: Maintain inverter/Charge controller/Protection circuits LU-5: Maintain battery bank LU-6: Perform post verification function of the system	13	87	100
Module 8: Adopt Safety Precautions	LU-1: Ensure Personal safety LU-2: Ensure workplace safety. LU-3: Ensure safety of tools and equipment	06	54	60



NVQs for Building Electrician - Solar PV System Technician



Module 9: Develop basic Entrepreneurial skills	LU-1: Develop basic computer operating skills			
	LU-2: Develop basic communication skills.			
	LU-3: Develop basic marketing skills			
	LU-4: Identify needs of the market.			
	LU-5: Follow Environmental, Health and Safety standards.			
TOTAL		134	536	670



BUILDING ELECTRICIAN SOLAR PV SYSTEM TECHNICIAN

CBT Curriculum

National Vocational
Certificate Level 4

Version 1 - January 2020

Module-1



3. Solar PV System Technician

Module – 1: Conduct site assessment for Solar PV system installation

Objective: This module covers the skills and knowledge required to carry out load assessment, perform shadow analysis, Estimate wiring requirements and identify the south direction for mounting structure.

Duration: 50 Hrs.

Theory: 18

Practice: 32

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU-1: Carryout load assessment	Trainee will be able to: <ul style="list-style-type: none"> Determine nature of load Identify rating of load Measure running load Calculate the load 	<ul style="list-style-type: none"> Types of Load. Specification of various Loads. Types of measuring instruments. Working principle of measuring instruments. Measuring techniques and Parameters of various loads. 	Theory: 04 Practice: 08 Total: 12		Class room Lab
LU-2: Perform shadow analysis	Trainee will be able to: <ul style="list-style-type: none"> Conduct physical visit of the site Identify path of the shadow Use shadow detector Enquire about future developmental prospects 	<ul style="list-style-type: none"> Interpret site maps. Use of different path identification tools. Techniques for site maps preparation. 	Theory: 04 Practice: 09 Total: 13		Class room Lab



NVQs for Building Electrician - Solar PV System Technician



LU-3: Estimate wiring requirements	Trainee will be able to: <ul style="list-style-type: none"> • Observe existing condition of wiring • Workout length of the wire • Select appropriate size of the wire • Select appropriate type of the wire. • Figure out required safety and control devices. 	<ul style="list-style-type: none"> • Types of wiring. • Interpretation of wiring diagrams. • Wiring specifications (Size and types of cable). • Types of Safety and control devices. • Functions of different safety and control devices. • Optimization techniques for wiring essential. 	Theory: 06 Practice: 09 Total: 15		Class room Lab
LU-4: Identify the south direction for mounting structure	Trainee will be able to: <ul style="list-style-type: none"> • Observe the location • Point out south direction by using compass 	<ul style="list-style-type: none"> • Use of Compass and GPS. • Direction description Methods 	Theory: 04 Practice: 06 Total: 10		Class room Lab



BUILDING ELECTRICIAN SOLAR PV SYSTEM TECHNICIAN

CBT Curriculum

National Vocational
Certificate Level 4

Version 1 - January 2020

Module-2



Module – 2: Develop Basic Solar PV system design

Objective: This module covers the skills and knowledge required to calculate load for solar PV system design, assess working schedule of load, Select Panels, determine backup time and Draw basic design of solar PV System

Duration: 90 Hrs.

Theory: 20

Practice: 70

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU-1: Calculate load for solar PV system design	Trainee will be able to: <ul style="list-style-type: none"> Enlist the No. of appliances Measure the PV system load Calculate the PV system load Record the PV system load. 	<ul style="list-style-type: none"> Types of appliances and their respective load. Sizing and compatibility of inverter. Load Calculation. 	Theory: 04 Practice: 14 Total: 18		Class room Lab
LU-2: Assess working schedule of load	Trainee will be able to: <ul style="list-style-type: none"> Inquire the load duty hours from customer Determine the peak load hours Observe peak sun hours. 	<ul style="list-style-type: none"> Base load hours. Peak sun hours. Peak load hours. Irradiance intensity estimation. Using instruments and/or empirical formula. 	Theory: 04 Practice: 14 Total: 18		Class room Lab
LU-3: Select Panels	Trainee will be able to: <ul style="list-style-type: none"> Select the type of PV panel Determine the capacity of PV solar panel Select number of PV solar panel 	<ul style="list-style-type: none"> Types of PV Module. Specification of PV Module. Size of PV Module Capacity of PV Module. 	Theory: 04 Practice: 14 Total: 18		Class room Lab



