----- RENEWABLE ENERGY TECHNOLOGIES -----

INSTALLATION OF BASIC LEVEL SOLAR POWER PLANTS

Preparation of Training Documents for the Installation, Maintenance, Repair and Storage Systems of Artificial Intelligence Supported Solar Energy Systems and Energy Efficiency Development Support

2023-2-TR01-KA210-VET-00017445

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It is intended to guide vocational education trainers. It is free for users, cannot be sold. It cannot be duplicated. It will be published as an e-book on the Project Website (https://ai-solarpower.com/)

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INTRODUCTION

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AREA	**Renewable Energy Technologies**
BRANCH/PROFESSION	**Güneş Enerjisi Sistemleri**
THE NAME OF THE MODULE	**BASIC RENEWABLE ENERGY SYSTEMS**
DESCRIPTION OF THE MODULE	This module will cover basic level renewable system and solar panels installation and basic calculations.
DURATION	**40/32**
PRECONDITION	This module has no prerequisites.
COMPETENCY	It completes definition and installation of solar energy systems
PURPOSE OF THE MODULE	**General Purpose** You will be able to perform the solar panel system installation and calculations practically when the environment of the solar energy systems workshop is provided. **Purposes** 1. 1. You will be able to recognize the elements of the installation system . 2. You will be able to determine power using formulas.

INTRODUCTION

EDUCATIONAL ENVIRONMENTS AND EQUIPMENT	**Environment:** Renewable energy technologies field, renewable energy systems workshop **Equipment:** Basic electrical knowledge, basic electronics knowledge, basic mechanics knowledge, vise, file, screwdriver, control pen, pickaxe, connector, key set, measuring tool.

MEASUREMENT AND EVALUATION	You will evaluate yourself with the measurement tools given after each learning activity in the module.At the end of the module, the teacher uses the measurement tool (multiple choice test, true-false test, fill in the blank, matching etc) to evaluate the knowledge and skills you have gained through module applications.

INTRODUCTION

Dear Students,

The importance of Solar Energy Systems is increasing day by day. The installation of the power plant and the efficiency obtained is coming to the fore with the increasing importance of these systems. In this context, the installation, reliability and performance of the system and its continuity are important and it is obvious that the countries of the world will tend to renewable energy in the future, and it is necessary to learn the installation and its system.

With this module, you will learn to control the materials to be used in the basic installation of the solar power plant, which is one of the subjects related to your profession in the field of renewable energy technologies. When you buy this module; You will learn to control the physical condition of measuring devices, test them in a laboratory environment and record test data.. It is always aimed to perform the analysis in complete safety, as quickly as possible with minimum error. This can only be achieved with the healthy operation of the measuring devices. It is possible to obtain accurate and reliable analysis results, with the regular, careful and planned work of the person performing the analysis. When you go to the enterprises for internship, you will better see how important the control of the materials to be used in the solar measurement station is and will benefit you a lot, and its importance for your profession..You will increase your professional competence and become an employee with the qualifications required by the sector when you successfully complete this module

You will learn the Basic Installation of Solar Energy Systems in this module.

LEARNING ACTIVITY –1

PURPOSE

You will know basic electrical knowledge and electrical circuit electrical situations and concepts.

RESEARCH

- Gather information about electricity.
- Share your observations with your teacher and your friends.

1. ELECTRICITY

1.1 Definition of Electricity

All objects are made of atoms. Atoms, on the other hand, consist of nuclei, protons, neutrons, and electrons moving in an orbit around this structure. The smallest building block that has all the properties of an element is called an atom. Electricity, arises from the presence of charged particles such as electrons or protons that make up the structure of the atom; a form of energy that occurs statically, either as an accumulation of charges or as a current. Briefly, the flow or movement of electrons from one position to another is called electricity.

1.2 Types of Electricity

There are two types of electricity; static electricity and dynamic electricity

1.2.1 Static Electricity

The static electricity is produced when there is an excess or deficiency of electrons on the surface of a material. This type of electricity is called "static" because there is no other material near the surface where static electricity is generated, to attract electrons and cause them to move. In addition, the Turkish equivalent of the word static is "duruk" (stagnant), that is, non-moving. A discharge event or spark will occur when two oppositely charged surfaces are brought close to each other. Especially, when we wear woolen clothes, our hair gets electrified, and those little shock moments; we experience when we touch other people around us are associated with this situation.

1.2.2 Dynamic Electricity

The dynamic electricity is the flow of electrical charges through a conductor. In other words, electric current is called dynamic electricity. The electric current has two modes of transmission: direct current (DC) and alternating current.

1.2.2.1 Direct current

The direct current (DC) occurs as electrons flow through a conductor from the beginning to the end. The direct current (DC) has a fixed positive value above zero and flows in only one direction, unlike alternating current.

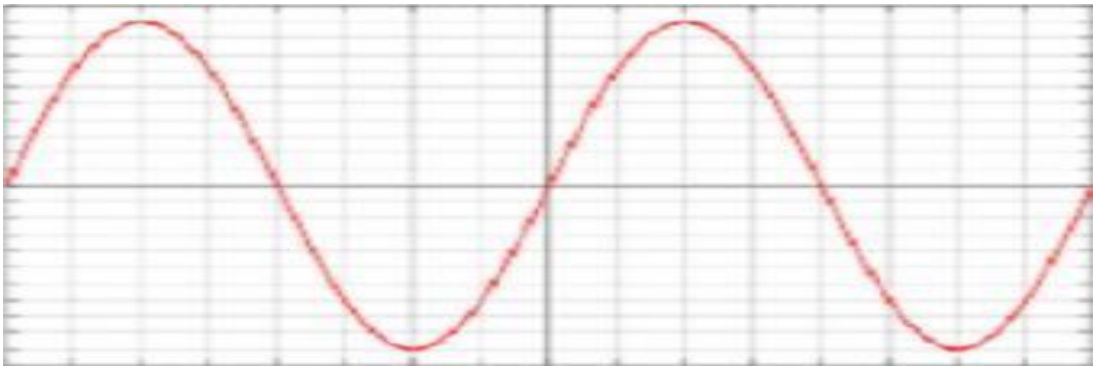
One of the most basic examples of direct current is standard dry cells. As an example of the use of direct current in industrial facilities, we can give businesses where

electrical equipment is used with batteries (forklifts ex.).

1.2.2.2 Alternative current

Alternating current (AC) is a form of current in which the energy in the electrons is transmitted from one electron to another electron through the conductive body by oscillation, rather than the flow of the electrons themselves. Alternating current is induced on a conductive body rotating in a magnetic field. The value of the current and the direction of flow on the conductor depend on the instantaneous position of the conductor relative to the magnetic flux

As the conductor makes one full turn in the magnetic field, the current first returns to zero to maximum value (positive), then to zero again, then to maximum value in the opposite direction (negative), and finally to zero again. As can be understood from this expression, the flow of electric charge periodically **changes direction** in alternating currents.



1.3 What is Current? What is Voltage? What is Resistance?

In order to understand the behavior of electricity, let's consider the downstream the water in a pipe on a sloped surface . The flow of water inside the pipe is similar to electric current flowing over an electrical cable. Water moves along the pipe from a high pressure area to a low pressure area. Electricity is transmitted in a similar way. Electric currents move from high voltage to low voltage (area of low resistance).

1.3.1 Current

Electric current can be defined as the flow of electric charge or the amount of flow of electric charge. Electric current is measured in amperes (A) and is briefly denoted by the symbol '**I**' . In the case of very small currents, we may encounter the expression milliamp (mA).

1.3.2 Voltage

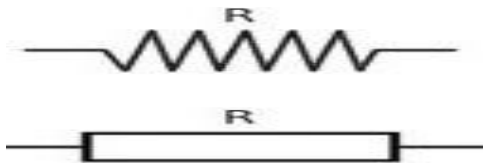
As the pressure difference increases along the pipeline, the water flow rate will increase.. Similarly, the greater the electric potential difference along the electric cable, the higher the amount of current will be. The electric potential difference that causes electric current to move between two points is called voltage. It is measured in volts and is denoted by the letter V.

1.3.3 Resistance

The flow of water inside the pipe will be affected by the roughness of the inner surface of the pipe and the narrowness of the pipe, as well as the pressure difference. As the rough areas on the inner surface increase, the water flow will slow down as the pipe narrows, thus the amount of flowing water will decrease. Similarly, the weaker the electrical conductivity of the material, the greater the amount of resistance, hence the less the amount of electricity transmitted. It is the **electrical resistance** of the material that determines the efficiency of this transmission.

The resistance of a material to current during the passage of electric current is called **electrical resistance**. Electrical resistance is expressed in ohms (Ω) and is briefly represented by the symbol **'R'**. The resistance used as a circuit element; it resists the current, limits the current passing through the circuit and keeps it at a certain value and ensures the operation of other circuit elements.

Resistors are found in all electronic devices we use and have a wide range of uses. One of the most basic examples of the use of resistors is the filament bulbs that we all use in our homes. As the electric current passes over it, the wire inside the bulb heats up and



begins to emit light.

Ohm's Law

There is a correlation between the three basic concepts of electricity; which are named voltage (V), current (I) and resistance (R). This relation is Ohm's law, which is the main formula of electricity. Ohm's law describes the flow of electricity.

V = I × R (volt)

If we want to find the **electrical power** (P), we use the following formula,

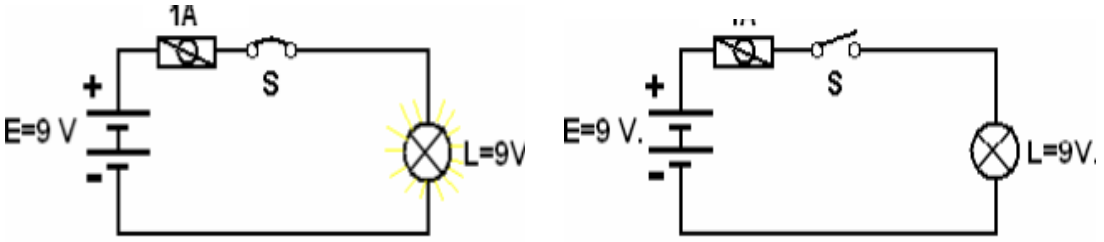
P = V × I (watt)

These are basic electrical formulas, choosing the right size fuse for an equipment, etc. They allow us to make the simple calculations necessary for the subjects.

Simple Electric Circuit

Electric current must be able to safely transmit and return from its source in order to do our jobs such as lighting, heating and powering. In order for the electricity to be transmitted and returned to its source, a suitable electrical circuit must be established

and the circuit must be in the closed position.



Let's think about the simple electrical circuit we saw during our school years. The event that takes place in this electrical circuit where the light bulb does not work when we turn the switch on, and when we turn it off, the electric flow occurs and the light bulb starts to burn, is the transmission of electricity and its return to its source. Electricity will not flow if we block the path back to the source.

