ODA-UNESCO PROJECT

The Training Course of " Workshop on Promotion of Energy Science Education for Sustainable Development in Myanmar"

Theme 5

Renewable Energy Technology

Presented by

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Proposed Time Table For Theme 5

Wind Energy	45min
Solar Energy	45min
Solar Energy application	25min
Small hydro turbine	20min
Bio mass and Bio diesel	25min
Wave and Tide energy	20min
Geothermal Energy	45min

OBJECTIVES AND LEARNING OUTCOME OF THEME 5

The objective of this theme is give a general overview of different technologies, especially those which are potentially feasible in Myanmar.

After completing this theme, the participants should be able to

- Define the RE and sustainable energy.
- List different technologies of renewable energy
- Describe the advantages and disadvantages of different technologies
- Explain the concept of different technologies
- Describe the role of different components used in each technology
- To know the uses of RE technology in Myanmar.
- To know the public awareness of RE technology in Myanmar.

Introduction

- Types of Renewable Energy
- Renewable Energy Resources in Myanmar
- World Wide Situation of Renewable Energy Applications

The Challenge

- Today's pattern and trends in overall energy demand and supply are not sustainable, neither in industrialized nor in developing countries.
- This can only change if the inherent benefits of efficiency and renewable energies are harvested through integrated strategies.

Fossil Fuel

Coal, **oil** and **gas** are called "fossil fuels" because they have been formed from the organic remains of prehistoric plants and animals.

How it works:

- **Coal** is crushed to a fine dust and burnt.
- **Oil** and gas can be burnt directly.
- **Natural gas** provides around 20% of the world's consumption of energy, and as well as being burnt in power stations, is used by many people to heat their homes. It is easy to transport along pipes, and gas power stations produce comparatively little pollution.

Solution

- Both energy end-use efficiency and renewable energies can reduce demand for risk-loaded fossil fuel and nuclear energies but only if they are combined will they enable an affordable and risk-minimizing path to sustainable energy systems.

ENERGY

- It is the ability to do work.
- In physics, work is done when a force applied to an object which moves it some distance in the direction of the force.
- Mathematically, W = Fs, where W is the work done, F is the force applied, and s is the distance moved.

DIFFERENT ENERGY SOURCES

- ‘Traditional’ fuels such as fuel wood, crop wastes, and animal dung.(non-commercial)
- Fossil fuels such as coal, oil and natural gas (commercial ‘traditional’ fuels)
- Non-traditional renewable energy sources as hydro, modern biomass, solar, wind, ocean and geothermal.

Sustainable Energy

- **Sustainable energy** is the sustainable provision of energy that meets the needs of the present without compromising the ability of future generations to meet their needs.
- Technologies that promote sustainable energy include renewable energy sources, such as hydroelectricity, solar energy, wind energy, wave power, geothermal energy, and tidal power, and also technologies designed to improve energy efficiency.
- Energy efficiency and renewable energy are said to be the *twin pillars* of sustainable energy.

Definition of Renewable Energy

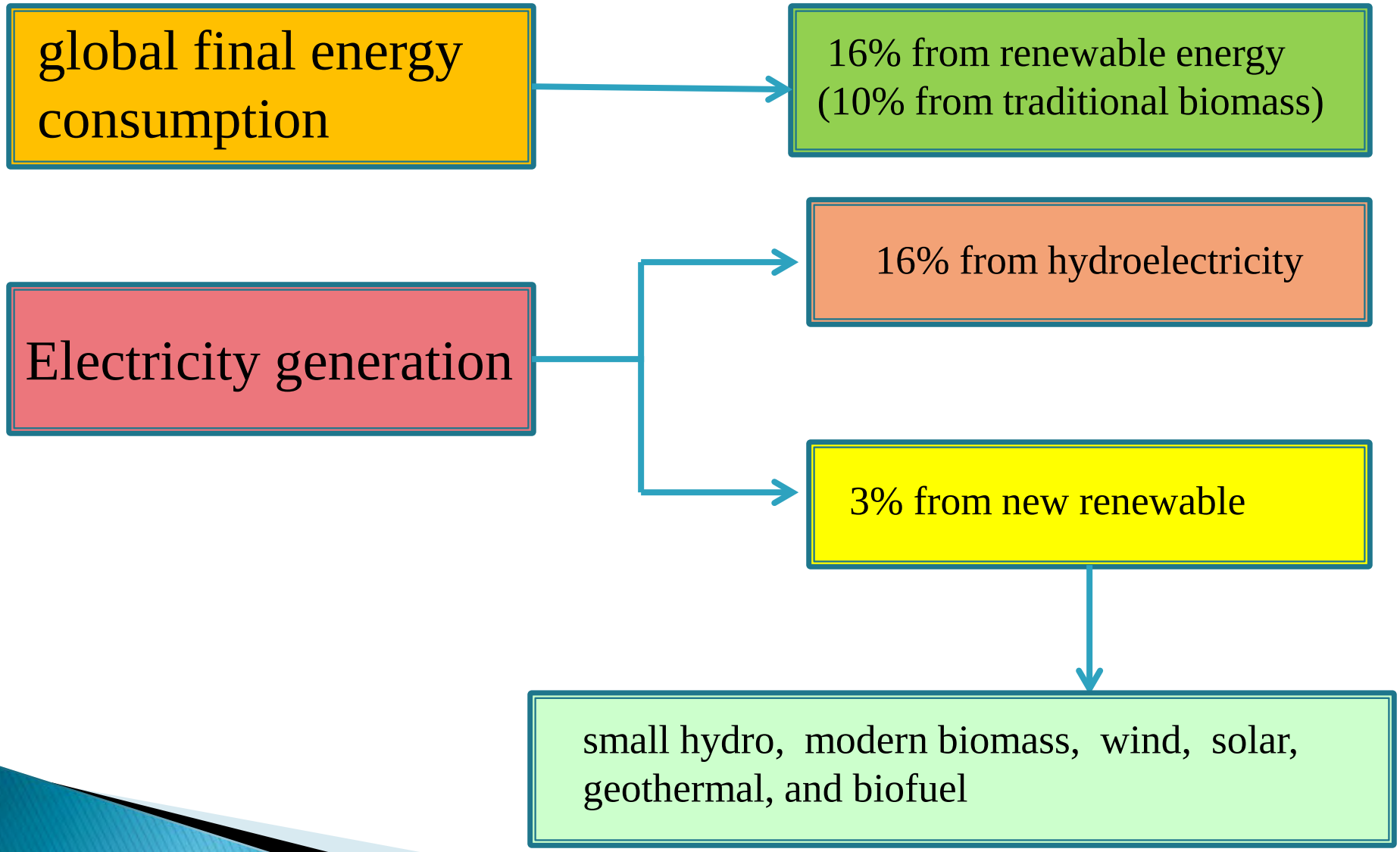
- **Renewable energy** is energy which comes from natural resources such as sunlight, wind, rain, tides, waves and geothermal heat, which are renewable (naturally replenished).

- About 16% of global final energy consumption comes from renewable, with 10% coming from traditional biomass.

- The share of renewable in electricity generation is around 19%, with 16% of global electricity coming from hydroelectricity and 3% from new renewable.

- New renewable (small hydro, modern biomass, wind, solar, geothermal, and biofuel) accounted for another 3% and are growing very rapidly.

Consumption of Renewable Energy



Characteristics of renewable energy sources

- High installation costs
- Low fuel costs
- Long term use
- Spread out to public awareness
- Highly site-specific
- Intermittent

Types of renewable energy

1. Solar energy
2. Wind energy
3. Hydro power
4. Biomass energy
5. Ocean energy
6. Geothermal energy

Solar Energy

Solar Energy

- Introduction to Solar Energy
- Solar Energy Calculation
- Solar energy technology –
  - Solar PV
  - Solar thermal system
  - Solar Energy Potential In Myanmar
  - Solar Energy Application in Myanmar
  - Solar Energy Research in Myanmar

Introduction to Solar Energy

Solar power is energy from the Sun.

We've used the Sun for drying clothes and food for thousands of years, but only recently we have been able to use it for generating power.

- The Sun is 150 million kilometres away from the Earth and amazingly powerful.

- Just the tiny fraction of the Sun's energy that hits the Earth is enough to meet all our power needs.

- In fact, every minute, enough energy arrives at the Earth to meet our demands for a whole year.