NVQs for Building Electrician - Solar PV System Technician



LU-4: Determine backup time	Trainee will be able to: <ul style="list-style-type: none"> Estimate the required backup time of load Estimate the capacity of battery bank Select the types of batteries for backup 	<ul style="list-style-type: none"> Battery duty hours/back up hours. Types of batteries and Specification. Battery Sizing. Inter-connection Techniques of Cells and Batteries 	Theory: 04 Practice: 14 Total: 18		Class room Lab
LU-5: Draw basic design of solar PV System	Trainee will be able to: <ul style="list-style-type: none"> Workout capacities of devices Sketch a diagram as per requirements Get the design approve by the client 	<ul style="list-style-type: none"> Understanding of basic design components of Solar PV system. Workout capacities of devices. Understanding of the single line diagram. Sizing and compatibility of the inverter. 	Theory: 04 Practice: 14 Total: 18		Class room Lab

Module-3

BUILDING ELECTRICIAN SOLAR PV SYSTEM TECHNICIAN

CBT Curriculum

National Vocational
Certificate Level 4

Version 1 - January 2020



Module – 3: Interpret job document

Objective: This module covers the skills and knowledge required to prepare checklist for the job, interpret schematic diagram, record the data and prepare log sheet for general maintenance.

Duration: 50 Hrs.

Theory: 18

Practice: 32

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU-1: Prepare checklist for job	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Prepare list of material required • Prepare list of tools required • Prepare list of equipment required 	<ul style="list-style-type: none"> • Identification and understanding of the required materials, tools and equipment. 	<p>Theory: 04 Practice: 08 Total: 12</p>		Class room Lab
LU-2: Interpret schematic diagram	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Read schematic diagram of wiring • Read schematic diagram of civil work • Read schematic diagram of mechanical work 	<ul style="list-style-type: none"> • Understanding of schematic diagram for solar PV system • Understanding maps civil and mechanical work. 	<p>Theory: 04 Practice: 09 Total: 13</p>		Class room Lab
LU-3: Record the data	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Collect the data • Enlist the data • Prepare report 	<ul style="list-style-type: none"> • Techniques for preparing bill of quantities (BOQ). • Reporting formats. 	<p>Theory: 04 Practice: 06 Total: 10</p>		Class room Lab



NVQs for Building Electrician - Solar PV System Technician



LU-4: Prepare log sheet for general maintenance	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Prepare schedule of routine maintenance • Identify the activities for conducting routine maintenance • Prepare list of tools for routine maintenance 	<ul style="list-style-type: none"> • Scheduling techniques. • Understanding of routine maintenance. • Types of maintenance (Corrective maintenance and Preventive maintenance). • Tools and techniques for maintenance. 	<p>Theory: 06 Practice: 09 Total: 15</p>		<p>Class room Lab</p>
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BUILDING ELECTRICIAN SOLAR PV SYSTEM TECHNICIAN

CBT Curriculum

National Vocational
Certificate Level 4

Version 1 - January 2020

Module-4



Module – 4: Install Solar PV System

Objective: This module covers the skills and knowledge required to Arrange required tools and equipment, Perform PV test, Erect the mounting structure, Fix PV modules as per circuit design, Install Battery Bank, install inverter / charge controller/variable frequency drive (VFD), Install Solar PV Pumps and Connect the PV modules as per circuit design

Duration: 100 Hrs.

Theory: 28

Practice: 72

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU-1: Arrange required tools and equipment	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> Collect the required tools and equipment Check physical status of tools and equipment Perform transportation of tools and equipment Manage safe storing of tools and equipment 	<ul style="list-style-type: none"> Identification and use of the required tools and equipment. Inspection techniques of tools and equipment. Calibration techniques of tools and equipment. Safety requirements for storing tools, equipment and materials. Safety tools, equipment (PPE) and techniques at the site. Safety requirements during Transportation. 	<p>Theory: 04 Practice: 09 Total: 13</p>		Class room Lab
LU-2: Perform PV test	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> Conduct short circuit current test Conduct open circuit voltage test 	<ul style="list-style-type: none"> Identification and use of testing equipment. Testing parameters and conditions. Procedure for Short-circuit current test. Procedure for Open-circuit voltage test. 	<p>Theory: 04 Practice: 09 Total: 13</p>		Class room Lab