In order to create a simple electrical circuit, a power source, resistor, conductive material to connect the circuit, and finally a switch that will enable the circuit to be opened and closed will be sufficient. For example a basic electrical circuit can be built using a batter

Power source, a light bulb as a resistor, a copper cable as a conductive material, and an electric switch for on-off operation.

Conductors and Insulators

Electricity is transmitted better with some materials than with others. Materials on which electric current flows easily are defined as conductive materials, while materials with low electrical conductivity are called **insulators**.

In addition, some metals that have very poor resistance values at low temperatures and conduct electricity very well are called **super conductors**. The conductive or insulating property of a material is related to its resistivity.

Almost all conductive materials are metal. **Insulators**, on the other hand, are materials that have high resistance and low conductivity, unlike conductors. We can show rubber, glass, wood, air and plastic materials as examples of insulators.

1.5 What is Leakage Current? What is Short Circuit? What is Grounding?

Let's end the basic electrical concepts with leakage current, short circuit and grounding caps.

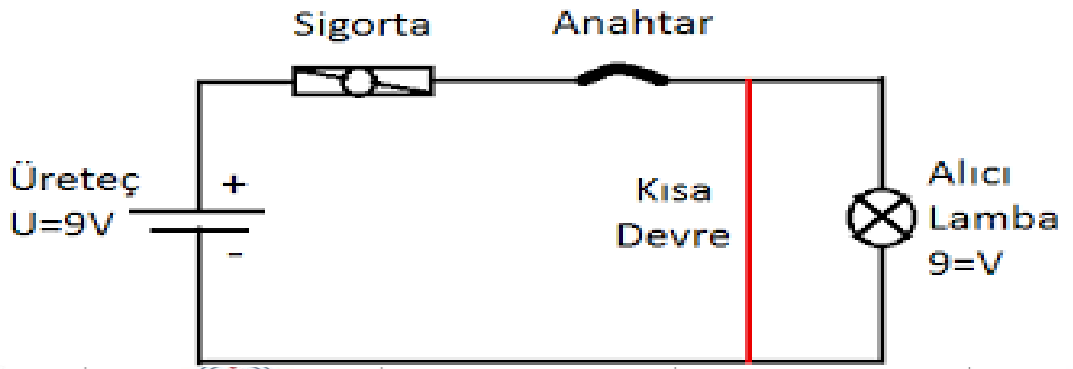
1.3.4 Leakage Current (Electric Leakage)

In an electrical circuit, the current entering the phase returns from the neutral, completing the circuit. The casings of the conductors may be damaged due to reasons such as wear of the cables over which the electric current passes and insulation faults. In this case, the currents that must return through the neutral complete the circuit by being grounded over the conductive parts that must not pass current in the circuit. (e.g. refrigerator door) This situation is called **electric leakage**, and this current is called **leakage current**.

As in the Regulation on Grounding in Electrical Installations, the current passing from the active parts of the operating element to the inactive parts, such as the body, through the operating insulator, during operation is called leakage current.

1.3.5 Short circuit

A **short circuit** is when the current deviates from its intended course and completes the circuit over a line with very low resistance. Extremely high currents resulting from a short circuit can burn the circuit and destroy the power supply. If a fuse is present at the time of the short-circuit in the supply circuit, the fuse opens the circuit, breaking the current and protecting the circuit.

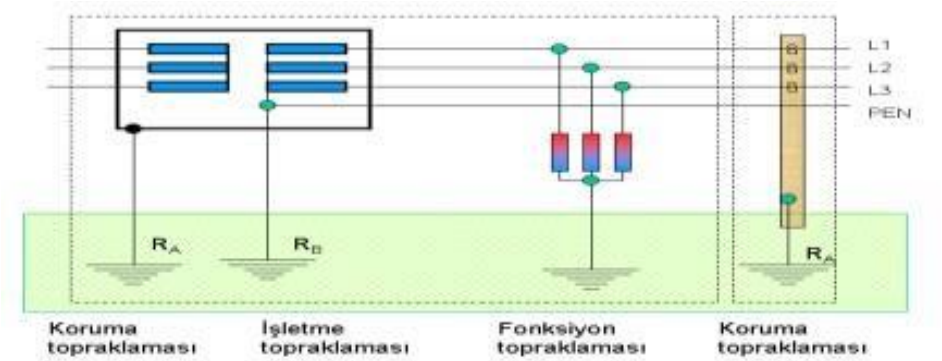


1.3.6 Grounding

One of the conductors of the company supplying the electricity is always firmly grounded. The reason for this is to prevent possible damage to the supply circuit by the fault current that occurs in case of a fault in the circuit.

The fault current is transmitted directly to earth via the low resistance conductor and the supply circuit is protected. This electrical protection process is called **grounding**. A good and effective grounding is of critical importance for the protection of the electrical circuit and people.

We briefly conveyed the basic electrical information and concepts. The information in this article will help us understand what we do and why while examining electrical hazards and precautions to be taken in electrical work safety.



MEASUREMENT OF ELECTRICAL QUANTITIES

While every unit of measurement can measure any quantity, electrical is measured in some situations and concepts. In these cases, the current, voltage and resistance of an electrical system can be measured. This measurement can be done with measuring instruments called millimeters and avometers.

When measuring voltage, we take the meter to the volt (V) level. When measuring current, (A) Range is set to (OHM) when measuring resistance.

APPLICATION ACTIVITY

Process steps	Suggestions
➢ Connect the cables of the earth resistance measuring device . ➢ Measure the ground rod resistance.	➢ Connect the cables of the other tool according to the instructions for use. ➢ Record the measured resistance.
➢ Explain the formation of short circuit. ➢ Calculate the current drawn	➢ Build the circuit by drawing. ➢ The current drawn must be above normal.
➢ Test a conductive wire using a measuring tool and explain whether it is conductive or not.	➢ Use the buzzer position.
➢ Think about what equipment we can use to design an Electrical System.	➢ The design will be made according to the electrical equipment.
➢ Share the project you are considering with your friends.	➢ Evaluate management and monitoring activities with your friends.

CONTROL LIST

Evaluate yourself by putting an (X) mark in the **YES** box for the skills you have gained from the behaviors listed below within the scope of this activity, and the **NO** for the skills you have not gained.

Evaluation Criteria	YES	NO
1. Did you get general information about what electricity does?		
2. Have you learned the definition and scope of electricity?		
3. Do you know what current and voltage do in electricity?		
4. Have you learned about the functions of electrical systems?		
5. Have you learned the usage areas of electricity?		

EVALUATION

At the end of the evaluation, review your "No" answers again. If you do not think you are proficient, repeat the learning activity. If all your answers are “Yes”, move on to “Assessment and Evaluation”.

MEASUREMENT AND EVALUATION 1

Please read the questions below carefully and tick the correct option.

1. The completion of the circuit in the shortest way is called …….

2. Avo meter is the name given to the instrument that measures ……,……..and …….

3. The electrical system that protects the circuit, material or person in leakage current is called ……..

4. Substances that conduct electricity are called..... , while those that do not are called substances.

EVALUATION

Compare your answers with the answer key. Return to the activity and repeat the topics related to the questions that you gave wrong answers or hesitated to answer. If all of your answers are correct, continue to the next learning activity.

LEARNING ACTIVITY –2

PURPOSE

You will know the basic electronic components in the inverter and its regulated circuit.

RESEARCH

- Gather information about electronic semiconductors.

Record the information you have acquired and share it with your teacher and friends.

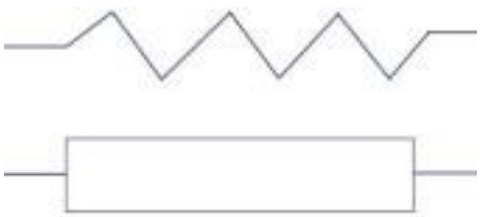
2 ANALOG CIRCUIT ELEMENTS

2.1 RESISTANCE

Resistors are electronic circuit elements that show difficulty in electric current. If the resistance value is high, the current passing through it will be low. This phenomenon was discovered by the German scientist Ohm in 1827.

Varieties; they are grouped under three headings as fixed resistors, regulated resistors and medium effect resistors.

Fixed Resistances: Resistors whose resistance value does not change are called fixed resistances. They have high sensitivity. The symbols are as shown below:

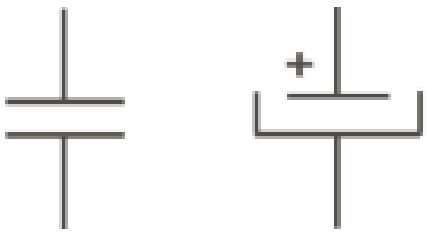


Wire Resistors: The wire resistors can be produced in different powers and values, both fixed resistance and adjustable resistance. In wire resistors, nickel-chromium, nickel- silver and constantan are used to ensure that the resistance value does not change with temperature and is durable.

Voltage Effect Resistors (VDR-Varistors) Elements whose resistance value changes inversely proportional to the amount of voltage applied to their ends are called varistors.

2.2 CAPACITORS

The circuit element, which is obtained by placing an insulator called di-electricity between two conductive plates and can store electrical energy, is called a capacitor. (Picture 2.1). It is denoted by the letter C and its unit is the farad (F).



Its types are divided into two groups as fixed and adjustable.

Fixed Capacitors: Fixed capacitors are of six types: paper, plastic, ceramic, mica, electrolytic, and smd.

Paper Capacitors: Elements produced by sticking 0.008 mm thick tin or aluminum plates on both sides of 0.01 mm thick paper impregnated with paraffin material in order to increase the insulation quality.

Plastic Capacitors: Not preferred in high frequency circuits. They are manufactured with precision capacity. It can usually be used in timing, filter or circuits with a frequency of several hundred kHz. There are three types according to their dielectric materials. These; polyester, polystyrene and polypropylene.

Ceramic Capacitors: They are manufactured using titanium or barium as di-electric material. It is often used as a bypass capacitor in high frequency circuits.

Mica Capacitors: Di-electric material is mica. They are elements with very high insulator constant and very little loss. Frequency characteristics are very good and because of these properties it is used in resonance and high frequency circuits.

Electrolytic Capacitors: Electrolytic capacitors are also called polarized capacitors. They are capacitors with positive and negative poles, in which acid boric solution is used as di- electric material between aluminum plates. The negative terminal is connected to the aluminum plate that forms the outer surface of the capacitor.

SMD Capacitors: They are capacitors produced in a structure suitable for mounting on multi-layer electronic circuit boards with surface contact. Its dimensions are much smaller than other capacitors, but it is produced with capacitance values that can be reached with lentil and mica capacitors.