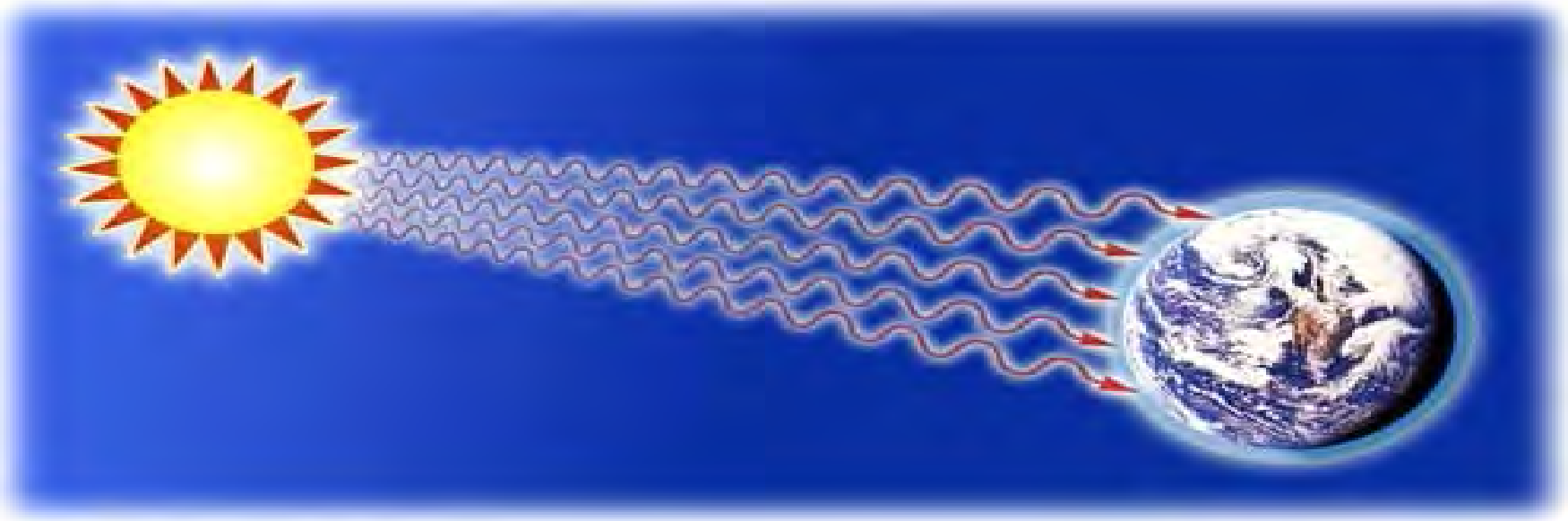
What is Solar Energy?

- Solar Energy is the radiation from the sun that is capable of producing heat, causing chemical reactions, or generating electricity.

- It is the largest source of energy received on Earth, but its intensity on the earth's surface is quite low.

- Solar energy is rapidly becoming the ultimate energy source because of its non-polluting character and its inexhaustible supply which are in stark contrast to such fossil fuel sources as coal, oil, and natural gas.

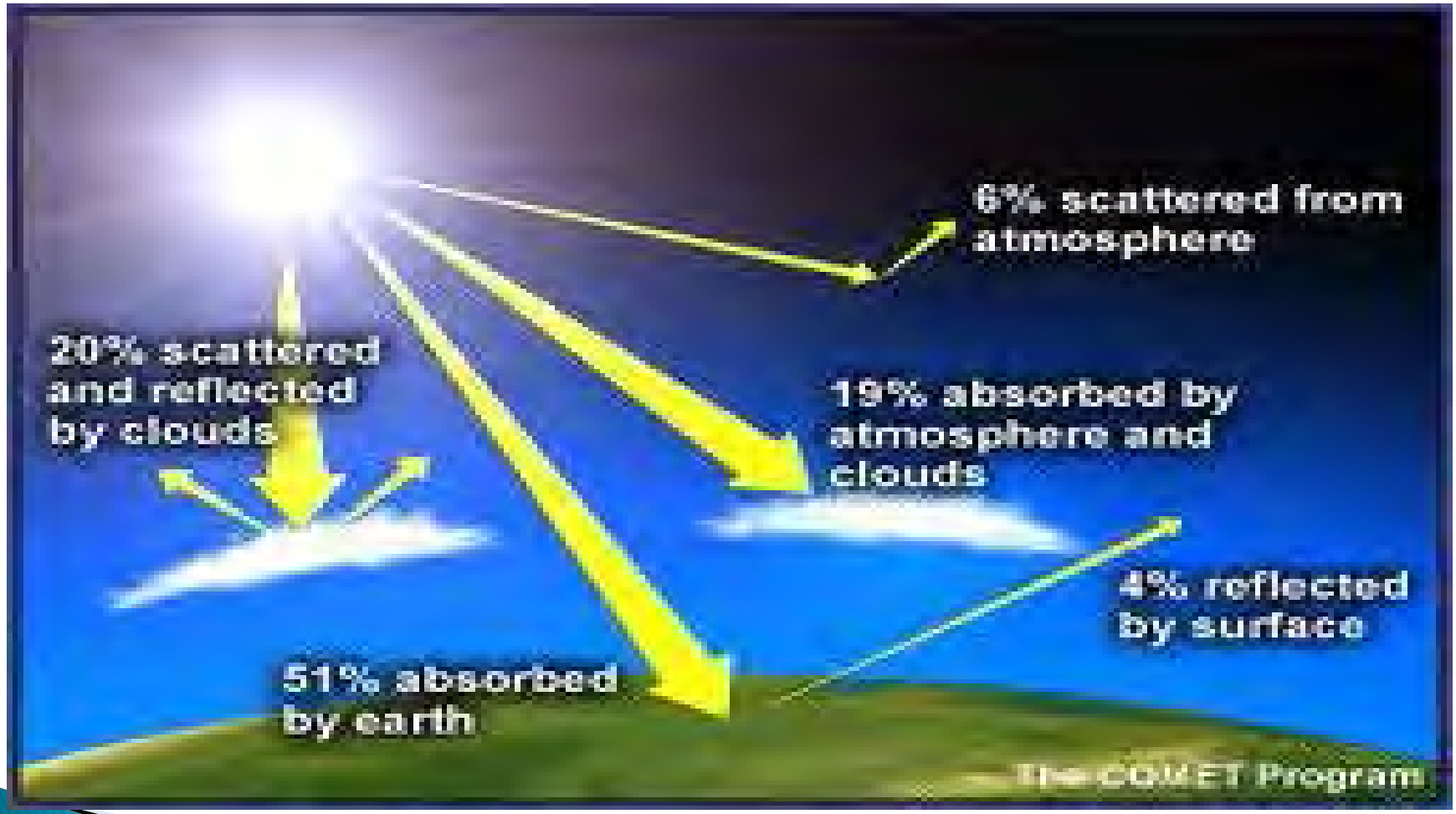
Solar resources



The sun emits light with a range of wavelengths, spanning the ultraviolet, visible and infrared sections of the electromagnetic spectrum.

Fig Source. 3.bp.blogspot.com

Solar resources



Source. www.johnsonwindowfilm.com

Composition

- The Sun emits EM radiation across most of the electromagnetic spectrum

- **The Sun does, however, emit X-rays, ultraviolet, visible light , infrared, and even Radio waves.**

- **When ultraviolet radiation is not absorbed by the atmosphere or other protective coating, it can cause damage to the skin known as sunburn or trigger an adaptive change in human skin pigmentation.**

Composition (cont.)

- The sunlight that reaches the ground consists of nearly 50% visible light, 45% infrared radiation, and smaller amounts of ultraviolet light and other forms of electromagnetic radiation.

- This radiation can be converted either into: thermal energy or into electrical energy.

Composition (cont.)

Two main types of devices are used to capture solar energy and convert it into thermal energy:

Flat-plate collectors and Concentrating collectors. The flat plate collectors are used for hot water heating and house heating.

Concentrating collectors are used when higher temperatures are needed. That is, where they reflect and concentrate sunlight from a wide area.

Composition (cont.)

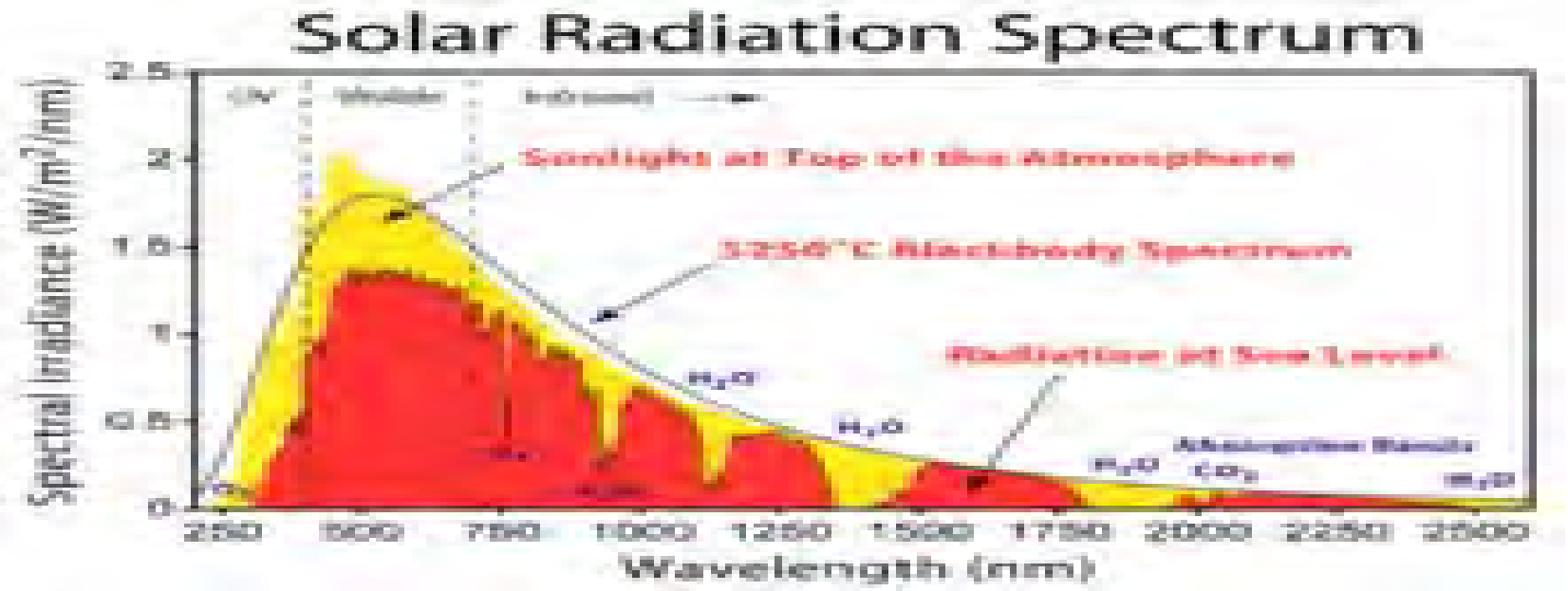
- Solar energy can be converted to electricity using photovoltaic cells/ solar cells.
- This converted energy is used to provide electricity for watches, calculators and cameras.
- Unfortunately, though solar energy is free, the high cost of its collection, conversion and storage has limited its exploitation.