NVQs for Building Electrician - Solar PV System Technician



LU-3: Erect the mounting structure	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Assemble the structure parts • Fix mounting structure • Adjust angles of the mounting structure 	<ul style="list-style-type: none"> • Types of mounting structures. • Fixing techniques. • Types of angles. • Adjustment techniques/Orientation of the mounting structure. 	<p>Theory: 04 Practice: 09 Total: 13</p>		Class room Lab
LU-4: Fix PV modules as per circuit design	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Install PV module on the mounting structure • Verify angle of the PV module with the help of angle finder/ meter • Ensure shadow overlapping. 	<ul style="list-style-type: none"> • Installation techniques of PV module on the mounting structure. • Verification of the angle of PV module. • Measuring techniques to avoid Shadow. • Use of Angle-finder. 	<p>Theory: 04 Practice: 09 Total: 13</p>		Class room Lab
LU-5: Install Battery Bank	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Arrange batteries with accessories as per requirements <ul style="list-style-type: none"> • Fix battery bank in the racks • Make parallel series strings for batteries, as per circuit design 	<ul style="list-style-type: none"> • Understanding of batteries and required accessories. • Installation techniques of batteries as per required circuit diagram. • Battery fixing and safety techniques. 	<p>Theory: 03 Practice: 09 Total: 12</p>		Class room Lab
LU-6: Install inverter / charge controller/variable frequency drive (VFD)	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Arrange inverter and charge controller in variable frequency drive (VFD) • Fix inverter and charge controller 	<ul style="list-style-type: none"> • Types of inverter and charge controller. • Specification of inverter and charge controller. • Installation of inverter and charge controller. • Setting parameters of inverter and charge 	<p>Theory: 03 Practice: 09 Total: 12</p>		Class room Lab



NVQs for Building Electrician - Solar PV System Technician



	<p>in variable frequency drive (VFD)</p> <ul style="list-style-type: none"> • Ensure fixation as per circuit design 	controller.			
LU-7: Install Solar PV Pumps	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Arrange Solar pumps as per desired capacity • Fix Solar pumps • Ensure fixation of Solar pumps as per circuit design 	<ul style="list-style-type: none"> • Types of solar pumps. • Specification of solar pumps. • Selection criteria of solar pumps and accessories. • Installation techniques of solar water pump. • Testing techniques of solar water pump. 	<p>Theory: 03 Practice: 09 Total: 12</p>		Class room Lab
LU-8: Connect the PV modules as per circuit design	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Make strings as per circuit design • Make arrays as per circuit diagrams • Connect arrays with junction boxes 	<ul style="list-style-type: none"> • Preparation of strings and arrays as per circuit diagram. • Standard operating procedure for PV Module inter-connection. 	<p>Theory: 03 Practice: 09 Total: 12</p>		Class room Lab



BUILDING ELECTRICIAN SOLAR PV SYSTEM TECHNICIAN

CBT Curriculum

National Vocational
Certificate Level 4

Version 1 - January 2020

Module-5



Module – 5: Perform Wiring of Solar PV System

Objective: This module covers the skills and knowledge required to Interpret wiring diagram, Connect the PV modules as per circuit diagram, Lay Cables, perform wiring test, carry out battery test, Interconnect the PV system and Configure the inverter/charge controller

Duration: 80 Hrs.

Theory: 20

Practice: 60

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU-1: Interpret wiring diagram	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Collect the wiring diagram and layout from job documents • Identify paths and marking for wiring 	<ul style="list-style-type: none"> • Interpretation of wiring diagram. • Layout techniques as per wiring diagram. 	<p>Theory: 03 Practice: 06 Total: 09</p>		Class room Lab
LU-2: Connect the PV modules as per circuit diagram	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Interconnect the strings to make arrays • Insulate all the arrays as per standard • Combine all the arrays through combiner box 	<ul style="list-style-type: none"> • Interconnection techniques for PV Module, strings and arrays. • Insulation materials and techniques. • Installation and connection of Junction box 	<p>Theory: 03 Practice: 09 Total: 12</p>		Class room Lab
LU-3: Lay Cables	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Install conduits for cables • Lay cables through the conduits • Connect the cables to the control and safety boxes 	<ul style="list-style-type: none"> • Types of conduits. • Cables laying techniques. • Types of wiring joints. • Cable color coding. 	<p>Theory: 03 Practice: 09 Total: 12</p>		Class room Lab