It is divided into groups as variabl and trimer capacitors.

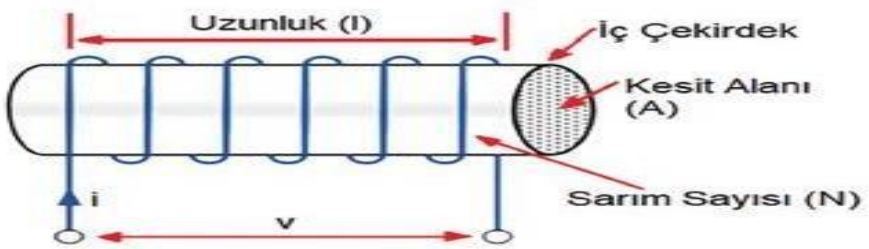
Variable Capacitors: Capacitors in this group are also called variabl (variable) in English. The Turkish equivalent of the w "variable" is "variable". Variable capacitors consist of multiple capacitors connected in parallel. One plate of each of these capacitors is fixed and the other plates can be rotated with a shaft. Thus, the capacitances of the capacitors can be changed as desired.

Trimer Capacitors: They are adjustable capacitors whose capacitance value can be changed with a screwdriver. In trimer capacitors, the capacitance value can be reduced or increased by changing the surface area with 360 degree rotating plates connected to the adjustment screw. Trimer capacitors have small dimensions and capacitance values. This kind of capacitors FM transmitter, radio and so on. Used in circuits.

2.3 COILS

Definition, Function and Structure the circuit element, which is obtained by winding insulated conductor wires on a durable insulator, generally called core, is called a coil. It is denoted by the letter L and its unit is Henry (H).

There are two types of coils, fixed and adjustable.



2.3.1 Fixed Coils

There are four types of fixed coils: air core, ferrite core, iron core, smd (surface mounted) coils.

2.3.2 Adjustable Coils

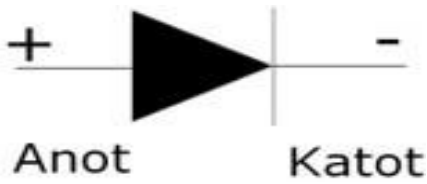
They are coils whose inductive resistance can change with the movement of the core in the chuck. The value increases as the core goes into the chuck. The value decreases as you go out. The inductance value is changed by moving the core up and down with the help of a screwdriver.

2.4 BASIC SEMICONDUCTOR ELEMENTS, DIODES

2.4.1 Conductor, Insulator and Semiconductor Materials

2.4.1.1 Definition and Structure of Diode

A diode is a semiconductor, two-terminal circuit element that carries current in one direction. These two end anode (A) cathode (K) ends. Here, positive terminals are connected to the anode and negative terminals are connected to the cathode is supplied, the diode becomes correctly polarized and a current begins to flow. If connected in reverse direction (anode minus, cathode plus) no current flows. This is called reverse polarization. reverse polarization method is applied only in some special diodes.



2.4.1.2 Types

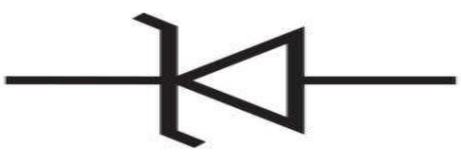
The diversity and use of diodes has increased with the developing technology. In our module only crystal diodes, zener diodes, photo diodes and light emitting diodes will be explained.

2.4.1.3 Crystal (Rectifying Diodes) Diodes

Crystal diodes are often referred to as rectifier diodes and are used in rectifier circuits used. Rectifier diodes are one of the most used diodes in the market.

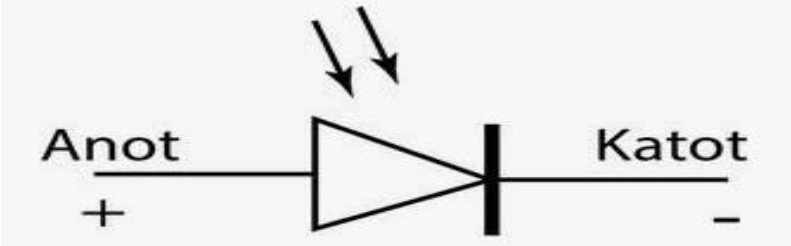
2.4.1.4 Zener Diodes

Zener diodes are manufactured according to the principle of passing current in the opposite direction when the voltage applied to the diode reaches a certain value.



2.4.1.5 Photo Diodes

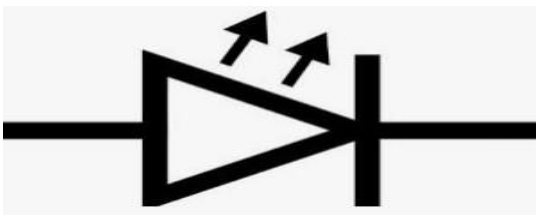
Photo diode symbol Elements that pass current from the cathode tip to the anode tip as a conductor when light falls on them. Photodiodes are similar to rectifier diodes.



2.4.1.6 Light Emitting Diodes

Light emitting diodes will be examined under two headings as LEDs and infrared diodes.

LEDs Picture 4.20: LED diode Light-emitting filament less semiconductor (diode) lamps are called LED (light emitting diode, light emitting diode, solid state lamp) (Picture 4.20). These elements are produced in various sizes (1-1.9-2-2.1- 3-5-10 mm etc.). Since they operate with very little current such as 2-20 mA and are resistant to Vibrations, they appear in all kinds of electronic circuits.



2.4.1.7 Infrared Diodes

The type of diode made of gallium arsenide semiconductor material, operating under the correct polarity, is called infrared diode. By adding various substances to semiconductors, LEDs that emit light at frequencies that cannot be seen by the human eye (infrared) have been obtained

STRENGTH CONTROLS WITH THE MEASUREMENT TOOL

Resistances: It is measured by determining its size in the OHM stage. A defective resistor will display a value less than its own value.

Diodes: The diode, which is a semiconductor, and the others from this family are measured at the buzzer stage. A solid diode shows a resistance, and a broken diode gives a signal.

Coils: It is measured in its own units called inductance.

Capacitors: They are measured in their unit size which is capacitance

APPLICATION ACTIVITY

Observe an example scale implementation

Process steps	Suggestions
➢ Calculate the resistance value determined for the resistance measurement. ➢ Verify the result with the measuring instrument.	➢ Measurement will be made by taking the measuring instrument to the ohm level. ➢ Use color codes.
➢ Perform the robustness test at the specified level for the diode measurement. ➢ Test a diode that is short-circuited and broken.	➢ Use the buzzer stage and make sure that you have connected the cables of the meter correctly. ➢ The diode may not show that it is broken from the outside, so you need to measure it.
➢ Perform the robustness test at the specified level for coil measurement.	➢ Measurement will be made at the inductance level.

CONTROL LIST

Evaluate yourself by putting an (X) mark in the "Yes" box for the skills you have gained from the behaviors listed below, and the skills you have not gained by placing a "No" box within the scope of this activity.

Evaluation Criteria	YES	NO
1. Did you understand the importance of basic electronic circuit elements?		
2. Do you know semiconductor materials?		
3. Did you learn about the contribution of basic electronics to technology?		

EVALUATION

At the end of the evaluation, review your answers as “No”. If you do not think you are proficient, repeat the learning activity. If all your answers are “Yes”, proceed to “Assessment and Evaluation”.

MEASUREMENT AND EVALUATION 2

Read the questions below carefully and fill in the blanks.

1. The challenge shown against the current ……..…. is called.
2. Electronic material made by placing an insulator between two conductive materials is called ……
3. The material we use with the method of adjusting the resistance value is called ……..….
4. Usually as a bypass capacitor in high frequency circuits ……..….. used.
5. A circuit element that passes current in one direction is called ……..…..….

EVALUATION

Compare your answers with the answer key. Return to the activity and repeat the topics related to the questions that you gave wrong answers or hesitated to answer. If all your answers are correct, proceed to the next learning activity.

LEARNING ACTIVITY–3

PURPOSE

You will know the definitions and usage areas of basic mechanical tools.

RESEARCH

- Gather information on basic mechanical hand tools.
- Record the information you have acquired and share it with your teacher and friends.

3 BASIC MECHANICS

3.1 Clamps

They are detachable temporary fastening tools used to hold, fix and assemble various parts. Various types of vices have been developed to be used in various business areas. The common feature of all of them is to compress the part.

3.1.1. Types and Applications

3.1.1.1 Leveler's Clamps

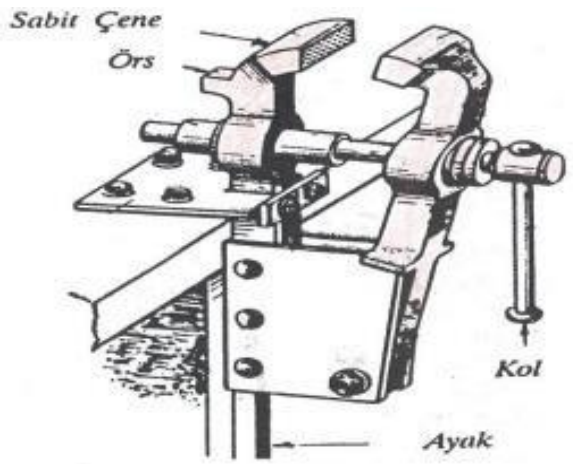
It is made of cast iron by casting and forging. It has two jaws, one fixed and the other movable. In order to protect the main jaws of the vices, two rectangular prism-shaped steel parts made of steel are attached to the jaws with the help of pins or bolts. It is the most widely used vise type.

3.1.1.2 Parallel Edge Machine Clamps

It is used for fixing the parts to be processed in workbenches such as drill bench, planer, shaper, milling machine. It has long channels so that it can move right, left, forward and backward.

3.1.1.3 Leg Clamps

They are the oldest vices. Made of mild steel. It got this name because there is a foot on the fixed jaw of the vise. It is mostly used in hot and cold blacksmithing, impact processes.

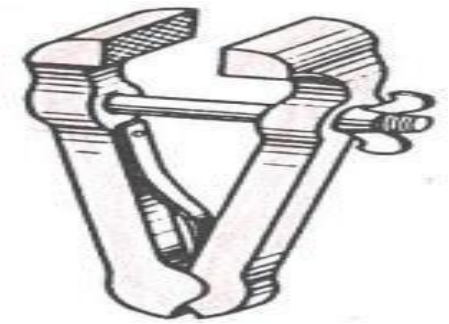


3.1.1.4 Chamfer Clamp

They are vices for beveling and chamfering 90-degree corners at 30 or 45-degree angles to prevent damage from sharp corners and pointed protrusions on the edges of various machinery and hand tools, and also to give an aesthetic appearance. These curved surfaces are called chamfers. After the piece is connected to the chamfer vise, the piece and the vise are connected together to another vise. It cannot be used alone, it is mobile.