Solar Irradiance

- The amount of radiant energy received from the sun per unit area per unit time – the solar irradiance- as a function of wavelength at a point outside the Earth's atmosphere.

- Solar irradiance is greatest at visible wavelengths, 300-800nm, peaking in the blue-green.

Solar Radiation Spectrum



STANDARD TEST CONDITIONS (STC)

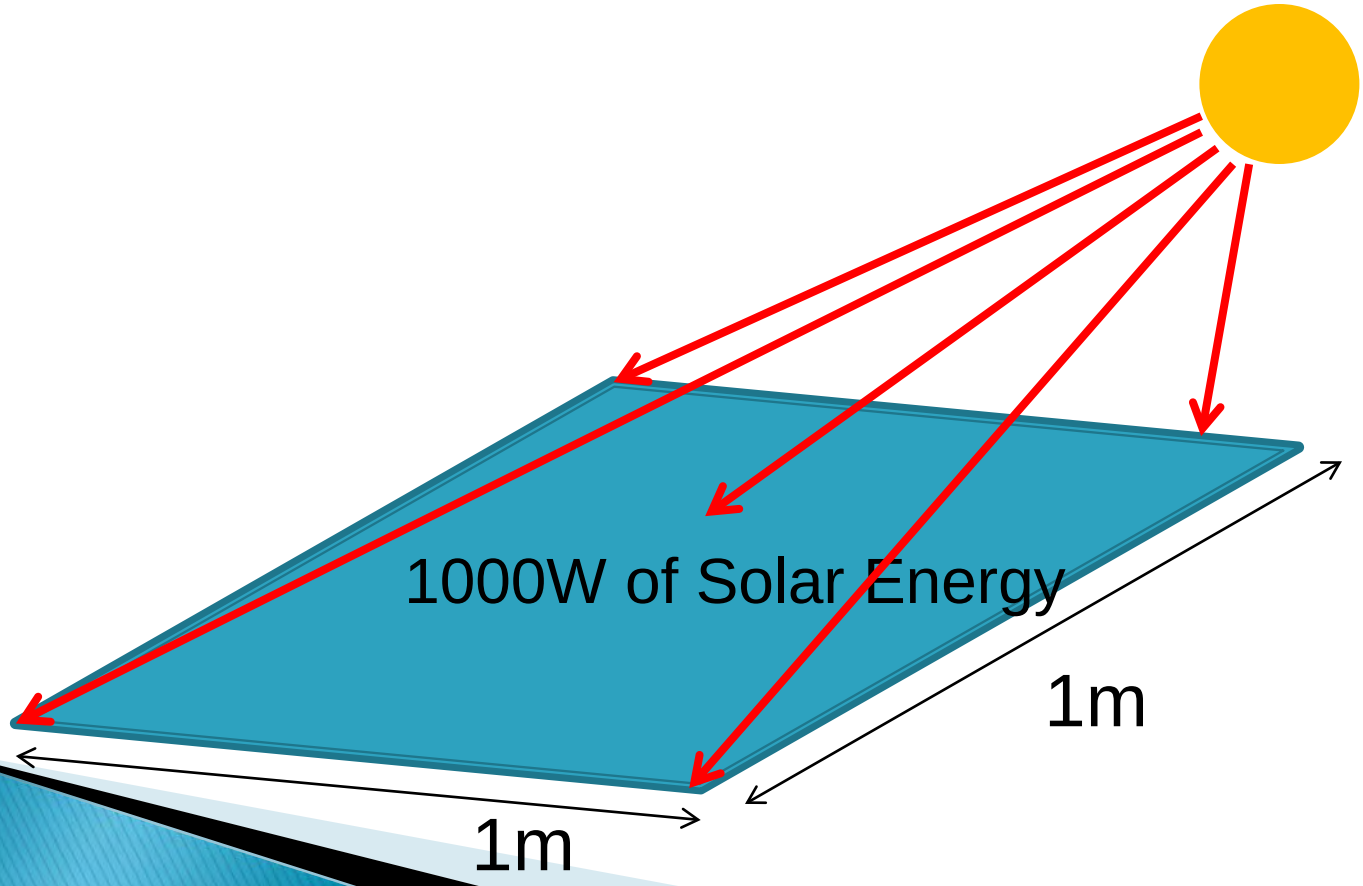
- The Standard Test Condition (STC) for solar cells is the Air Mass 1.5 spectrum

- an incident power density of 1000W m^{-2}

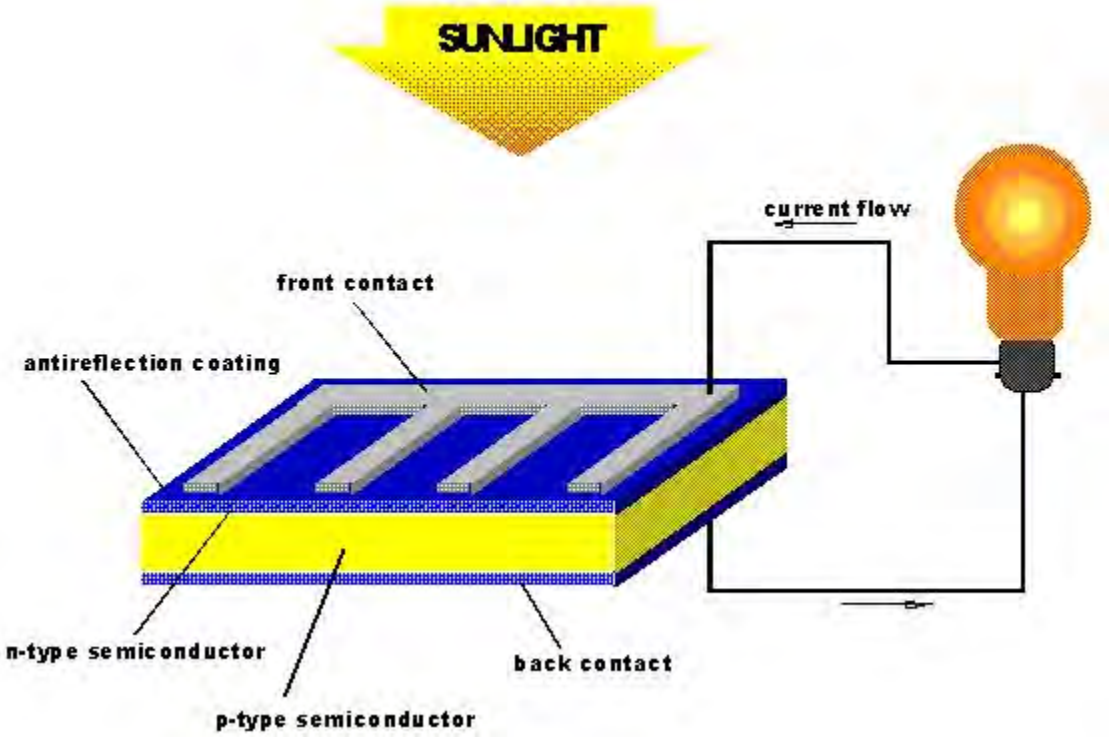
- The standard cell temperature for testing purposes is 25° C (it is important to note that 25° C is cell temperature, not ambient temperature).

SOLAR RADIATION ON THE EARTH'S SURFACE

- Under clear sky, 1 m^2 of the Earth's surface intercepts 1000W solar energy



SOLAR CELL



A basic structure of a typical solar cell

Solar modules/panels

SOLAR CELL

- A **solar cell** (also called **photovoltaic cell** or **photoelectric cell**) is a solid state device that converts the energy of sunlight directly into electricity by the **photovoltaic effect**.
- **Solar Cells** also known as "photovoltaic" or "photoelectric" cells.
- The solar cell is the basic building block of solar photovoltaics.
- The cell can be considered as a two terminal device which conducts like a diode in the dark and generates a photovoltage when charged by the Sun.

SOLAR CELL (cont.)

- Usually it is a thin slice of semiconductor material of around 100 cm^2 in area.
- Assemblies of cells are used to make solar modules, also known as *solar panels*. The energy generated from these solar modules, referred to as *solar power*, is an example of *solar energy*.
- Cells are described as *photovoltaic cells* when the light source is not necessarily sunlight. These are used for detecting light or other electromagnetic radiation near the visible range, for example infrared detectors, or measurement of light intensity.

Power generation of Solar Cell

- When charged by the sun, the basic unit generates a dc photovoltage of 0.5 to 1 volt and, in short circuit, a photocurrent of some tens of milliamps per cm^2.
- Although the current is reasonable, the voltage is too small for most applications. To produce useful dc voltages, the cells are connected together in series and encapsulated into ***modules.***

Power generation of Solar Cell

- A module typically contains 28 to 36 cells in series, to generate a dc output voltage of 12V in standard illumination conditions.
- 36 cells for 12 system voltage
- 72 cells for 24 system voltage

- The 12 V modules can be used singly, or connected in parallel and series into an array with a larger current and voltage output, according to the power demanded by the application.

- The array is also called a Photovoltaic generator.