NVQs for Building Electrician - Solar PV System Technician



LU-4: Perform wiring test	<i>Trainee will be able to:</i> <ul style="list-style-type: none"> • Perform continuity test • Perform polarity test • Perform earth test 	<ul style="list-style-type: none"> • Proper earthing procedure and testing. • Understanding and use of testing equipment/instruments. 	Theory: 03 Practice: 06 Total: 09		Class room Lab
LU-5: Carry out battery test	<i>Trainee will be able to:</i> <ul style="list-style-type: none"> • Perform specific gravity test • Perform internal short circuit test • Perform terminal voltage test • Check terminal for carbon contents • Perform battery bank polarity test 	<ul style="list-style-type: none"> • Identification of battery testing instruments. • The use of battery tester. • Understanding standard operation condition of battery. • Battery maintenance techniques. 	Theory: 04 Practice: 09 Total: 13		Class room Lab
LU-6: Interconnect the PV system	<i>Trainee will be able to:</i> <ul style="list-style-type: none"> • Connect the battery bank to the inverter/charge controller through safety circuits • Connect the PV modules to the inverters /controllers through safety circuits • Connect the inverter with the input A.C source • Connect the load to the inverter through safety circuit 	<ul style="list-style-type: none"> • Types of safety circuits. • Connection of arrays via fuses to inverter <ul style="list-style-type: none"> ➤ Use of DC circuit breaker on DC side. ➤ Use of SPDs. ➤ Use of AC breaker on AC side. • Interconnection techniques of the PV solar system. 	Theory: 04 Practice: 09 Total: 13		Class room Lab



NVQs for Building Electrician - Solar PV System Technician



LU-7: Configure the inverter/charge controller	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Interpret the inverter manual • Inquire the customer's/site requirements • Set the parameters as per requirement 	<ul style="list-style-type: none"> • Interpretation of inverter manual. • Setting parameters of charge controller/inverter as per requirements. • No-load testing techniques. 	<p>Theory: 02 Practice: 10 Total: 12</p>		<p>Class room Lab</p>
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BUILDING ELECTRICIAN SOLAR PV SYSTEM TECHNICIAN

CBT Curriculum

National Vocational
Certificate Level 4

Version 1 - January 2020

Module-6



Module – 6: Troubleshoot Solar PV System

Objective: This module covers the skills and knowledge required to diagnose faults, identify solution of the faults, rectify the faults, carryout post rectification function test and finally perform wiring test.

Duration: 70 Hrs.

Theory: 16

Practice: 54

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU-1: Diagnose faults	<i>Trainee will be able to:</i> <ul style="list-style-type: none"> • Check inverter for fault code • Verify safety circuits • Check status of wiring • Verify status of battery • Check status of PV Panels • Identify nature of the fault (Hardware or software) • Diagnose the cause of fault • Document the fault 	<ul style="list-style-type: none"> • Consult the respective manuals • Types of fault code. • Required tools/equipment. • Safety procedure for fault diagnoses. • Method for testing of wiring. • Method for testing batteries. • Method for testing of PV panel • Common fault in Hardware • Common fault in software. • Standard report format. 	Theory: 04 Practice: 12 Total: 16		Class room Lab
LU-2: Identify solution of the faults	<i>Trainee will be able to:</i> <ul style="list-style-type: none"> • Trace out solution of fault code with the help of manual • Estimate cost of rectification • Report the fault to the concerned persons 	<ul style="list-style-type: none"> • Standard fault code correction procedure. • Bill of quantity (BOQ) & or estimated cost. • Reporting format. 	Theory: 03 Practice: 09 Total: 12		Class room Lab



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LU-3: Rectify the faults	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Reset the software for rectification • Arrange the required tools and equipment • Arrange the required material and components • Repair faulty component / equipment • Replace faulty component / equipment • Refer irreparable / un-replaceable faults to the concerned lab 	<ul style="list-style-type: none"> • Rectification procedure. • Tools and equipment. • Materials/components • Repair or replace procedure. 	<p>Theory: 03 Practice: 12 Total: 15</p>		<p>Class room Lab</p>
LU-4: Carryout post rectification function test	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Re connect the system with the load • Verify function of the system on full load • Document the services as per instructions • Clean and pack the store as per sop 	<ul style="list-style-type: none"> • No load test • Full load test • Standard operating procedure (SOP). • Reporting format. • Preventive Maintenance. • Standard Housekeeping procedure. 	<p>Theory: 03 Practice: 12 Total: 15</p>		<p>Class room Lab</p>
LU-5: Perform wiring tests	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Perform continuity test • Perform polarity test • Perform earth test • Rectify the problem 	<ul style="list-style-type: none"> • Method of: <ul style="list-style-type: none"> ◦ Continuity test ◦ Polarity test ◦ Earth test • Rectify the problem as per sop. 	<p>Theory: 03 Practice: 09 Total: 12</p>		<p>Class room Lab</p>

Module-7

BUILDING ELECTRICIAN SOLAR PV SYSTEM TECHNICIAN

CBT Curriculum

National Vocational
Certificate Level 4

Version 1 - January 2020



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Module – 7: Maintain Solar PV system

Objective: This module covers the skills and knowledge required to prepare check list for maintenance, follow routine maintenance log sheet, maintain Solar PV modules, maintain inverter/Charge controller/Protection circuits, maintain battery bank and perform post verification function of the system

Duration: 100 Hrs.