3.1.1.5 Hand Clamp

These vices are used for machining very small parts. Both jaws are mobile. There is a spring between the jaws to bring it back. As the wing nut on one side is tightened, the part is tightened.



3.1.1.6 Countersunk Clamp

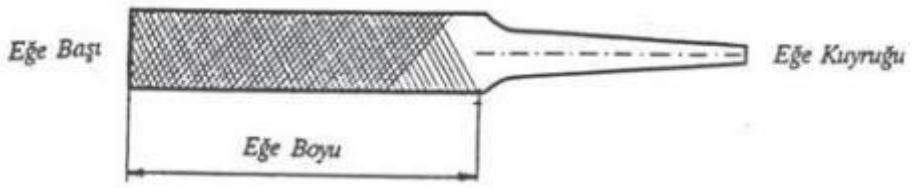
It is a two-piece flat bar with different holes for countersinking parts of different diameters. After the pipes are placed in the space suitable for their diameter, the end of the pipe is countersunk with a special puller. It is used for countersinking in diesel fuel system, brake system hydraulic pipes and fittings.

3.2 RASPS

3.2.1 Mission

They are hand tools that help us to give the desired shape by removing chips from

metal parts. It works by breaking off sawdust from the surface of metal parts with the help of the teeth on it.



3.2.2 Types and Applications

There are many types of files in the market according to the purpose of use and the characteristics of the materials to be filed. These files are divided into groups as follows.

3.2.2.1 Rasps According to Sections

Lama rasp: These are the rasps used for filing flat surfaces.

Square rasp: It is used for filing angular holes and filing internal surfaces.

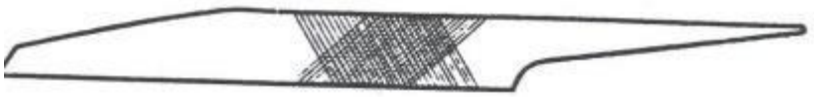
Triangle rasp: It is used for filing inner corners and cleaning screw threads.

Round rasp: It is used for processing hole works and similar works.

Herringbone rasp: Rasps used mainly for filing concave surfaces

Trapezoidal rasp: It is a small toothed file with a chisel tip on its surface.

Knife rasp: It is a chiseled file that looks like a knife.



3.2.2.2 Rasps According to the Tooth Shape

Single row rasp: It is used for rasping steel and hard metals.

Double-row rasp: It is a type of rasp used for rasping hard materials such as steels and brass.

Curved tooth rasp: Used for rasping compressed paper or duralumin materials.

Rasp-toothed rasp: These rasps are also called wood rasp. It is used for rasping wood and similar soft materials

3.3 SAWS

The process of breaking a material into pieces using a cutting tool is called cutting. The cutting process is divided into two as chip less and chip cutting. Cutting with a saw is a machining process. Hand saws have many uses in industry.

3.3.1. Places of Use

It is used for cutting all kinds of metals and iron pipes in industry. Metal cutting works have been made practical with hand saws, which are frequently used in automotive, sanitary ware, metal and machinery departments.

3.4 SCREWDRIVER

3.4.1 Definition

Screwdriver Hand tools that assist us in removing and installing various screws. Flat and Phillips screwdrivers are widely used in the market. In workshop environments, the blades of flat screwdrivers can be sharpened with the help of stones.

3.4.2 Cusp Features

Flat and Philips screwdrivers are made in a variety of sizes to suit where they are used. The cusps are heat treated and hardened. Some flat screwdrivers have a magnet feature on the ends.

APPLICATION ACTIVITY

Working with clumps and other hand tools.

Process steps	Suggestions
➢ Fix the copper plate on the clump ➢ Drill the plate with the help of a drill.	➢ Turn the vise handle counterclockwise, open it and place the plate. ➢ Drill a hole in the middle with the help of a drill
➢ Cut a wood with a diameter of 1mm with a saw.	➢ For wood cutting, fix the wood to be cut in the clump
➢ Remove sawdust with a rasp	➢ Fix the material while rasping
➢ Clean up the material.	➢ Carry out the cleaning work with solutions.

CONTROL LIST

Evaluate yourself by putting an (X) mark in the "Yes" box for the skills you have gained from the behaviors listed below, and the skills you have not gained by placing a "No" box within the scope of this activity.

Evaluation Criteria	Yes	No
1. Is the clump sufficiently rigidly mounted?		
2. Is the copper plate fixed in the clump?		
3. Was the drilling done successfully?		
4. Were the chips removed successfully?		

EVALUATION

At the end of the evaluation, review your answers as “No”. If you do not think you are proficient, repeat the learning activity. If all your answers are “Yes”, proceed to “Assessment and Evaluation”.

MEASUREMENT AND EVALUATION

Read the questions below carefully and mark (T) for the TRUE sentences and (F) for the FALSE ones.

1. ( ) Screwdrivers are hand tools that assist us in removing and installing various screws.

2. ( ) Cutting a material into pieces using a cutting tool is called a screwdriver.

3. ( ) Detachable temporary connection tools used to hold, fix and assemble various parts are called clumps.

4. ( ) Hand tools that help us to give the desired shape by removing chips from metal parts are called hammers.

EVALUATION

Compare your answers with the answer key. Return to the activity and repeat the topics related to the questions that you gave wrong answers or hesitated to answer. If all your answers are correct, proceed to the next learning activity.

LEARNING ACTIVITY–4

PURPOSE

You will know how to determine and measure the location of power plants for installation.

RESEARCH

- Gather information about the installation station.
- Record the information you have acquired and share it with your teacher and friends.

4 LOCATION OF SOLAR POWER PLANT

What is the Physical Condition of the Field? What are the Effects on the Station Site? When the physical condition of the field is mentioned, surface formations such as oceans, seas, lakes, rivers, mountains and plains, especially surface forms, should be understood. The physical condition is related to the external appearance of the earth.

4.1 SOLAR MEASUREMENT STATION

While selecting the site for the solar measurement station, the solar measurement station should be installed at a distance of at least 10 times the height of the surrounding elevations (building, tree, etc.) or in such a way that it can receive the sun's rays at an angle of at least 5° with the horizontal during sunrise and sunset.

4.2 DETERMINING THE RADIUM ANGLE OF THE STATION LOCATION

4.2.1 Compass and Usage

The most important part of the compass is a magnetic needle. This needle is mounted on the compass body so that it can move freely. When the needle is released it always points in the same direction. This is because there is a force in the earth that pulls the needle. The earth is like a large magnet with one end in the north and the other in the south. Earth's magnetism causes the compass needle to rotate toward magnetic north. The north-pointing end of the needle is painted red or black. On some compass needles, the tip is pointed like an arrowhead. Some even have the letter N on the north pointing end of the needle. The compass has a 4-cornered surface. These indicate the main directions: north, south, west, east. These directions divide the compass into 4 quadrants. They are divided among themselves: northeast, northwest, southeast, southwest.

Use of Station Location Radiation Angle Determiner: Radiation or radiation is the emission or transfer of energy in the form of electromagnetic waves or particles. Thin beams of light that come out of a light source and reach us in a straight line are called rays. The energy emitted from atoms, the sun and other stars is also called radiation or radiation, inspired by this term. The term radiation, which is derived from a Latin word meaning ray, which is the equivalent of radiation in western languages, is also used a lot.

In solar energy applications, since the surfaces where the solar energy is converted to thermal or electricity are placed inclined, the solar radiation coming to the inclined surface is an important and basic parameter in the calculations. Total solar radiation coming to any surface on the earth; It consists of direct, diffuse and reflected radiation.

4.2. STATION RADIATION ANGLE

While determining the station radiation angle in our country, there will be two different angles as summer and winter. The first of them is adjusted to be 57 degrees in summer and the other is adjusted to be 27 degrees in winter, and the southern part is taken as the latitude.

4.3 CHECKING THE PHYSICAL CONDITION OF MEASURING DEVICES

4.3.1 SENSOR AND CONNECTION TYPES

At the solar measuring station; Variables such as solar radiation, sunshine duration, wind speed, wind direction, air temperature and relative humidity need to be measured and recorded. Below are the meteorological variables and the names of the sensors.

Variant Name	Measuring Device
Solar Radiation	Solar Radiation Meter, Pyranometer
Sunbathing Duration	Sunshine Duration Sensor
Wind speed	Wind Speed Meter (Anemometer)
Wind direction	Wind Direction Meter
Temperature	Air Temperature Meter, (Thermometer)
Relative humidity	Relative Humidity Meter-Relative Humidity Meter

1. **Solar radiation meter (pyranometer):**

-The solar radiation meter (pyranometer) should be in the horizontal plane and should be checked with a spirit level on the device.

-The device is deployed to the south in the north-south direction.

- Dehumidifier chemical control should be done.

-Solar radiation meter (pyranometer) in ISO 9060 and WMO Guide-8

It must be selected as a defined First Class -Good Quality or better sensor and must have a current (covering the prescribed measurement period) calibration certificate.

-The sensitivity coefficient of the pyranometer should be checked in the program running in the data collection unit.

Sunshine duration sensor:

-The sun time meter should be installed in such a way that it makes an angle with the horizontal with an accuracy of ±5° according to the latitude and faces north.

-The dehumidifier must not have lost its chemical properties.

-The sun time meter must have a current (covering the foreseen measurement period) calibration certificate.

Other sensors:

-The air temperature and humidity meter should be in a shield with proper ventilation, not directly affected by solar radiation, and should be installed on the pole.

-The height of the wind measurement mast can be 10 m.

If a 10 m high pole will be used, it will be placed on the pole day and night. LED illuminated warning lamp can be installed with a sensor, emitting red light.

-Wind speed and direction meters can be installed at the top of the mast at a height of 10 m and on a sensor arm of at least 1 m.

-The north setting of the wind direction meter should be checked with a compass.

-Wind speed meter, air temperature and humidity meter must have a current (covering the foreseen measurement period) calibration certificate.

Wiring:

-All sensor and energy cables should be clipped to the pole and arms at 1 m intervals in order to ensure device safety, visual improvement and no load and vibration on the pole.

-Sensor, energy and communication system connections must be durable and clearly labeled in the data collection unit.

Grounding and lightning protection:

• An effective lightning protection and grounding system can be installed to protect the measuring station from lightning and sudden voltage fluctuations. The proposed lightning protection and grounding system is described below.

• If a 10 m high mast is used, a solid copper lightning arresting rod can be used (1 – 1.5 m) long enough to rise at least 50 cm above the wind sensors at the top of the mast and to protect the sensors at an angle of 60°.

•This catch point can be connected to at least two grounding rods to be driven into the ground with the down conductor mechanically fixed to the pole and grounding can be done so that the grounding resistance is maximum 10 Ω.