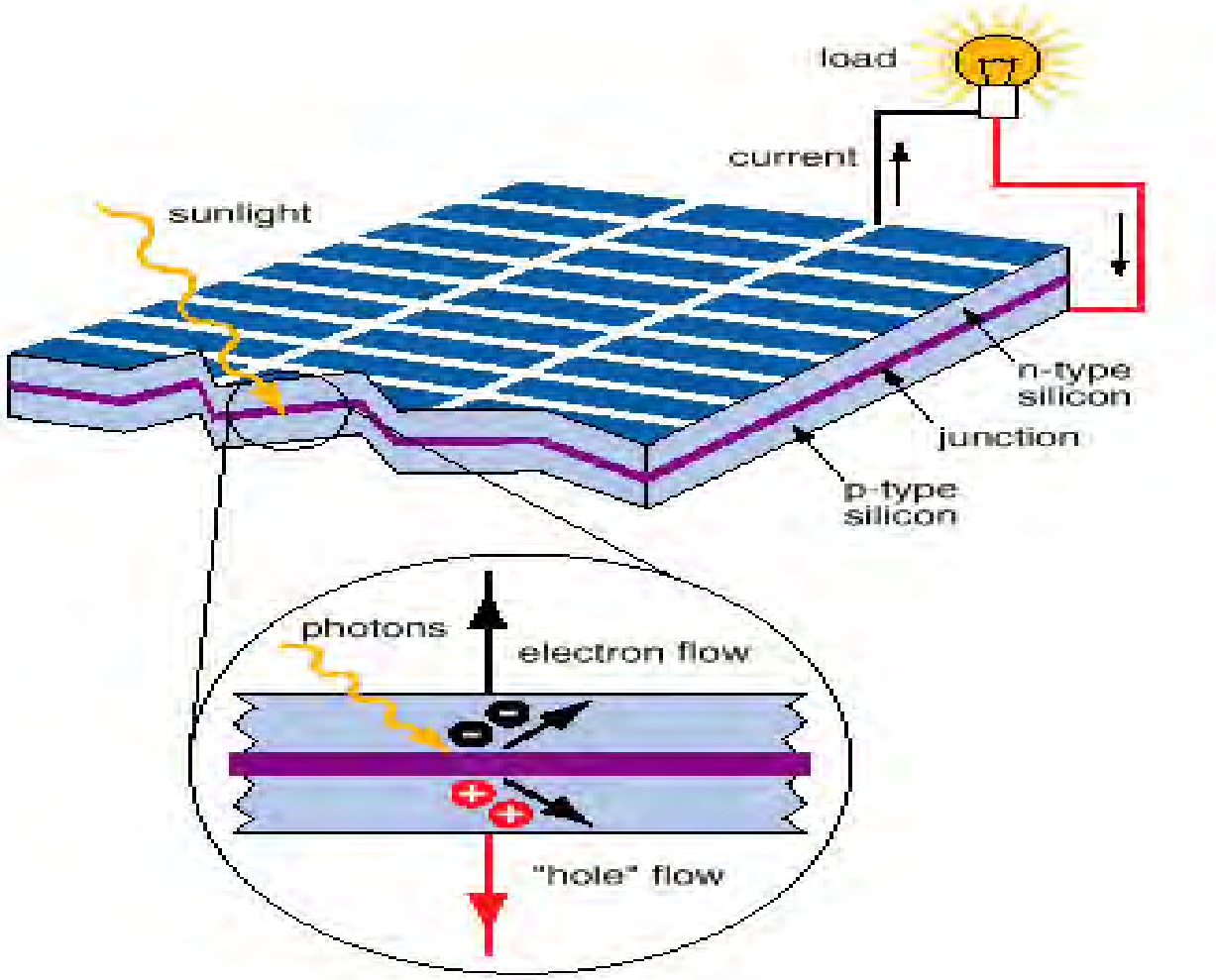
Solar photovoltaic energy conversion

- Solar photovoltaic energy conversion is a one-step conversion process which generates electrical energy from light energy.

- In a photovoltaic device, however there is some built-in asymmetry which pulls the excited electrons away before they can relax, and feeds them to an external circuit.

- The effectiveness of a photovoltaic device depends upon the choice of light absorbing materials and the way in which they are connected to the external circuit.

Solar Cell Generate Electricity



Source www.solarpower2day.com

Characteristics of a Photovoltaic Cell

- **Four quantities**: **J_{sc}, V_{oc}, FF and η** are the key performance characteristics of a solar cell.

- The voltage developed when the terminals are isolated (infinite load resistance) is called the ***open circuit voltage V_{oc}***.

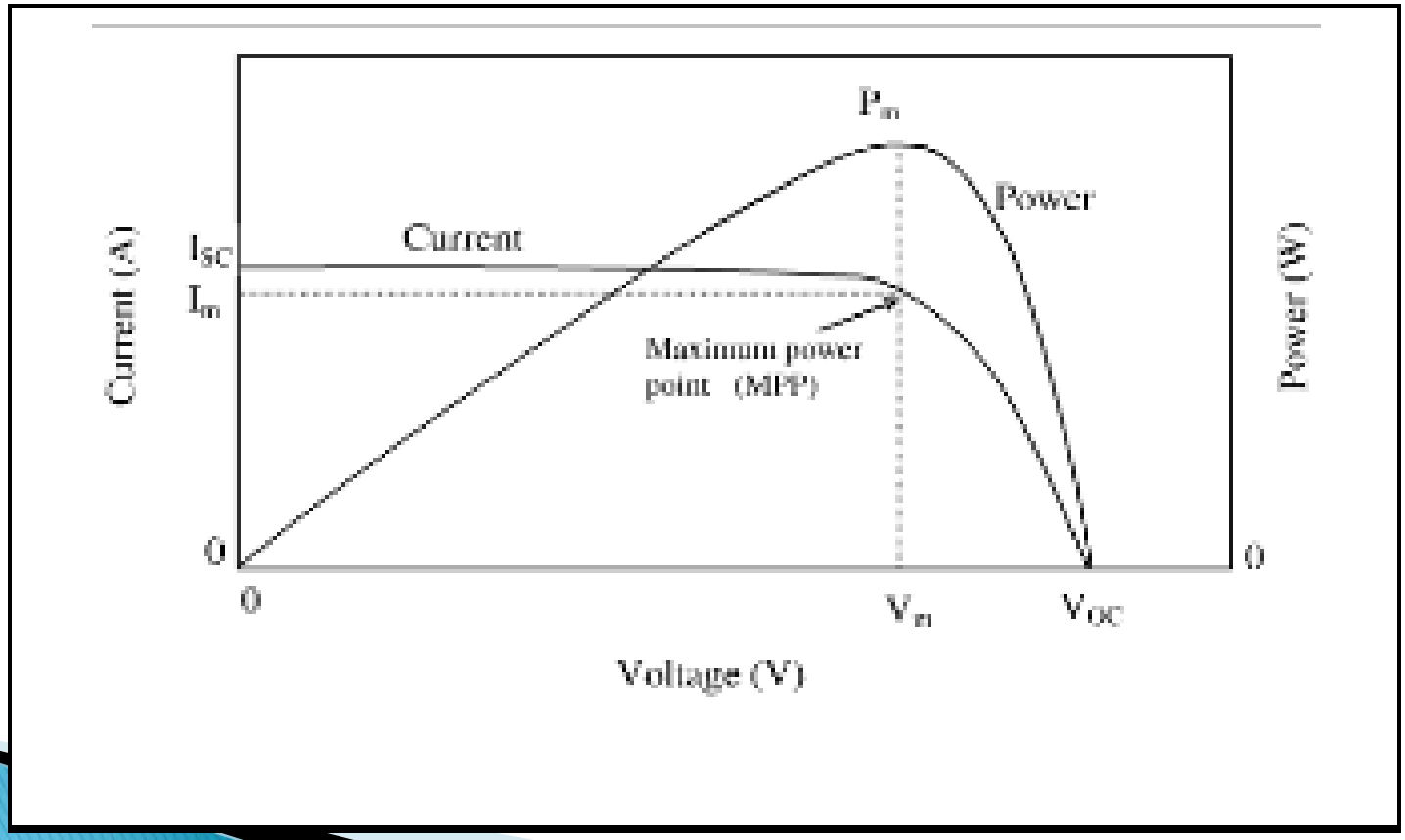
- The current drawn when the terminals are connected together is the ***short circuit current I_{sc}*.**