Theory: 13

Practice: 87

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU-1: Prepare check list for maintenance	<i>Trainee will be able to:</i> <ul style="list-style-type: none"> • Prepare list of tools and instruments for maintenance • Prepare list of materials for maintenance • Prepare list of activities for maintenance 	<ul style="list-style-type: none"> • Check list for instruments • Check list for tools & equipment • Check list for material as per scope of course. • Maintenance activity check list. 	Theory: 02 Practice: 09 Total: 11		Class room Lab
LU-2: Follow routine maintenance log sheet	<i>Trainee will be able to:</i> <ul style="list-style-type: none"> • Collect maintenance log sheet • Arrange required tools/instruments for maintenance • Perform activities as per schedule • Place equipment after maintenance as per SOP 	<ul style="list-style-type: none"> • Tools and material required in routine maintenance. • Log sheet • Understand the procedure and techniques of routine maintenance. (5S) 	Theory: 02 Practice: 09 Total: 11		Class room Lab
LU-3: Maintain Solar PV modules	<i>Trainee will be able to:</i> <ul style="list-style-type: none"> • Arrange cleaning materials • Wash the panels as per instructions (Avoid washing during peak sun hours). • Check connections and joints of solar PV modules 	<ul style="list-style-type: none"> • Cleaning material for PV Panels. • Cleaning procedure and techniques. • Safety requirement of PV Panels. • Checking procedure of PV Panels 	Theory: 03 Practice: 15 Total: 18		Class room Lab



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	<ul style="list-style-type: none"> • Check the physical and mechanical health of modules as per standard • Adjust the seasonal tilt angle 	<ul style="list-style-type: none"> • Tilt angle. 			
LU-4: Maintain inverter/Charge controller/Protection circuits	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Arrange servicing equipment • Check the status of cooling fans • Check input output terminals of invertors • Perform servicing with electrical blower • Maintain connection status as per standards. 	<ul style="list-style-type: none"> • Types of servicing equipment and materials • Methods of checking of cooling fans. • Inverter input output terminal • Checking procedure as per standard. 	<p>Theory: 02 Practice: 18 Total: 20</p>		Class room Lab
LU-5: Maintain battery bank	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Clean terminals of battery with sand paper • Maintain level of electrolytes • Maintain gravity of electrolytes • Maintain battery connections • Apply grease to terminal to avoid corrosion / sulphation • Verify the operations of battery bank 	<ul style="list-style-type: none"> • Tools & equipment for maintenance. • Material for maintenance. • Battery terminal cleanness. • Battery electrolytes. • Battery connections. • Testing procedure. 	<p>Theory: 02 Practice: 18 Total: 20</p>		Class room Lab
LU-6: Perform post verification function of the system	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Switch on the system • Observe display reading of inverter/ charge controller 	<ul style="list-style-type: none"> • Post verification of the system. • Inverter display parameter. • Post maintenance record. 	<p>Theory: 02 Practice: 18 Total: 20</p>		Class room Lab



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	<ul style="list-style-type: none"> • Perform full load test • Prepare the report of maintenance activities performed 				
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Module-8

BUILDING ELECTRICIAN SOLAR PV SYSTEM TECHNICIAN

CBT Curriculum

National Vocational
Certificate Level 4

Version 1 - January 2020



Module – 8: Adopt Safety Precautions

Objective: This module covers the skills and knowledge required to protect from all security threats by ensuring personal safety, workplace safety prepare and safety of all tools and equipment.

Duration: 60 Hrs.

Theory: 06

Practice: 54

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU-1: Ensure Personal safety	<i>Trainee will be able to:</i> <ul style="list-style-type: none"> • Arrange PPEs as per requirements • Wear proper PPE as per nature of job • Store PPEs at appropriate place after use • Ensure availability of first aid box 	<ul style="list-style-type: none"> • Electrical risk and basic electrical safety. • Relevant PPEs in PV system installation • Use of PPEs • Storage precaution for PPEs. • Common emergency and first Aid procedures. 	Theory: 02 Practice: 18 Total: 20		Class room Lab
LU-2: Ensure Work place safety.	<i>Trainee will be able to:</i> <ul style="list-style-type: none"> • Ensure cleaning of workplace properly • Avoid hazardous (electric / chemical) by adopting safety precautions 	<ul style="list-style-type: none"> • Workplace safety. • Workplace safety requirements • Work place cleaning procedure. • Workplace Lighting and ventilation requirements 	Theory: 02 Practice: 18 Total: 20		Class room Lab
LU-3: Ensure safety of tools and equipment	<ul style="list-style-type: none"> • Ensure availability of emergency exit • Ensure lighting and ventilation • Ensure availability of Firefighting equipment • Report to the concerned immediately in case of emergency • Ensure safe access to the system 	<ul style="list-style-type: none"> • Types of hazards. • Reporting of hazards and emergency. • Emergency handling techniques. • Firefighting equipment and its use. • Safety of tools and equipment. • Requirement of tools and equipment safety. 	Theory: 02 Practice: 18 Total: 20		Class room Lab