• Equipotential bonding can be achieved by connecting all groundings to the same point.

• The grounding down conductor can be mechanically fixed to the pole at 2 m intervals so that it does not create a knuckle or drooping image.

Data collection unit (data logger):

• Data collection unit (data logger), protection units, communication devices and energy supply units are placed in a box with IP66 (protection classification). The box should be installed at an appropriate height so that it will not be affected by environmental effects.

• The data collection unit (data logger) is an electrical measurement and recording device that runs a program that converts electrical signals from sensors into meteorological parameters. For all the applicant sensors, the conversion coefficient of electrical signals into meteorological parameters, correction etc. will show the values in the data acquisition unit program.

• The data collection unit must have the ability to store the measured and calculated data from the sensors for at least 1 (one) year, communication ports for communication elements and maintenance connections, and protective circuits for impacts from sensors and lightning.

•-Calibration certificates and brochures of all sensors and installation photos taken in the field are added to the report. Protection fence and warning signs should be placed at the solar measurement station in order to take the necessary security measures for the safety of life and property.

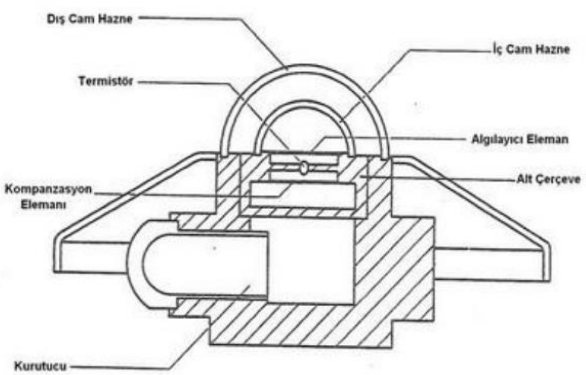
•-Damage, deterioration or loss of data that may occur for any reason in the solar measurement system is the responsibility of the applicant.

•-All measures to be taken at the solar measurement station to prevent damage to the life or property of third parties are the responsibility of the applicant. In the event of such an event, MGM (General Directorate of Meteorology) has no responsibility for the damages of third parties and all responsibility belongs to the applicant.

• -In case more than one solar measurement station belonging to different or same company is established in the same field, the distance of a station from other stations can be at least 5 times the height of the installed pole.

PYRANOMETER

Working Principle



Global (global) solar radiation meter (pyranometer):

The sum of direct and emitted radiation reaching the earth is called global solar radiation (photo above). Solar radiation (insolation intensity) is measured by three different methods:

1. Thermal resistance: Solar energy is absorbed by the black painted disc, whose resistance changes with temperature. By measuring the change in resistance in the disk, the amount of insolation is measured.

2. Thermoelectricity: Solar radiation is collected at the junction of two different types of metals connected to each other. With the effect of heat, a voltage of mV is produced at the junction of the metals. As the radiation intensity increases, the voltage increases. By measuring voltage, radiation is measured.

3. Photoelectricity: Photosensitive photoelectric material generates voltage by solar radiation. By measuring the generated voltage, global radiation is measured.

Pyrometer is the type defined as "First Class – Good Quality" by the WMO (World Meteorological Organization) at least, measurement range: 0–1500 W/m², resolution: 5 W/m², accuracy: ±% 5 (daily total), stability: ± 1.5 % /year (over the entire measuring range).

4.3.2 Sunshine duration sensor (heliograph):

Devices that record the duration of the sun's rays or how much of the day is sunny are called heliographs. The heliograph instrument records direct sunlight from the sun on a diagram. Sunbathing time; It expresses the sum of the minutes during the day when the amount of direct (direct) solar radiation is 120 W/m² or more. Measuring range: minute sunny or no sun, resolution: 1 minute, accuracy: 0.1 hour (hourly total)

4.3.3 Wind speed meter (anemometer)

The wind speed sensor works with three buckets, opto-electronic principle (according to the number of turns). The bucket rotates with the effect of the wind. The speed is determined according to the number of turns per unit time. There are different methods for determining the number of turns. However, the most widely used system is the photodiode and magnetic switch method. The bucket is connected to a disc by the shaft. The slot in the disk has an LED or magnet on one side and a photodiode or magnetic switch on the other.

As the disk rotates, the photodiode or magnetic switch generates a pulse. The wind speed is measured by counting the blow produced.

Measuring range: 0 - 65 m/sec, threshold value: 0.5 m/sec, resolution: 0.1 m/sec, accuracy: ± 0.5 m/sec (up to 5 m/sec), ± 10 % (5 m/sec' above), distance constant : 2 - 5 m

Wind direction meter: The wind direction sensor is mounted so that the marked part points north. It works with the potentiometer principle (Picture 1.4). Measuring range : 0…360°, resolution:1°, accuracy: ± 5°

Air temperature meter: The sensor will be installed in a properly ventilated special shield. The shield used in the temperature sensor must be made of a material that is least affected by sun exposure. The temperature is measured with a resistance thermometer (RTD). The measuring element used in the resistance thermometer is Pt-100. The Pt-100 is the most widely used resistance thermometer for temperature measurement. The measuring element is platinum. At 0°C, the resistance is 100W. As the temperature increases, the resistance increases linearly. The resistance of Pt-100 is measured and converted to temperature. A 4- wire measuring system is generally used to make precise measurements. Measuring range: - 40 °C…..+60 °C, resolution: 0.1 °C, accuracy: ± 0.3 °C

4.3.4 Air Humidity Meter

Meteorologically, the relative humidity of the air is measured. The maximum rate of water vapor that air at any temperature can carry at the same temperature is called relative humidity. Moisture is measured using a polymer film with varying moisture-resistance capacity (Figure 1.3). The dielectric coefficient changes as the polymer film

absorbs the humidity of the air. The change in dielectric coefficient changes the capacitance. Thus, when the capacitance is measured, the humidity is also measured. The sensor is properly ventilated. It will be installed inside the special trench. The shield used on the humidity sensor should be made of a material that is least affected by sun exposure. Measuring range: 0%…..100%, resolution: 1%, accuracy: 3%

APPLICATION ACTIVITY

Process steps	Suggestions
➢ Mount the pyranometer as part of the station installation.	➢ Identify the appropriate location for mounting the pyranometer and begin the installation using a drill.
➢ Carry out the installation and mounting of the anemometer.	➢ Identify the appropriate site for installing the anemometer.
➢ Perform the installation and mounting of the data logger, ensuring careful attention to the system signal status.	➢ The data logger is the data provider of the system. Data is collected from this device, so pay attention to its installation and the connections to other sensors.
➢ Install and mount the heliograph device.	➢ Identify a suitable location for installing the heliograph.

CONTROL LIST

Evaluate yourself by putting an (X) mark in the "Yes" box for the skills you have gained from the behaviors listed below, and the skills you have not gained by placing a "No" box within the scope of this activity.

Evaluation Criteria	Yes	No
6. Has the anemometer been mounted firmly and securely?		
7. Has the data logger been properly fixed in place?		
8. Has the heliograph been properly fixed in place?		
9. Is the station receiving data accurately and reliably?		

EVALUATION

At the end of the evaluation, review your answers as “No”. If you do not think you are proficient, repeat the learning activity. If all your answers are “Yes”, proceed to “Assessment and Evaluation”.

MEASUREMENT AND EVALUATION 4

Read the questions below carefully and fill in the blanks.

1. THE DEVICE THAT MEASURES SOLAR RADIATION IS CALLED …….

2. THE DEVICE THAT MEASURES WIND SPEED IS CALLED ……..

3. THE NAME OF THE DEVICE THAT MEASURES THE AIR TEMPERATURE IS ……...

4. THE NAME OF THE INSTRUMENT THAT MEASURES AIR HUMIDITY IS ……...

LEARNING ACTIVITY–5

PURPOSE

You will know renewable energy pv solar panel parts.

RESEARCH

-Collect information about solar batteries.
-Record the information you have obtained and share with your teacher and friends.

5 BASIC INSTALLATION EQUIPMENT AND CALCULATIONS

5.1 SOLAR PANELS

GENERAL INFORMATION

Semiconductors

Semiconductors conduct current well under some conditions, not conduct under others. The conductivity of pure silicon or germanium can be adjusted by varying the number of free electrons or holes. This is achieved by adding an additive to the semiconductor.

Additive Process

The process of adding foreign atoms to the semiconductor crystal in a controlled manner is called "doping". An increase in the number of current carriers (electrons or holes) leads to an increase in conductivity (reduced resistance), while a decrease leads to a decrease in conductivity (increase in resistance)

N-Type Semiconductor

It is obtained when phosphorus atoms with 5 valence electrons (such as arsenic, bismuth or antimony) are added to the silicon crystal in a certain ratio (Figure 1-1). The 4 valence electrons of the phosphorus atom form a covalent bond with the 4 valence electrons of the silicon. Phosphorus has one valence electron exposed. This electron is very weakly bound to the Silicon atom. The conductivity can be increased by increasing the number of these weakly bound electrons. This happens with the number of atoms added to the silicon. This conductivity electron, which is created as

ıce band

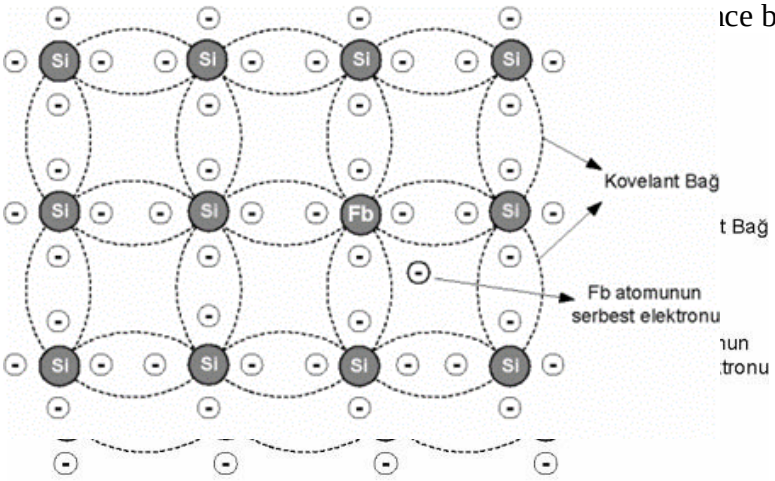


Figure Creation of n-type semiconductor

In n-type semiconductors, electrons are called "majority carriers". Thus, in the n-type material, the current carriers are electrons. There are also few electron-hole pairs formed by heat in the n-type semiconductor. These vacancies are not formed by additive atoms and are called "minority carriers".