- The cell power density is given by

$$P = IV.$$

Three main points on the I-V curve of PV cell

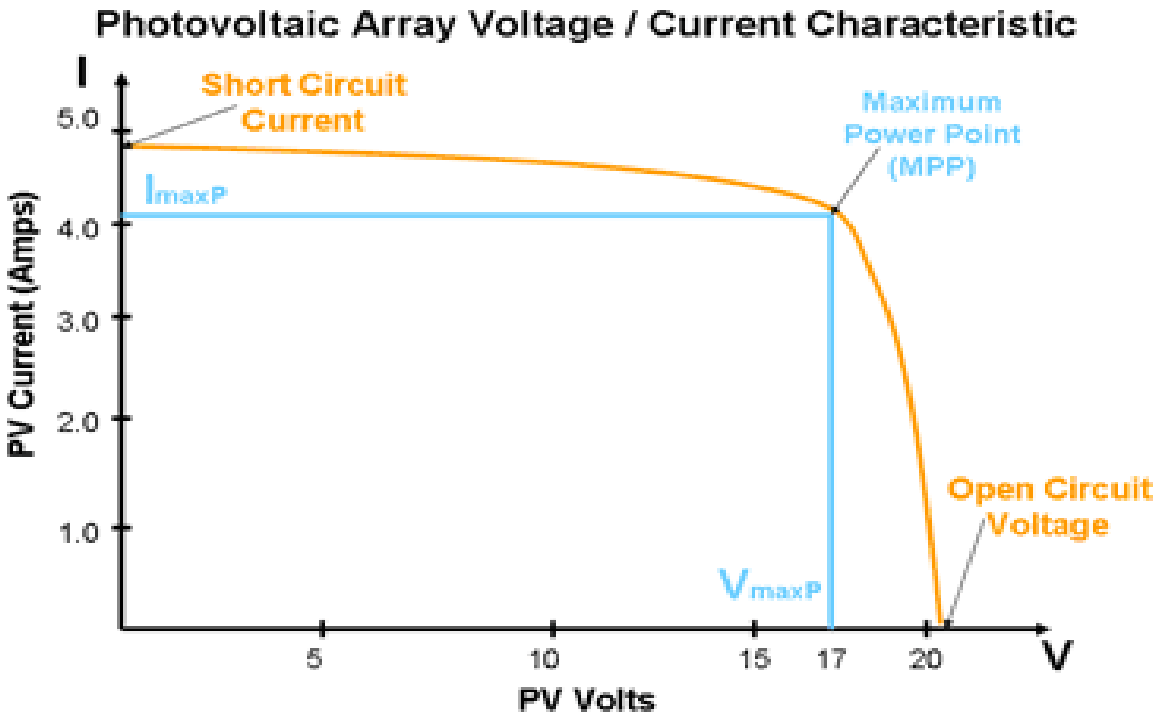
- Short circuit current (Isc)
- Open circuit voltage (Voc)
- Maximum Power Point (MPP)



The Fill Factor

- Fill Factor (FF) is a quantity that is often used to characterize module performance.
- The fill factor is the ‘squareness’ of the I-V curve.
- The fill factor is defined as the ratio

$$FF = \frac{P_{max}}{I_{sc}V_{oc}}$$



The Efficiency η of The Solar Cell

- The efficiency η of the cell is the power density delivered at operating point as a fraction of the incident light power density P_{in},

$$\eta = \frac{P_{out}}{P_{in}} = \frac{I_m V_m}{P_{in}}$$

- Efficiency is related to J_{sc} and V_{oc} using FF,

$$\eta = \frac{FF . I_m . V_m}{P_{in}}$$

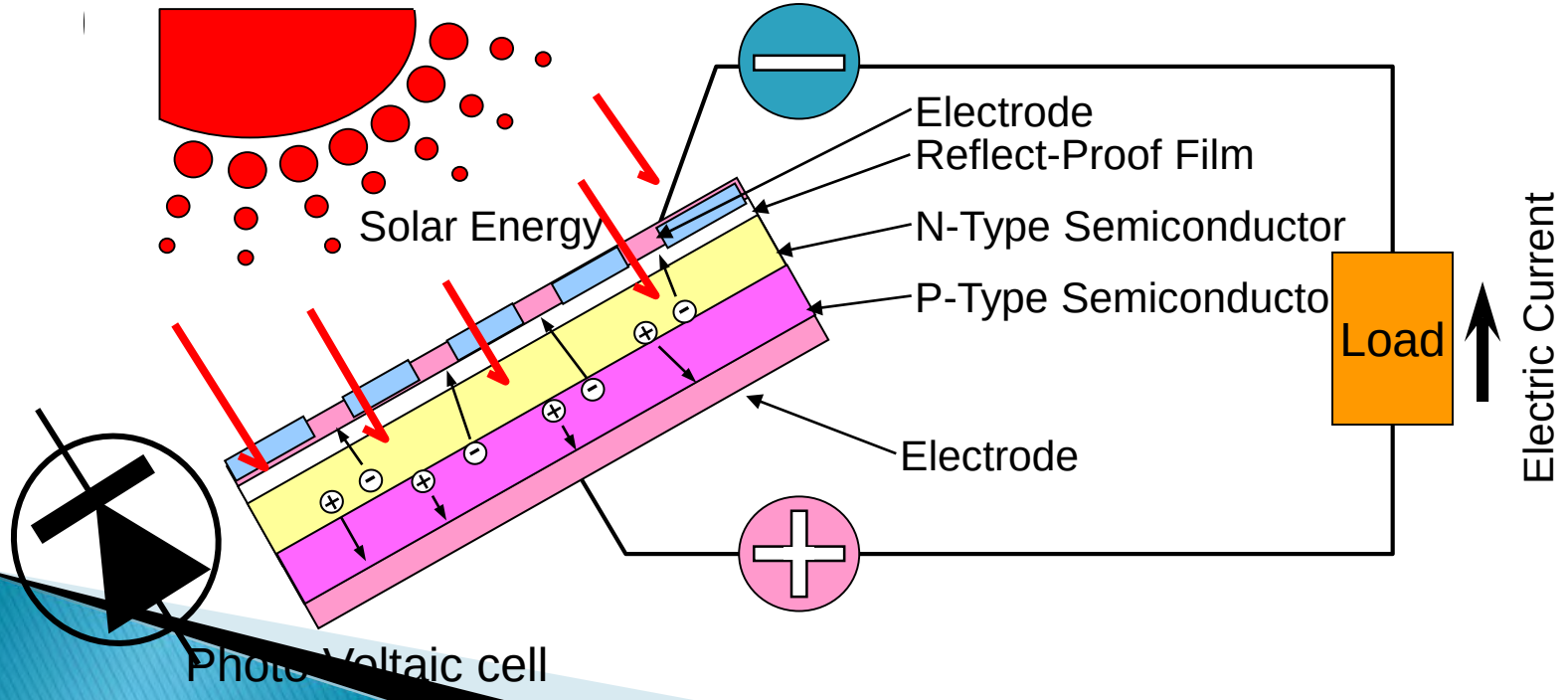
Basic principle of PV

- **Contents**

Mechanism of generation

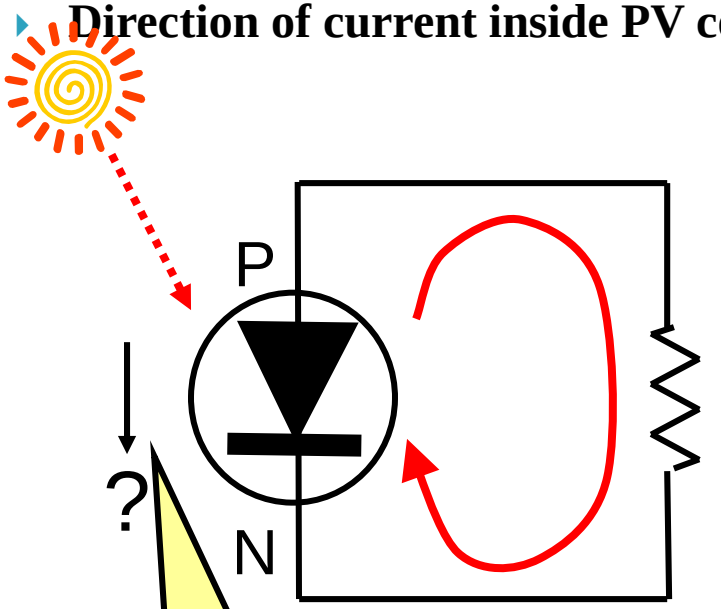
The solar cell is composed of a P-type semiconductor and an N-type semiconductor. Solar light hitting the cell produces two types of electrons, negatively and positively charged electrons in the semiconductors.

Negatively charged (-) electrons gather around the N-type semiconductor while positively charged (+) electrons gather around the P-type semiconductor. When you connect loads such as a light bulb, electric current flows between the two electrodes.



Mechanism of generation (cont.)

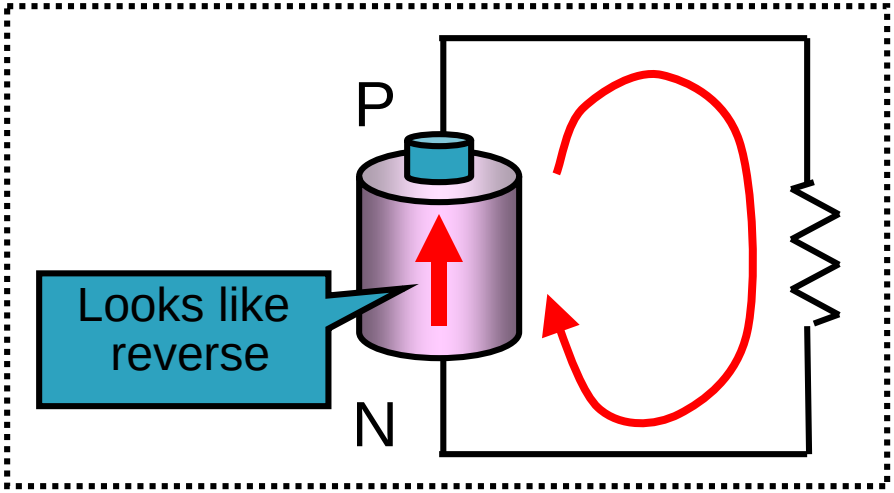
- **Direction of current inside PV cell**



Current appears to be in the reverse direction ?