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	<ul style="list-style-type: none"> • Ensure insulation of tools and equipment • Store safely tools and equipment • Clean tools on a regular basis as per schedule 	<ul style="list-style-type: none"> • Storage precaution of tools and equipment. • Maintenance of tools and equipment. 			
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BUILDING ELECTRICIAN SOLAR PV SYSTEM TECHNICIAN

CBT Curriculum

National Vocational
Certificate Level 4

Version 1 - January 2020

Module-9



Module – 9: Develop basic professional skills

Objective: This module covers the skills and knowledge required to develop basic computer operating skills, develop basic communication skills, develop basic marketing skills. Identify needs of the market and Follow Environmental, Health and Safety standards

Duration: 100 Hrs.

Theory: 22

Practice: 78

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
LU-1: Develop basic computer operating skills	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Perform Microsoft basic commands in MS word <ul style="list-style-type: none"> o Open File o Format a file <ul style="list-style-type: none"> ➢ Font (Type/size/bold/Italic) ➢ Header Footer ➢ Page number ➢ Insert pics / table/hyperlink ➢ Save a File ➢ Save a folder • Perform basic commands in Microsoft MS Excel <ul style="list-style-type: none"> o Open a worksheet o Sum functions o If functions o Basic calculations o Table and graphs o Save a worksheet/folder • Prepare Microsoft power point presentation by using basic commands <ul style="list-style-type: none"> o Make a power point file 	<ul style="list-style-type: none"> • Basics of operating system. • MS Word. • MS Excel. • MS Power point. • Internet browsers. 	<p>Theory: 10 Practice: 30 Total: 40</p>		Class room Lab



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	<ul style="list-style-type: none"> ○ Insert pics/table/hyperlink ○ Design a theme for slides ○ Save a power point file • Perform browsing on the internet as per needs • Perform research online on new trends in the market with the help of internet 				Class room Lab
LU-2: Develop basic communication skills.	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Negotiate with a client to understand the demand • Plan product supply as per client's requirements • Set price(s) according to client's requirements • Communicate the plan to the client • Take feedback from client on understanding of the exact job with timeline and cost 	<ul style="list-style-type: none"> • Basic communication skills. • Clients' requirements analysis techniques. • Supply order management. • Agreement with clients. 	<p>Theory: 03 Practice: 12 Total: 15</p>		Class room Lab
LU-3: Develop basic marketing skills	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> • Present a design to the client as per requirement • Finalize the business deal • Purchase the equipment/tools and consumables as per agreed design • Adopt correct means of transportation • Select promotional means, according to target needs of clients 	<ul style="list-style-type: none"> • Presentation skills. • Business development techniques. • Procurement procedures. • Appropriate Transportation. • Feedback analysis • Promotional channels. 	<p>Theory: 03 Practice: 12 Total: 15</p>		Class room Lab



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LU-4: Identify needs of the market.	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> Analyze upcoming market trends. Develop Professional network. Demonstrate behavioral skills. Develop sound interpersonal skills Develop new designs. 	<ul style="list-style-type: none"> Market need analysis. Marketing skills. Interpersonal skills. Market exploration / Market Mapping. Design of marketing strategies. 	<p>Theory: 03 Practice: 12 Total: 15</p>		<p>Class room Lab</p>
LU-5: Follow Environmental, Health and Safety standards	<p><i>Trainee will be able to:</i></p> <ul style="list-style-type: none"> Follow Health and Safety Rules Ensure environmental safety Ensure compliance of net metering policy Ensure workplace safety by following safety standards Ensure safety while operating wires and electricity. Store all tools and equipment properly in a safe area. 	<ul style="list-style-type: none"> Environmental and health safety standards. Net metering policy. Workshop safety. Material storage safety. 	<p>Theory: 03 Practice: 12 Total: 15</p>		<p>Class room Lab</p>



4. List of Tools and Equipment

Sr. #	Description	Specifications
1.	Combination plier	180mm
2.	Long nose Plier	
3.	Cable Cutter	180mm
4.	Cable Cutter	12"
5.	Cable Cutter	18"
6.	Claw Hammer	1 pound