P-Type Semiconductor

It is obtained when boron atoms (or aluminum) with 3 valence electrons are added to the silicon crystal in a certain ratio (Figure 1-2). The 3 valence electrons of the boron atom form a covalent bond with the 3 valence electrons of the silicon. However, 1 valence electron of silicon cannot form a bond. In this case, 1 electron deficiency occurs. This is called a “gap” or “hole=hole”. Vacancies behave like positive charges. The amount of additives and the number of voids can be

controlled. Increasing the number of these gaps increases conductivity.

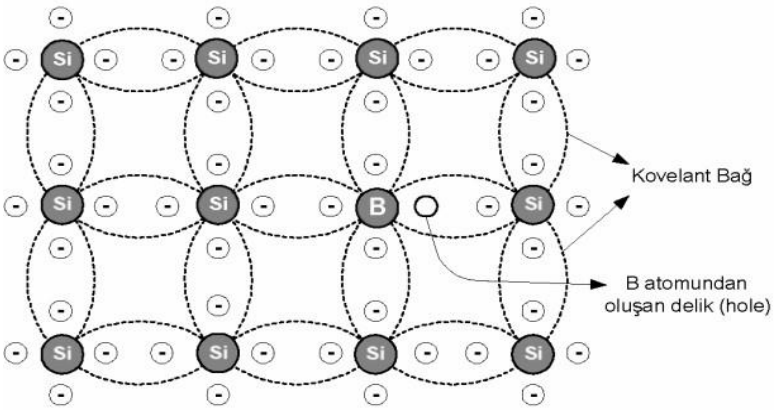


Figure Creation of p-type semiconductor

Formation of p-type semiconductor material In p-type semiconductors, the current is mostly provided by gaps. These gaps are called "majority carriers". It occurs in a small number of free electrons in p-type semiconductors. These are electron-hole pairs formed by heat. These free electrons are not formed during the doping of silicon and are called "minority carriers"

P-n Joint (Joint)

If p and n type semiconductors are brought together under suitable conditions, p-n junction or p-n junction occurs. p-n junction is widely used in electronics industry such as diode, transistor, photovoltaic battery, etc. It is used in the construction of circuit elements. Figure 1-3 shows the structure of the p-n joint.

Neutral Zone

Figure 1-3 shows the structure of the p and n joints. As soon as the junction is formed, some of the free electrons in the n-type semiconductor combine with the holes in the p-type semiconductor. Some of the holes in the p-type semiconductor combine with the electrons in the n-type semiconductor. In this case, the p side gains a net (-) load,

and the n side gains a (+) load. Thus, an "electric field" from an n to p occurs in the joint region and a "potential difference" occurs, this region is called the "purified region".

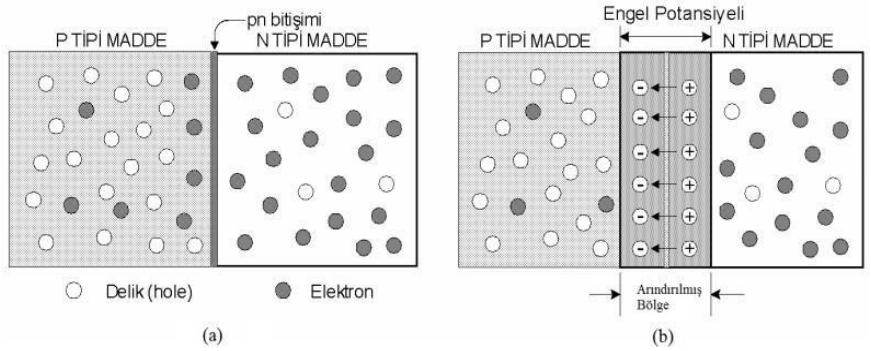


Figure p-n joint

Figure p-n joint shows the purified zone formed by positive and negative ions in the p-n junction region. This potential difference at this junction is around 0.7 V for silicon and 0.3 V for germanium at 250 °C. This voltage is called the “diode bias”. The diode bias is affected by temperature. For example, every 10 °C increase in temperature causes the diode bias voltage to decrease by about 2.3 mV.

5.2 Solar Cells (Photovoltaic Batteries)

Systems that convert solar energy falling on its surface into electrical energy are called “photovoltaic batteries” or “solar cells”. The solar cell consists of two basic layers (Figure 1- 4). The layer where the sun's ray’s fall is called the "Window layer", and the layer where the rays are absorbed is called the "Absorption layer". When the light rays fall on the window layer, the light rays reaching the joint area create an electron-hole pair. With the help of the available electric field in this electron-hole pair junction region, electrons are swept to the n side and to the p side in the holes (Figure 1-4). If the solar cell is connected to an external load, it produces direct current (DC). The smallest unit of a solar cell is solar cells. Cells come together to form modules, modules come together to form panels, and panels come together to form solar fields (Figure 1-5). The desired voltage can be made by connecting in series, and a PV module can be

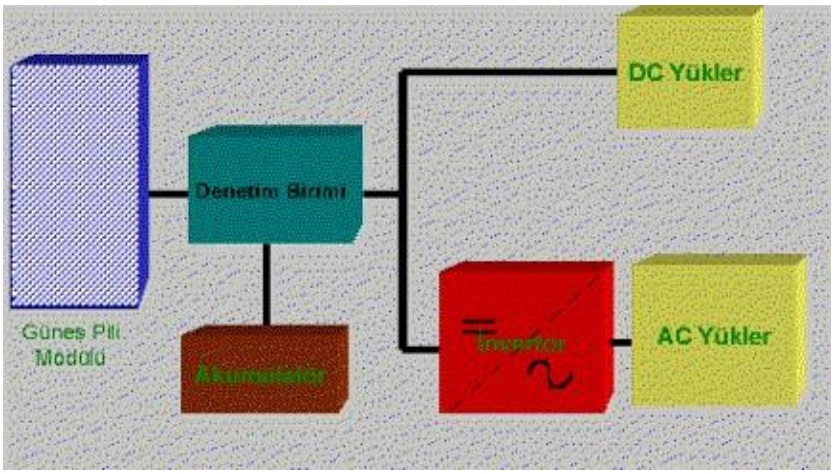
made with the desired current and desired power by connecting in parallel. Depending on the power demand, systems can be built from a few W to MWs.

5.2.1 Connection Formats of Panels

When the panels are connected in series, the short-circuit current remains constant and the open-circuit voltage gradually increases. When the panels are connected in parallel, the open-circuit voltage remains constant and the short circuit current increases.

5.2.2 Photovoltaic System Components

It consists of PV modules, PV cable connections, inverter , Loads and Battery(optional)



Parallel connection of the panels

Briefly, Solar Panel technology has made a lot of progress since 1839. It has made good progress in terms of efficiency and cheap solar panel prices. If the history of solar panels is listed below in chronological order

The main types of solar panels are:

- monocrystalline solar panel (Monocrystalline Silicon Solar Module)
- polycrystalline solar panel (Polycrystalline Silicon Solar Module)
- thin film solar panel (Thin Film Solar Module)

• flexible solar panel

• transparent solar panel

5.2.3 Monocrystalline Solar Panel (Monocrystalline Silicon Solar Module)

The most efficient solar panel among the solar energy panel types is monocrystalline. This type of solar panel produces big energy in a small space. However, the price of monocrystalline energy panels is comparable to other solar panels is more expensive than the efficiencies of monocrystalline solar cells are about 24%. This rate is much higher than other solar energy panels on the market. But the unit price per watt is also in the same way, it can find almost 2 times more than other energy panels. These solar panels have a longer usage and electricity production life. In addition, monocrystalline solar panels can operate more efficiently in hot climates. Finally, in case of more or less shading these solar cells, the entire solar panel can be adversely affected.

5.2.4 Polycrystalline Solar Panel (Polycrystalline Silicon Solar Module)

We can say that the polycrystalline solar panel is a complete market product. It is balanced in terms of both efficiency and unit cost, and it is the cheapest solar panel. Many solar power plants are built with polycrystalline solar panels. Almost more than 68% of the market uses polycrystalline solar cells. In addition, it cannot be said that it is affected by temperature changes in the air (compared to monocrystalline). The efficiency rate of these solar cells is around 15%. Polycrystalline solar panel occupies

5.2.5 Film Solar Panel (Thin Film Solar Module)

Thin-film solar panel has the smallest share in the solar power generation market. Thin film solar cells are not preferred. The biggest reason why this type of solar panel is not preferred is its low efficiency. These thin-film solar cells take up a lot of space. But despite taking up so much space, it has a very bad performance in terms of space-efficiency relationship. The approximate efficiency of this type of solar panel is around 7%. This is really low efficiency. However, these solar panels have a very stylish

appearance. We can say that it is preferred for more design. Moreover, it is not overly affected by extreme temperature changes and shading.

5.2.6 Flexible Solar Panel

Flexible solar panel is a solar panel with a lot of usage possibilities. These solar cells are really very flexible. And flexible solar cells are unbreakable and very durable. The structure of this type of solar cells can be both monocrystalline and polycrystalline. In this case, it also diversifies the efficiency of these energy panels. Flexible solar panel, very light. Because these panels' aluminum frame and tempered they don't have windows. This makes them much lighter. It is also very ideal for dome style pitched roofs. The roof does not have to be flat. As for usage areas, whatever comes to your mind can be preferred. For example, bus shelters, sloping factory roofs, sloping parking canopies.

5.3 TRANSPARENT SOLAR PANEL

Actually, this is not a solar panel. But it is a good method for generating electricity from solar energy. Thanks to a sphere filled with water, maximum efficiency can be obtained from the light. It seems that the global solar generator will come to the fore much more in the future. It is currently on sale in the market.

5.3.1 INVERTERS

Inverter, power converter or inverter, which can be defined as an electrical power conversion element, is used in many different areas from small power supplies used in computers to large systems powering electrical distribution systems. Inverter provides AC current at desired voltage, power or frequency values. In solar panels, wind turbines to generate electricity from renewable energy sources; Inverters are used in televisions and lighting lamps so that they can be operated in mobile environments such as cars, boats or camping areas. In particular, as a result of studies on the benefits

of renewable energy sources and the increase in the need and demand for these systems, more quality and stable inverter types with more features are produced in order to make the energy obtained from wind and solar energy systems suitable for use. Devices with microprocessor or low voltage control, alarm and warning outputs, overload protection and static regulation are offered to the market by manufacturers. Since there is no inrush current, the devices that do not harm the network operate at minimum and maximum ranges. The purpose of the inverter development is to save money. The inverter device, which cleans the voltage fluctuations and peaks coming from the network by passing it through the filter circuit, reduces the motor and mechanical parts faults caused by these effects; this minimizes the repair and maintenance costs of these parts and extends their life. In addition, the inverter allows savings by reducing reactive energy.