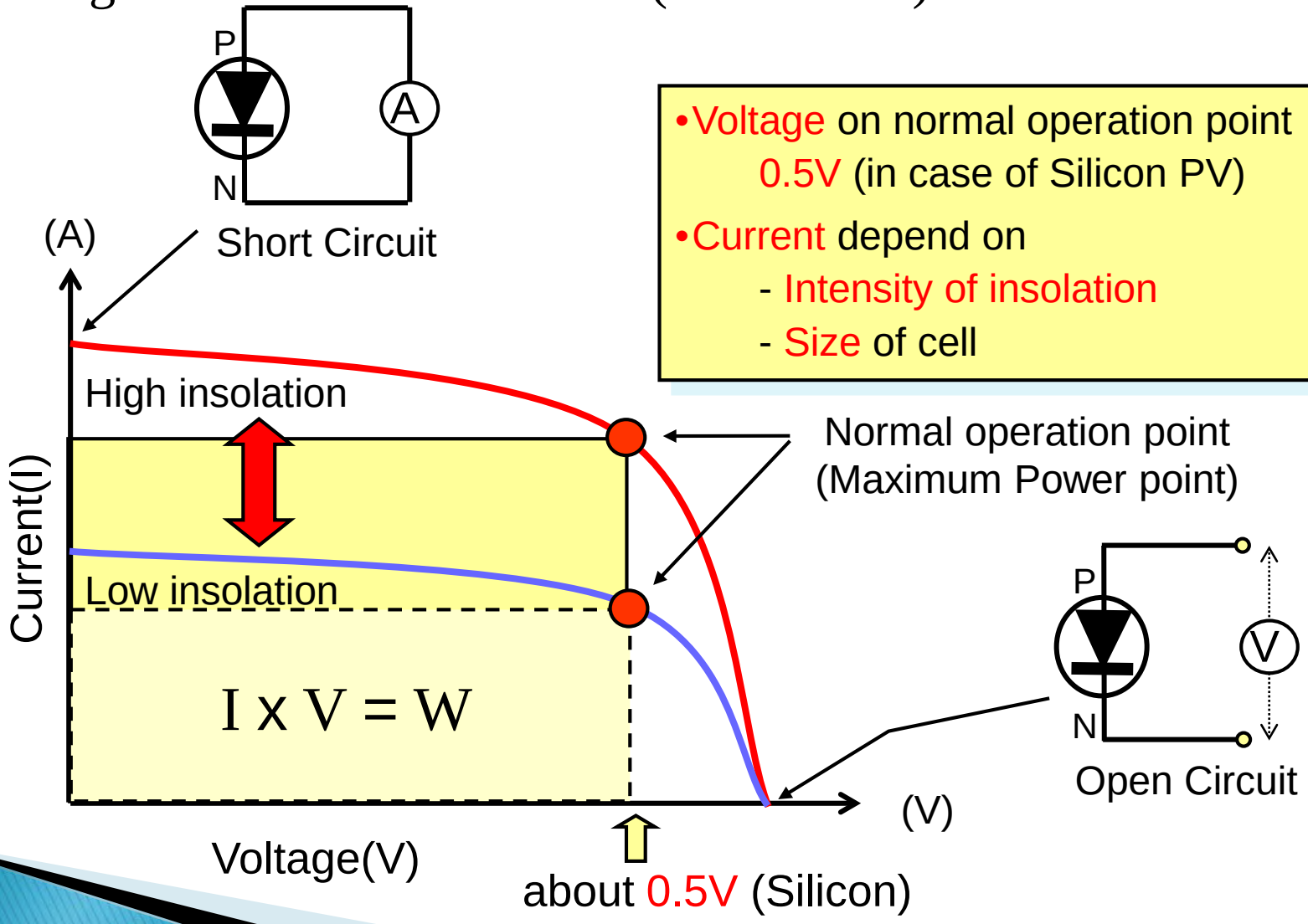
- Inside current of PV cell looks like "Reverse direction." Why?

- By Solar Energy, current is pumped up from N-pole to P-pole.
- In generation, current appears reverse. It is the same as for battery.



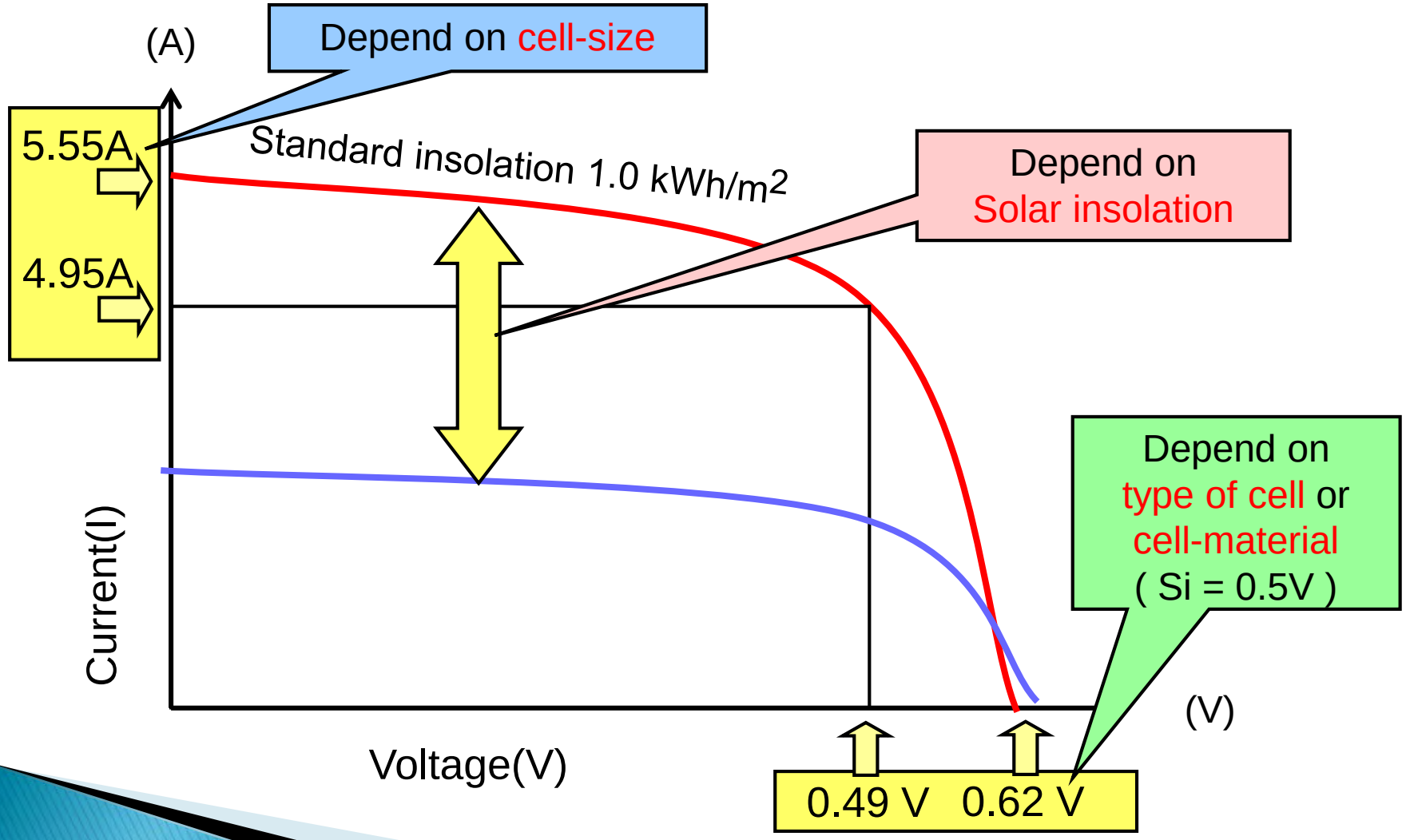
Mechanism of generation (cont.)

- Voltage and Current of PV cell (I-V Curve)



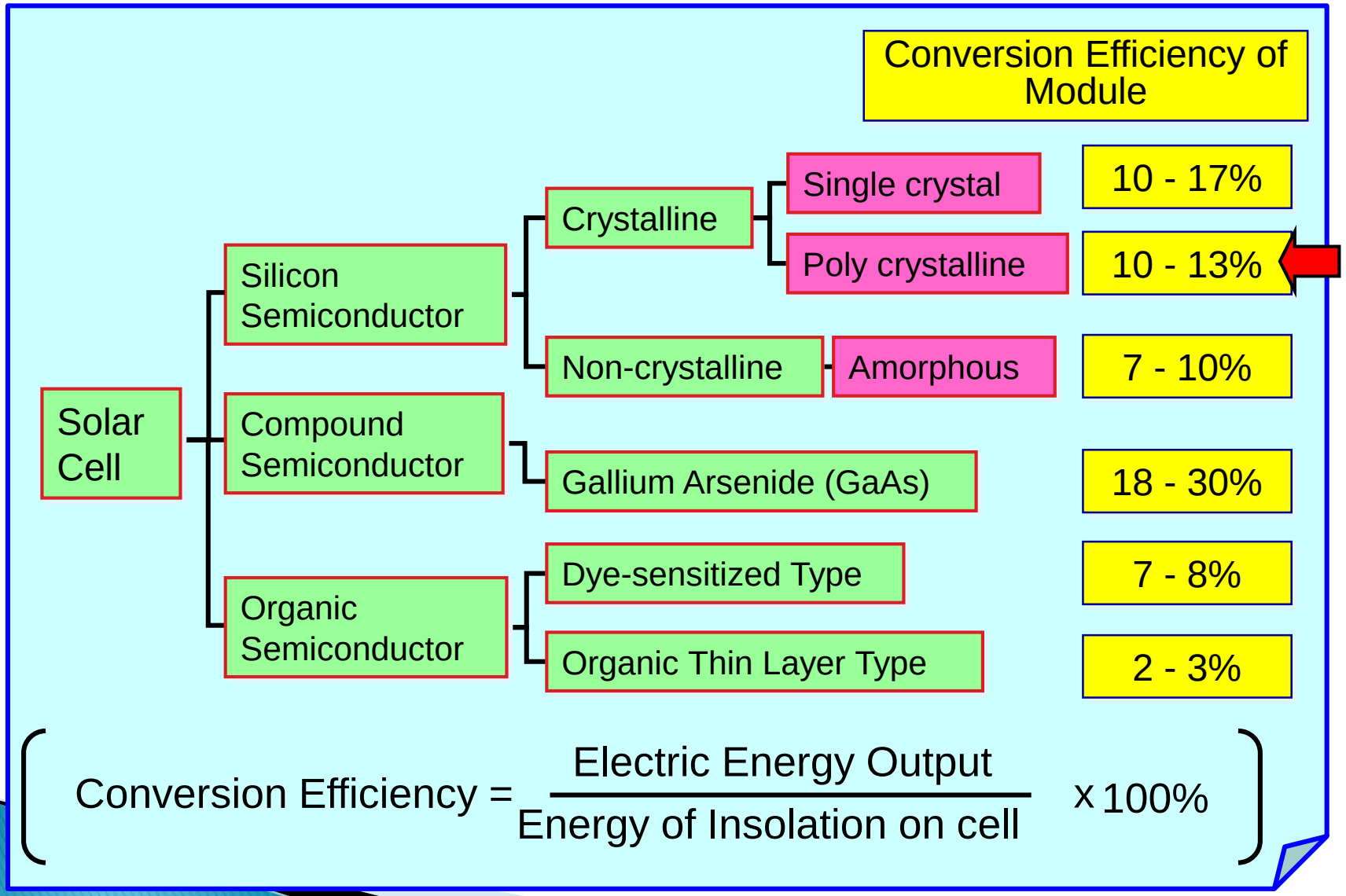
Mechanism of generation (cont.)