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7.	Hammer	Cross pin 200g
8.	Screw Driver Set	
9.	Mini Screw Driver Set	
10.	Screw Driver Set (metal head type)	
11.	Hammer	1 kg
12.	Cable Knife/paper cutter	
13.	Wire Striper/insulation remover	
14.	Soldering Iron with Stand	60W , 80W, 120W
15.	Sucker	For Soldering Iron
16.	Tool box	18"
17.	Bench vice	6"
18.	Angle Grinder	5"
19.	Mini Drill machine	for PCB drilling with bits
20.	Drill Machine Rotary Hammer	
21.	Drill Machine	Reverse Forward 13mm
22.	Cordless Drill machine	18V
23.	Extension board	multi Sockets With 10 Meters Wire
24.	Chisel	8"
25.	Chisel	12"
26.	Torpedo level / spirit level	Different size
27.	Compass	
28.	Adjustable Wrench	8"
29.	Adjustable Wrench	12"
30.	Richet Set	72 Pcs
31.	Spanner Set	12 pcs
32.	Torque wrench with deep sockets	Small 12"
33.	Pipe wrench	16"



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34	Welding plant With holder and lead	300 Amp
35	Thimble press	16mm to 240mm
36	Electric blower	
37	Heat gun	
38	Measuring Tape	3m
39	Measuring Tape	5m
40	Measuring Tape	50m
41	Hack Saw With blades	
42	File Set	Small size
43	File Set	large Size
44	L-key Set	
45	Fish Tape	100ft
46	Wood Saw	
47	Hole Saw For panel	25mm
48	Hole Saw For panel	50mm
49	Hole Saw For panel	70mm
50	Wooden Bit Set	
51	Twist Drill bit Set	HSS 0.5mm to 16mm
52	Tap and Die Set	32 pcs Set
53	Hand Tin Scissors	18"
54	Pipe vice with Stands	4"
55	Scissor	8" for fabric
56	Taser	6", 8", 12"
57	Gas Cutting torch with Oxygen And LPG Cylinders.	Oxygen LPG & Oxy Gas Cutting Torch 520mm.
58	Magnetic wristband for holding bits and parts	
59	Hot Melt Glue Gun 20W	20 watt with 50 glue Sticks



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60	Tool Belt	18 pcs
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List of Equipment		
Sr. #	Description	Specifications
1.	Digital Oscilloscope	Tektronix TDS 3000
2.	Digital Oscilloscope	Tektronix TBS 2000
3.	Synchronizing meter /smart energy meter	For Grid Tied
4.	DC Power Supply	Tektronix Keithly 2268
5.	Phase Sequence Meter	Kyoritsu KEW 8031F
6.	Function Generator	Tektronix AFG 1000
7.	Clamp On meter	Kyoritsu 2432
8.	Clamp on meter	Uni-T UT203
9.	DC volt Meter Digital	0 to 250 VDC 10Amp panel type Small Size
10.	DC ampere Meter Digital	100 amp with CT(current Transformer)



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11.	AC volt Meter Digital	0 to 50 Amp 0 to 600 VAC panel type Small
12.	AC ampere Meter Digital	0 to 50 Amp 0 to 600 VAC panel type Small
13.	Digital multi meter	Tecpel 8062
14.	Analog multi meter	Sunwa
15.	megger meter/insulation tester	Analog
16.	megger meter/insulation tester	digital MIT 300
17.	Earth Tester	Digital
18.	Micro meter	Digital
19.	Vernier Caliper	Digital
20.	Watt Ampere meter For Solar	thermodin System 130 amps
21.	Tachometer	Digital
22.	Tachometer	Analog
23.	Frequency Meter	AC 80-300V/30-70HZ 3 in1 LCD Time Voltage
24.	Hydro meter	Digital
25.	Hydro meter	Analog
26.	Variable AC power Supply	Super world 1KVA



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27.	Battery tester	Original Launch BST-460 6V & 12V Battery Tester for Battery
28.	battery level indicator	DC 3.5-30V Mini LED Battery level voltage monitor meter indicator
29.	Watt meter	EU Plug-In Electricity Power Energy Meter Monitor Analyzer KWh Watt Volt Amps
30.	Hour Meter	digital 220v
31.	Hour Meter	digital 12v
32.	Energy meter	Digital single phase
33.	Lux meter	Digital Light, Meter, Tester 200,000 LUX, FC Photo Camera
34.	Inductive and Capacitive meter	digital Hp-4070L
35.	Temperature gun	Non-Contact IR Infrared Digital Temperature Temp Thermometer Laser Point Gun
36.	Temperature controller	With thermocouple
37.	Digital Camera	Sony Cyber-shot DSC-H300 35x Optical Zoom Digital Camera - Black
38.	digital angle Finder	Sprit Level type