5.3.2 Types of Inverters

There are 2 types of inverters, square wave and full sine, giving 220 Volt AC output. Square wave inverter, also known as modified sine, has an algorithm called maximum power point tracking (MPPT). Developed to achieve maximum efficiency, this

The algorithm automatically performs its calculations on the current load in the system. Since modified inverters do not give pure sinusoidal electrical output, they are used in refrigerators, washing machines, sensitive electronic devices, etc. may cause malfunctions of the devices. If the inverter (inverter) is going to be used for feeding such sensitive loads, a pure sine inverter should definitely be preferred. Square wave inverter (modified sine inverter) is suitable for low precision work such as lighting and heating. Full sine inverter operating without any problems in motorized loads, suitable for heavy loads, high starting current

It is advantageous for loads due to its high inrush capability. A full sine inverter sets incoming voltages and frequencies as full sine waves. Their operating frequency is

50/60 Hz, and their efficiency is between 89% and 94%. The waveform used in the network is full sine. In fact, a pure sine wave does not exist. Due to various losses and harmonics, the pure sine wave form comes to mind only when the mains electricity is theoretically mentioned.

How to Select Inverters by System?

Inverters, which have a light and portable structure at small powers, have the opportunity to work at different voltages according to each system. Generally, inverters, which can operate in the power range of 50W-50kW, provide quiet operation and high efficiency in various systems they have advantages. Inverters selected according to the way they will be used in the system support many features. For example, inverter models with microprocessor control or low voltage control, alarm and warning outputs can be preferred. Overload in another system a protected, statically regulated inverter variant can be selected. While selecting the power of the inverter to be used, it should not be less than 10% of the power of the PV plant feeding the inverter for on-grid systems, and for off-grid systems.It is often preferable that the load to be fed is chosen to meet the demand value.

5.4 POWER ANALYZERS

In addition to producing energy, one of the other important issues is to use energy with high quality. The first condition of using energy with quality is to follow it in every aspect. With network analyzers, it can measure every parameter of electricity, which is an invisible power, and savings in facilities. Various parameters of an electrical distribution system are monitored and measured with an energy analyzer. It is of great importance to use energy analyzers in facilities to improve energy quality. For example, in order to reduce electrical waste in a building, the cost and relations of loads (such as air conditioning, heating) can be calculated and an energy plan can be determined according to the data obtained later. Measured data for energy quality and network analysis can be transferred to remote monitoring and control software thanks

to the communication feature of the devices. Single- phase-three-phase systems RMS values, phase-neutral & phase-phase voltages, neutral current, total current, phase currents, power factor, instantaneous active power (W),instantaneous apparent power (VA), reactive power (VAr), frequency (Hz), average and maximum powers, harmonic distortion, active power consumed per hour (Wh),Inductive reactive energy (kVArh or MVArh), capacitive reactive energy (kVArh or MVArh) and phase angles, which can also occur in the electrical network and cause the failure of electronic devices and electronic cards in all equipment; It measures the instantaneous rise (right), instantaneous fall (swell) values and saves them in its memory. In this way, the quality of the network can be analyzed and with the necessary interventions, malfunctions can be prevented before they occur.

5.5 SOLAR CHARGING REGULATOR

A charge controller is a device that prevents the battery from being overcharged by "regulating" (balancing/managing) the current and voltage (voltage) coming from the solar panels. Although 100 Watt or 150 Watt solar panels are offered as 12 V, you can see in their technical specifications that the voltage is higher (17-18.5 V). If the batteries are charged directly with this voltage, the batteries will be damaged. A voltage of approximately 13.6-14.4 volts is needed to fully charge a 12 Volt battery, and the charge regulator ensures that the batteries are charged as soon as this voltage is reached. The charge controller cuts off the current after the batteries are full. Thus, the battery is not overcharged and the battery life is longer.

The reason why solar panels do not have 12 Volt output as standard is as follows:

The most important reason for this is that the sun does not reflect optimally all the time, the air temperature is not always at the desired temperature, and other ideal conditions are not always available for the solar panel to produce electricity in the best way. Because of these sensitivities output voltage of solar panels is set higher. In this way, it is tried to obtain the maximum level of 13.6 -14.4 Volts needed by the batteries.

The solar charge controller is selected according to the current from the solar panel and the total solar panel power. The charge controller is the most important device that affects the performance and life of your solar energy system. If the charge controller is of poor quality, the life of your solar energy system will not be very long. One of the most important causes of fires in solar systems is the wrong choice of these devices.

Solar Charge Controller Selection

The first point we will pay attention to when choosing a charge controller is the selection according to the power of the system. Step by step solar charge controller selection is as follows;

1. Selection According to Solar Panel Power

One of the first points we should look at is the solar panel power and number in the solar energy system. You can choose a PWM charge controller up to 450 Watt and 40 Ah solar panel power in total. If the solar panel power is higher than 450 Watts, the charger we call MPPT .

You need to select the controllers. If you connect a solar panel with a power higher than 450 Watts to the PWM charge controller, the solar charge controller will probably burn out in a short time.

2. Selection According to the Number of Solar Panels

Normally, solar panels with a power of 150 watts are considered 12 volts. 250 watt solar panels are considered 24 volts. You can use it at maximum power by connecting 3 pieces of 150 watt solar panels in parallel to the 30 Ah charge controller. However, in this case, the total solar panel voltage remains at 12 Volts. If you want to connect it as 24 volts, you must connect 2 pieces of 150 watt solar panels in series. Only in this case, 3 pieces of 150 watt panels cannot be connected in series. That's why you need to know the relationship between the solar panel and the charge controller well.

3. Selection According to Battery Voltage and Number of Battery

If the battery voltage to be used is 12 Volts, the charge controller should also be 12 volts. Likewise, 24 volt and 48 volt options can be selected. The most important point here is that the PWM solar charger voltage and the battery voltage should be the same.

4. Solar Charge Controller: Does it have a screen? No screen?

You can instantly see the voltage of your batteries with the screened solar regulator. If the battery voltage drops below a certain level, your batteries will start to run out. In this case, if you do not interfere with the batteries, the batteries will break down irreversibly. You also get a chance to see the voltage and current coming from the solar panel. Thus, if there is a glitch in the solar panels or the solar panel connection, you can immediately detect it. If the solar panels do not charge your batteries for a long time (in days), the battery life starts to run out. In short, if you want to monitor the solar energy system easily, a charge controller with LCD screen should be selected.

5. Selection According to Battery Type and Battery Type

Many types of batteries can be used in solar energy systems. Wet type batteries, dry type batteries or gel batteries can be preferred. In this case, the solar charge controller you will use must be able to distinguish between battery types. Or, depending on the battery to be used, you should be able to manually change the voltage values of the charge regulator. Because it is recommended to charge at a certain speed for each battery. The purpose of this is to extend the life of the batteries. Many pwm chargers on the market have this feature. And whichever type of battery you connect, it can immediately identify that battery and automatically program itself accordingly.

5.6 BATTERY AND BATTERY GROUPS

What is Solar Battery?

What is a solar battery? It is the most popular electrical system among power systems. Considering the power cable to be used, it is seen that these cables have low efficiency and high cost. In this respect, these batteries are preferred in order to eliminate these problems and achieve higher efficiency. As a matter of fact, thanks to these batteries, you can store electrical energy and use it wherever you want. These needs are increasing day by day and the importance of wiring begins to decrease. Cells containing a gel-like electrolyte are called solar batteries. In particular, these batteries are resistant to environmental conditions, including temperature and vibration. For this reason, they are preferred especially in renewable energy systems such as wind and solar.

Why Use Solar Battery?

Solar batteries are generally used for storage. It has a feature that saves electrical energy to avoid working in current times. At the same time, the existence of sunless days is important for the storage of energy. The most important issue to determine the power of the solar battery is to calculate the number of days or hours that will not be sunny.

How Does a Solar Battery Work?

The purpose of the storage system is clear. It is generally used to provide solar energy in the evening and at night when necessary. The principle here is that the energy produced by the solar system is first used for its own consumption. This means that electrically active consumers such as refrigerators and other appliances will be powered by solar energy instantly. However, if there is more power than needed, the extra power will flow into the battery and be recharged. If the battery is not charged and there is no demand in the house, power will be supplied to the grid. If the demand

in a day is more than the amount of energy produced by the sun, the accumulated energy can be used regardless of whether the battery is fully or partially charged. Power is taken from the grid only when the solar battery is completely discharged. Therefore, the electricity produced by the solar power system can meet most of the energy needs.

Solar Battery Features

Solar batteries are available in various sizes and can be smaller or larger. In general, size and weight vary depending on the capacity of the solar battery. Specifically, the sizes of solar batteries range from 4 kg to 100 kg. If you need a battery with a large storage capacity, you need to make sure you have enough room to accommodate as many batteries as you need.

At the same time, the electrical capacity of the solar battery is variable. Multiple solar batteries are available, designed for individual needs. Usually a 2V solar battery provides the most storage capacity, but if your system is 48V, you can get more efficiency. In addition, these batteries can be connected in series, parallel or a combination of both, depending on the system voltage and storage capacity. Large capacity solar batteries can be costly, but with regular maintenance they can last 5-10 years.

Solar Battery Types

Solar battery has four different types. These are differentiated as marinated, flooded, gel and AGM. RV or marine solar batteries are ideal for small systems and are often used by boat and RV owners. In addition, these types of batteries have low continuous operating capacity and offer the best performance that other types of electricity cannot produce. Flooded batteries have a longer life compared to marine solar batteries. It is recommended to be used outdoors as it releases gas during charging. Unlike flooded solar batteries, gel batteries do not have holes and do not release gas.

Therefore, ventilation is not critical and such batteries can be used indoors without risk. AGM batteries use glass between the plates to store the electrolyte. Such batteries are sealed, meaning they do not release gas while charging. In addition, AGM batteries

have the same performance as other batteries. In this respect they have all the advantages of gel batteries, but of higher quality. Other benefits are that they can hold tension better and ultimately last longer.

Which Solar Battery Type Should Be Used?

There are several points to keep in mind when choosing a solar battery for a solar power system. So you cannot add any battery to the system. These actions reduce the efficiency of the system. Thus, it does not provide the necessary power and even the system may malfunction. Things to consider when choosing a battery are generally:

• Lifespan: The life of gel batteries is about 8-10 years, while the maximum life of lead-acid batteries is 2-3 years.

• Safety: Lead acid batteries emit gas and should be installed in a well-ventilated room. For gel batteries, this is not necessary.

•Discharge depth: The gel battery is discharged up to 100% of the stored energy. Lead-acid batteries, on the other hand, can only discharge up to 50%.

• System efficiency: Gel battery system efficiency can exceed 90%, while lead acid battery can be around 70%.

Solar Battery Advantages

Solar battery advantages can be listed as follows:

• It has a long service life.

• They have high energy densities.