- Typical I-V Curve



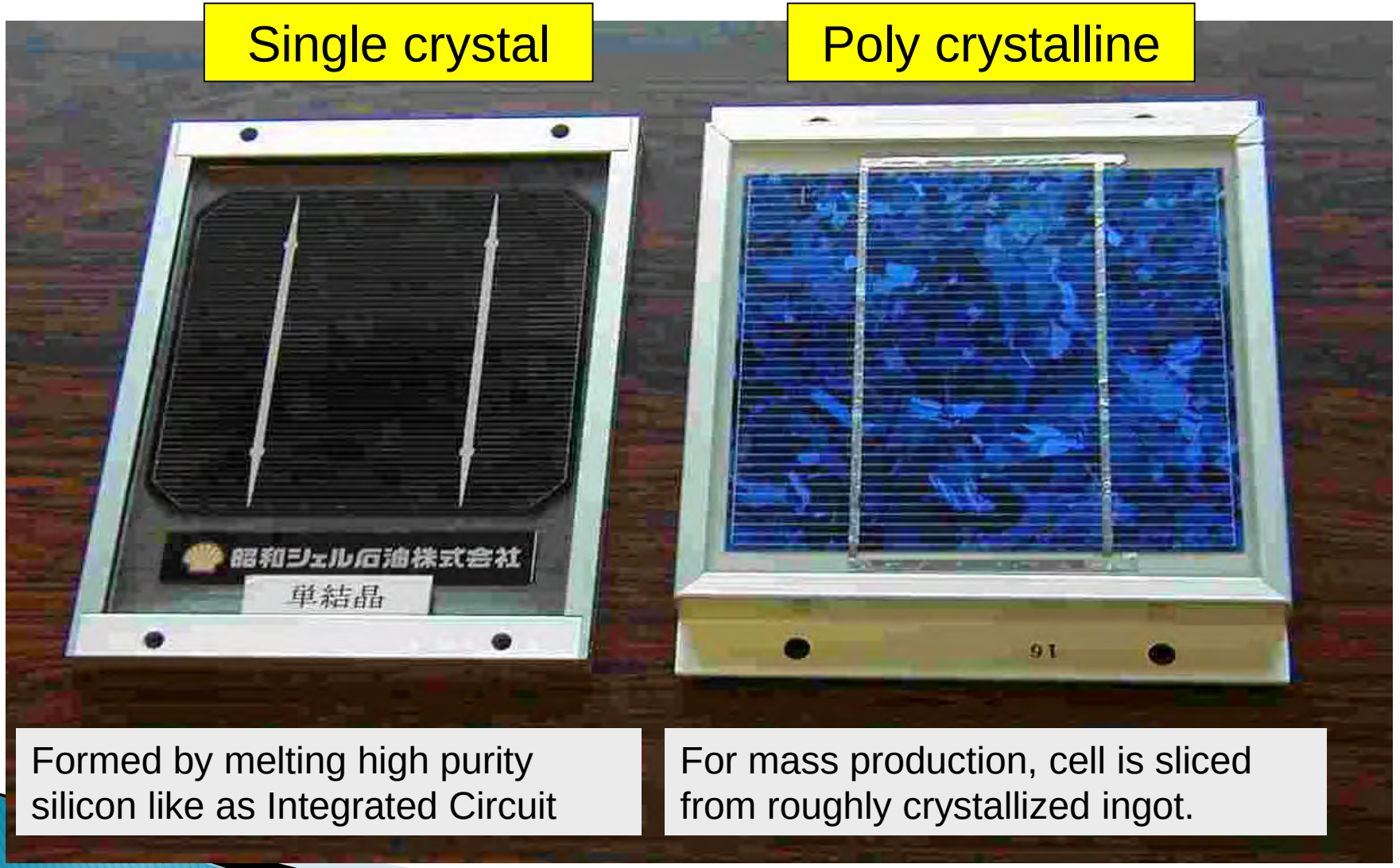
Various type of PV cell

- Types and Conversion Efficiency of Solar Cell



Various type of PV cell

- Crystal cell (Single crystal and Poly crystalline Silicon)



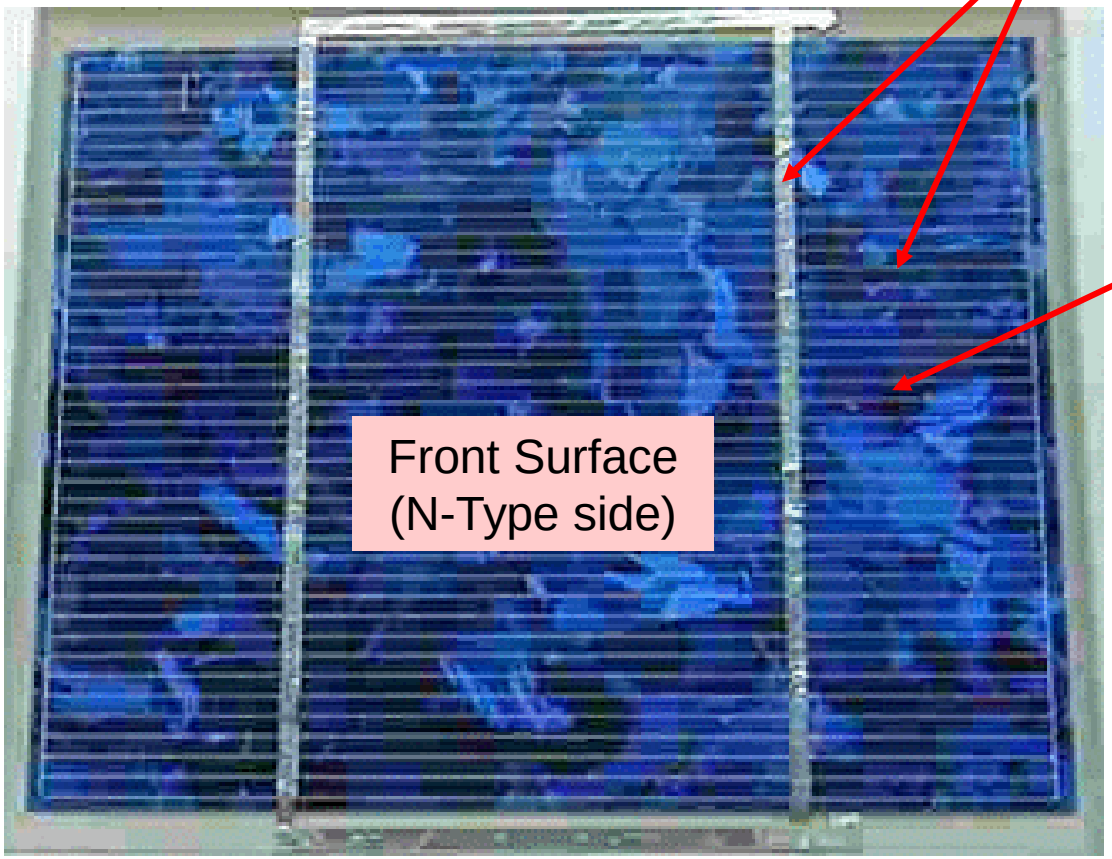
Formed by melting high purity silicon like as Integrated Circuit

For mass production, cell is sliced from roughly crystallized ingot.

Various type of PV cell

- Surface of PV cell

Example of Poly Crystalline PV



- Aluminum Electrode (Silver colored wire)
- To avoid shading, electrode is very fine.