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39.	Stud Finder	Zircon
40.	PC	HP COMPAQ, Core i7-1TB-8GB- 3.40 GHZ- 2600 QUAD CORE- WIN 7 P1GB GRAPHICS-DVD-RW
41.	Printer	HP LaserJet P1102
42.	Scanner	HP
43.	Multimedia projector	Sony VPL-DX147 3200 Lumens XGA
44.	Charge Controller	PWM 15 amp
45.	Charge Controller	PWM 40 amp
46.	Charge Controller	MPPT 20 amp
47.	Charge Controller	MPPT 50 amp
48.	Solar Hybrid Inverter On/Off Grid	MPPT 10 kW 3 phase
49.	Solar Hybrid Inverter	MPPT 5 KVA
50.	solar Hybrid Inverter	MPPT 3 KVA
51.	solar Hybrid Inverter	PWM 3 KVA
52.	Inverter	1500 watt sine wave
53.	Inverter	1000 watt sine wave
54.	Submersible Solar pumps	3hp And 5hp 3phase
55.	VFD	5 HP 3 phase for solar pump



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56.	Inverter	500 watt Sine wave
57.	DRY Batteries	200amp 12 v
58.	DRY Batteries	12amp 12 v
59.	DRY Batteries	100amp 12 v
60.	DRY cell	2V 200amp
61.	Solar panel	polycrystalline 250 watt YINGLI solar
62.	Solar panel	polycrystalline 150 watt
63.	Solar panel	polycrystalline 100 watt
64.	Solar panel	monocrystalline 100 watt
65.	Solar panel	Thin film 50 watt
66.	Solar panel	monocrystalline 50 watt
67.	Solar panel	monocrystalline 20 watt
68.	Solar panel	monocrystalline 10 watt
69.	Solar panel	Polycrystalline & Monocrystalline 5 watt
70.	Solar Photovoltaic Cells	3 watt
71.	Battery Charger	20 ampere Transformer Less
72.	DC power Supply	12 to 24 volt Omron
73.	DC solar Pump	24VDC 400 watt China
74.	Solar panel Stands	For 250 watt
75.	Infrared camera	Flir instruments
76.	Solar power meter	Tes-1333r solar power meter
77.	Irradiance meter	TN-2340
78.	3 phase inverter for solar water pump	5KVA
79.	3 phase inverter for solar water pump	7KVA
80.	Solar installation tester	SEAWARD PV150
81.	Solmetric pv analyzer	PVA 1000 PV analyzer kit



List of Personal Protective Equipment		
Sr. #	Description	Specifications
1.	First AID Box	
2.	Fire Extinguisher Cylinder	Co2- 5 Kg
3.	Fire Blanket	
4.	Fire Bucket	
5.	Safety Gloves	Leather
6.	Safety Gloves	Rubber for 1000 volt
7.	safety googles	White
8.	Safety Helmet	Yellow
9.	Safety Helmet	White
10.	Safety mask	
11.	Formal Uniform For Work	
12.	Safety Shoes	
13.	Safety Belt	
14.	Ear Protector	



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List of Trainers Kit		
Sr. #	Description	Specifications
1.	EPH3 professional photovoltaic trainer	Lucas Nulla
2.	IGBT chopper inverter trainer	Labvolt model No 8857-1
3.	AC/DC training system	Labvolt model No 3351
4.	VFD training system	Labvolt model No 3356
5.	solar power training system	Labvolt model No 8010-2
6.	lead acid batteries training system	Labvolt model No 8010-4
7.	Dc fundamental 1&2	Labvolt model No 91001-20
8.	Ac fundamental 1&2	Labvolt model No 91003-2
9.	Semiconductor devices	Labvolt model No 91005-2
10.	Transistor amplifier	Labvolt model No 91006-2
11.	Transistor feed back	Labvolt model No 91008-24
12.	Power supply regulation	Labvolt model No 91009-25
13.	FET fundamental	Labvolt model No 91010-2
14.	Thyristor and power control	Labvolt model No 91011-2
15.	Operational amplifier	Labvolt model No 91012-2



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16.	Power transistor and GTO thyristor	Labvolt mode No 91013-2
17.	Starter USB for pic	Mikro electronica
18.	Pic kit2 starting kit	MP Lab



5. Members of the Curriculum Development Committee.

1. **Muhammad Saeed khan**
Chapter Chairman KP, Renewable & Alternative Energy Association of Pakistan (REAP)
2. **Engr. Asfand yar Khan**
Manager Procurement Sky Green Engineering (pvt.) Ltd
3. **Engr. Farhan Ali**
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4. **Engr. Muhammad Yawar Khan**
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