• Self-depletion rates are low.

• Accepts ideal charge.

• It is resistant to heat.

• It has a high operational safety.

• It shows resistance to abrasion.

Solar Battery Maintenance

Solar battery maintenance is important as it can significantly affect the life of a solar battery. This means that the battery must monitor enough temperature and humidity to cause a voltage drop that degrades performance, depending on the equation. Another important point to consider is the depth of discharge of the battery before the next charge. If you keep the solar battery as full as possible, they will last even longer. Lead-acid batteries work best when fully charged. It will last a long time if you do not drain it well. However, there is a risk of a shorter lifespan and can withstand discharges maximally. The battery charge rate can be determined with a voltmeter.

SOLAR BATTERY VOLTAGE STANDARDS

The maximum voltages of the solar panels are as written on the label values, they do not go out of this. Measured values will vary.

The reasons for this variation are:

1. Panel angle
2. Luminous intensity
3. Material quality

Panel angle: Positioning at a 90 degree angle to the sun will always increase efficiency. The reason is that the rays come to photovoltaic cells without being completely dispersed, which is always better in terms of efficiency, but we may not catch it in practice.

Luminous intensity: The intensity of light will always show priority and excess in terms of latitude.

Material quality: The quality of the material will always have a direct impact, so the material types will also affect the quality, a polycrystalline material and a monocrystalline material will not be the same.

3. SOLAR ENERGY COMPUTATIONS

Residential solar power plant technical analysis and calculations

-The PV system we will install should be of a quality that will provide all the annual electrical energy needs of a house.

- We can calculate the annual electricity consumption by adding together the electricity bill values of January and July and multiplying by 6: If the electricity consumption in January is 240 kWh and the consumption in July is 160 kWh, the total amount is 2400 kWh/year.

- In this case, the annual return of our PV plant, which we have planned as a roof type (fixed position), should be at least 2400 kWh

- Our region is 38.-39. In latitudes, we can get the sunshine duration of Turkey as 7.2 hours/year, which is the average sunshine duration.

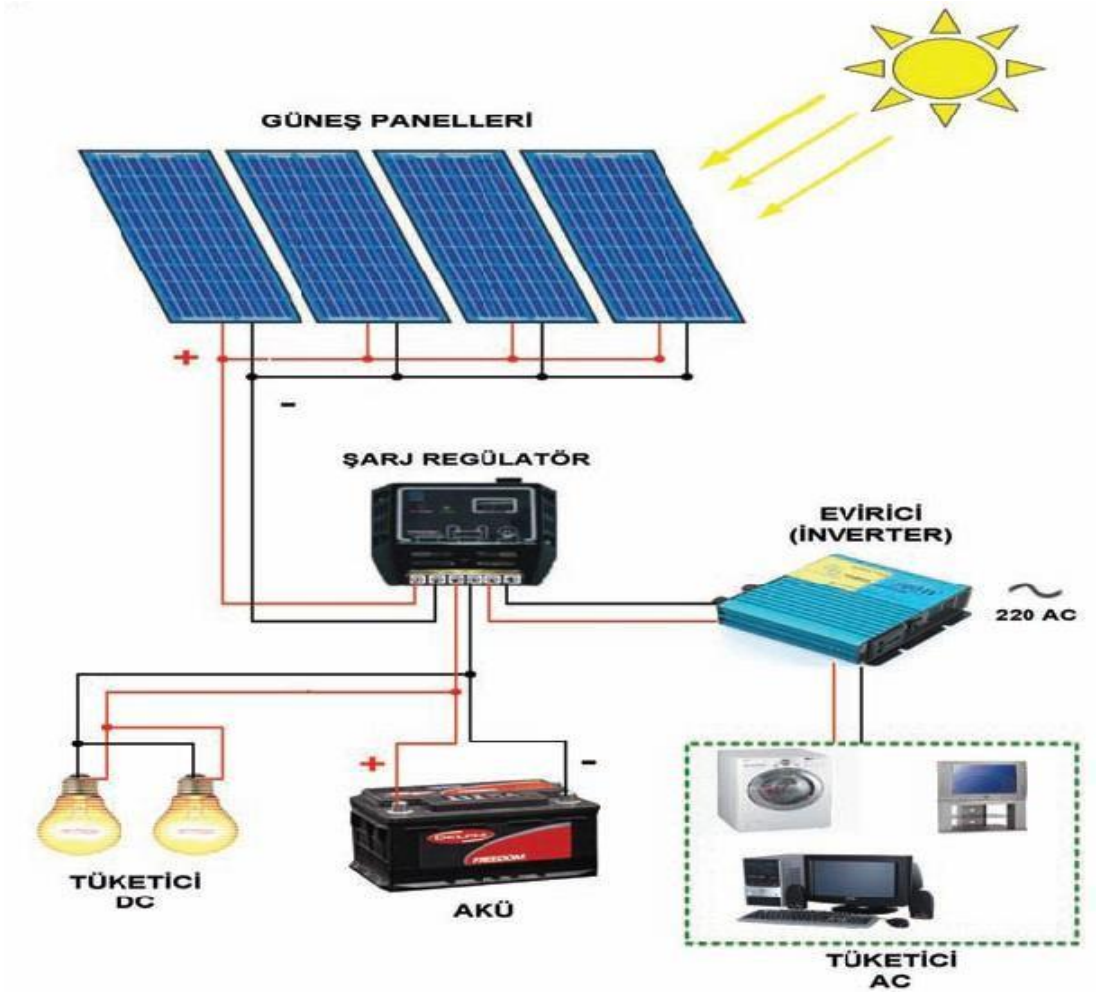
- System efficiency can be between 55-65% in fixed sunbathing. Using the 60% value, our expression is;

If 2400 = Wp(system) x 0.6 x 7.2 x 35 is written, it is calculated as Wp(system) = 2400

/1577 = 1.52 KW (1542 Watts).

If the cost per watt is 6-7 TL, the money to be allocated for this work will be 9-10 thousand TL. The recovery period for a total invoice value of 1000 TL/year is 9-10 years.

5.7 PV ENERGY SYSTEM SIMPLE INSTALLATION



For the installation of the system, first of all, the panels must be connected in series or parallel with each other (according to the desired voltage and current values). Since it will be charged, we can feed DC loads with cables coming from or going to the battery.

The cables going to the Inverter will go as DC and these will come out of the Inverter as 220 AC and will feed the AC loads. Load cables + and - values are important in DC cabling, pay attention to this, otherwise all materials in the system may be damaged.

APPLICATION ACTIVITY

Process steps	Suggestions
➢ Expose the solar cell to sunlight if there are suitable conditions. (If not possible, use an artificial light system (projector).	➢ The location where the light intensity is intense enough is selected.
➢ Measure the voltage produced by the solar cell with a DC voltmeter and record it in the table.	➢ Take the measuring instrument to volt level.
➢ Change the angle by 10 degrees. Record the voltage value obtained from the panel in the table at each change.	➢ Determine the angles and record the measurements.
➢ Record the received values in the table. ➢ End the experiment.	➢ Return the set as you received it and leave it ready for the next experiment.

CONTROL LIST

Evaluate yourself by putting a (X) in the box for the skills you have gained from the behaviors listed below within the scope of this activity.

Evaluation Criteria	Yes	No
1. Is the anemometer fixed enough?		
2. Is the data logger fixed?		
3. Is the heliograph fixed?		
4. Is the data received on the station in a healthy way?		

EVALUATION

At the end of the evaluation, review your answers as “No”. If you do not think you are proficient, repeat the learning activity. If all your answers are “Yes”, proceed to “Assessment And Evaluation”.

Read the questions below carefully and mark (D) for the correct sentences and (Y) for the incorrect ones..

1. ( ) The system element that converts DC current to AC is called an inverter.
2. ( ) Silicon is used to ensure that the voltage value produced in the system is complete and smooth.
3. ( ) Panels are produced in only one type.
4. ( ) Batteries are generally preferred as gel batteries in the renewable energy sector.

MODULE EVALUATION

In the parentheses left blank at the beginning of the sentences below, write D if the information given in the sentences is true, and Y if it is false.

1 ( ) The difficulty shown against the current is called a diode.

2 ( ) Renewable energy resources include fossil resources.

3 ( ) Files are used to shape the metal by taking sawdust from the metal.

4 ( ) Solar panels are produced in two types.

5 ( ) When charging and storing batteries, the charge controller provides space for storage.

6 ( ) Anemometer is a material used to measure solar radiation.

EVALUATION

Compare your answers with the answer key. Return to the activity and repeat the topics related to the questions that you gave wrong answers or hesitated to answer. If all your answers are correct, proceed to the next performance test.

CONTROL LIST

Evaluate yourself by placing a check mark (X) in the Yes box for the skills you have gained from the behaviors listed below within the scope of this module, and No for the skills you have not gained.

Evaluation Criteria	Yes	No
1. Has the Ground Investigation of the Solar Power Plant been defined?		
2. Has it been determined that the parameter values to be applied for the SPP can be measured and monitored?		

3. Have the electrical characteristics of the devices whose parameters were determined, taken into account?		
4. Is it planned to monitor the automatic installation of the determined circuit elements of the electrical properties?		
5. Has the system been controlled if necessary?		
6. Has the operation of the system been checked?		
7. Did the system values provide control over scada?		
8. Was the efficiency observed by comparing the scala values with other values?		

EVALUATION

At the end of the evaluation, review your answers as "No". If you do not think you are proficient, repeat the learning activity. If all your answers are "Yes", contact your teacher to move on to the next module.

ANSWER KEYS

ANSWER KEY TO LEARNING ACTIVITY-1

1	Short circuit
2	Current, Voltage, Resistance
3	Grounding
4	Conductor, Insulator

ANSWER KEY TO LEARNING ACTIVITY-2

1	Resistance
2	Condenser
3	Potentiometer
4	Ceramic condenser
5	Diode

ANSWER KEY TO LEARNING ACTIVITY-3

1	Correct
2	False
3	Correct
4	False

ANSWER KEY TO LEARNING ACTIVITY-4

1	Pyranometer
2	Anemometer
3	Thermometer
4	Heliograph

ANSWER KEY TO LEARNING ACTIVITY-5

1	Correct
2	False
3	False
4	Correct

ANSWER KEY TO MODULE EVALUATION

1	False
2	False
3	Correct
4	False
5	False
6	False

REFERENCES

Http://www.cn.com.tr/ingilterede-gunes-ilk-defa-komuru-gecti/
Homes in England Producing Their Own Energy with Solar Energy

Http://www.cn.com.tr/tesla-2-giga-fabrikayi-avrupada-kuracak/
Planned Solar Power Plant Project TESLA-2

Turkish Ministery of Education Renewable Energy Systems 'MEGEP' modules

Http://www.solarbaba.com/index.html