Anti reflection film (Blue colored film)

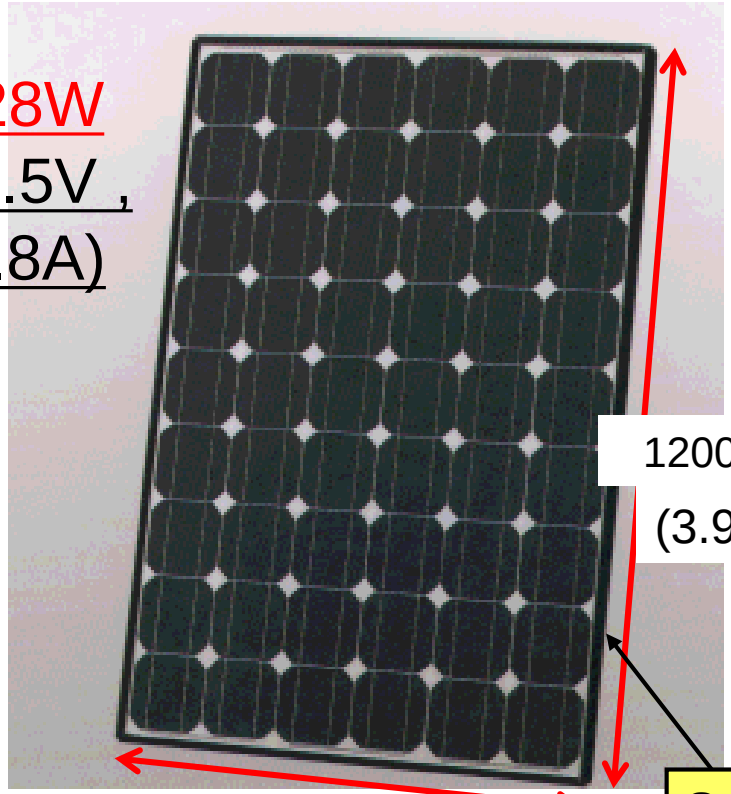
- Back surface is P-type.
- All back surface is aluminum electrode with full reflection.

Various type of PV cell

- PV Module (Single crystal, Poly crystalline Silicon)

Single crystal

128W
(26.5V , 4.8A)

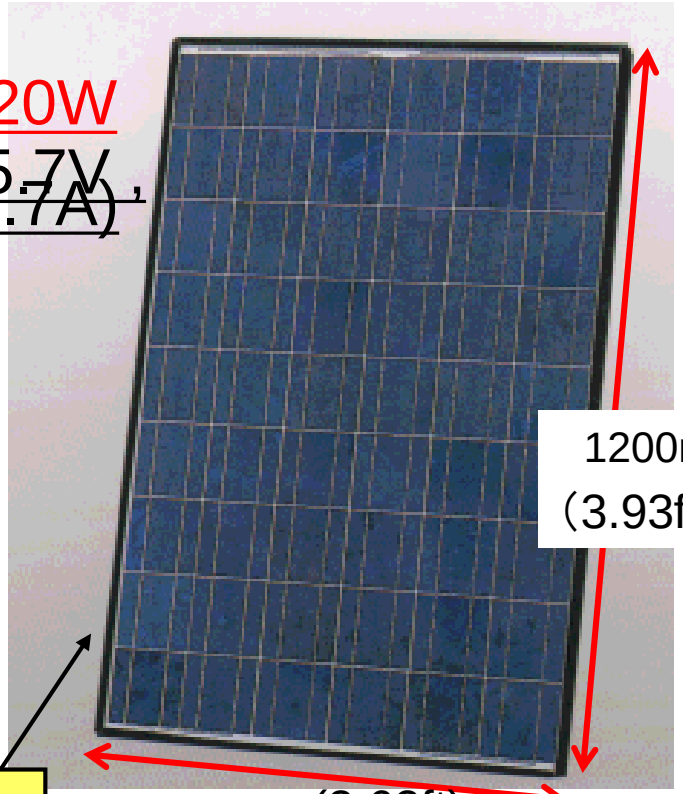


Efficiency is higher

Same size

Poly crystalline

120W
(25.7V , 4.7A)



Efficiency is lower

Various type of PV cell

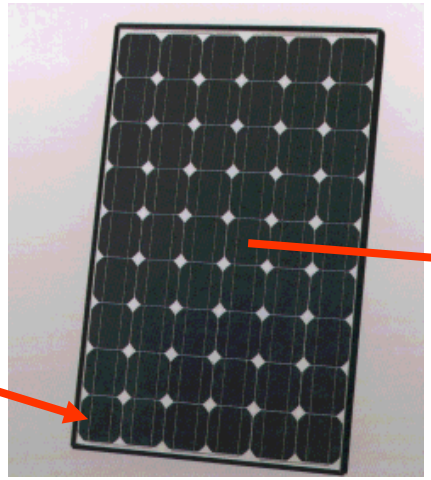
	Volt	Ampere	Watt	Size
Cell	0.5V	5-6A	2-3W	about 10cm
Module	20-30V	5-6A	100-200W	about 1m
Array	200-300V	50A-200A	10-50kW	about 30m

Array

10 - 50 kW

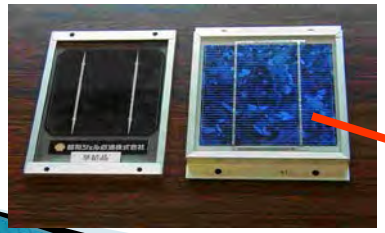
Module,Panel

100 - 200 W



Cell

2 – 3 W



6x9=54 (cells)

100-300 (modules)

Roof top of residence (Grid connected)

Owner can sell excess power to power utility.

Most popular installation style in Japan.
(Almost 85% PV in Japan)

- Roof top of school ,community-center building.
  (For education and emergency power)

Solar cell capacity: 250 kW

Solar cell capacity: 20 kW

Solar cell capacity: 10 kW

Solar cell capacity: 30 kW

Installation example

Inverter and controller

1.2kW system

Installation example

- Stationary power station (Grid connected)

Site: Funafuti Tuvalu
Installation: Feb. in 2008
Capacity: 40kW
Purpose: Grid connected power supply for fuel conservation and CO2 reduction.

Installation example

- Stationary power station (Off grid or mini grid))

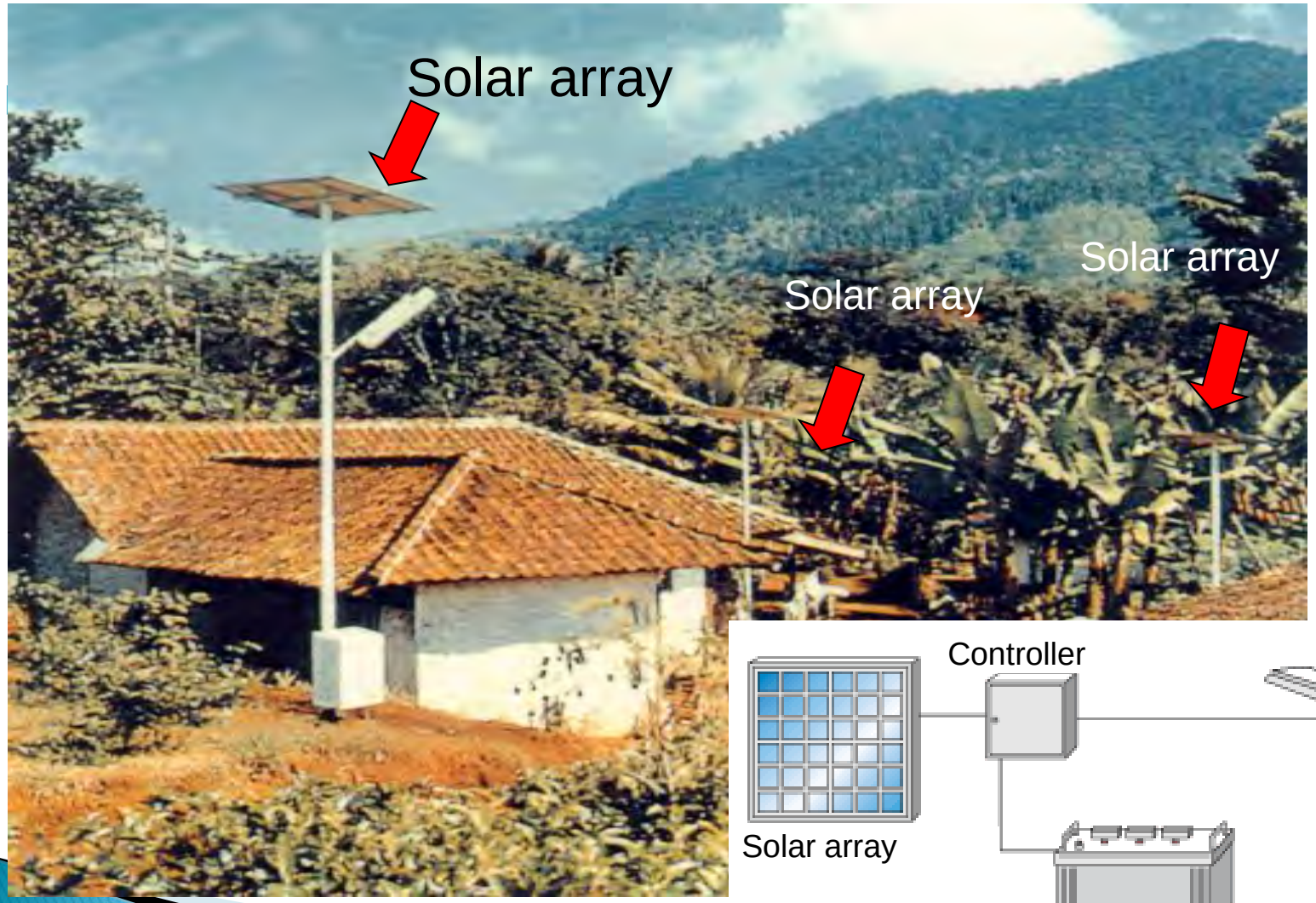
Site: Mongolia

Installation: May & June in 1999

Purpose: For lighting, refrigerator and outlet in a hospital.

Solar cell capacity: 3.4kW
Wind Power capacity: 1.8kW
Inverter capacity: 5kVA

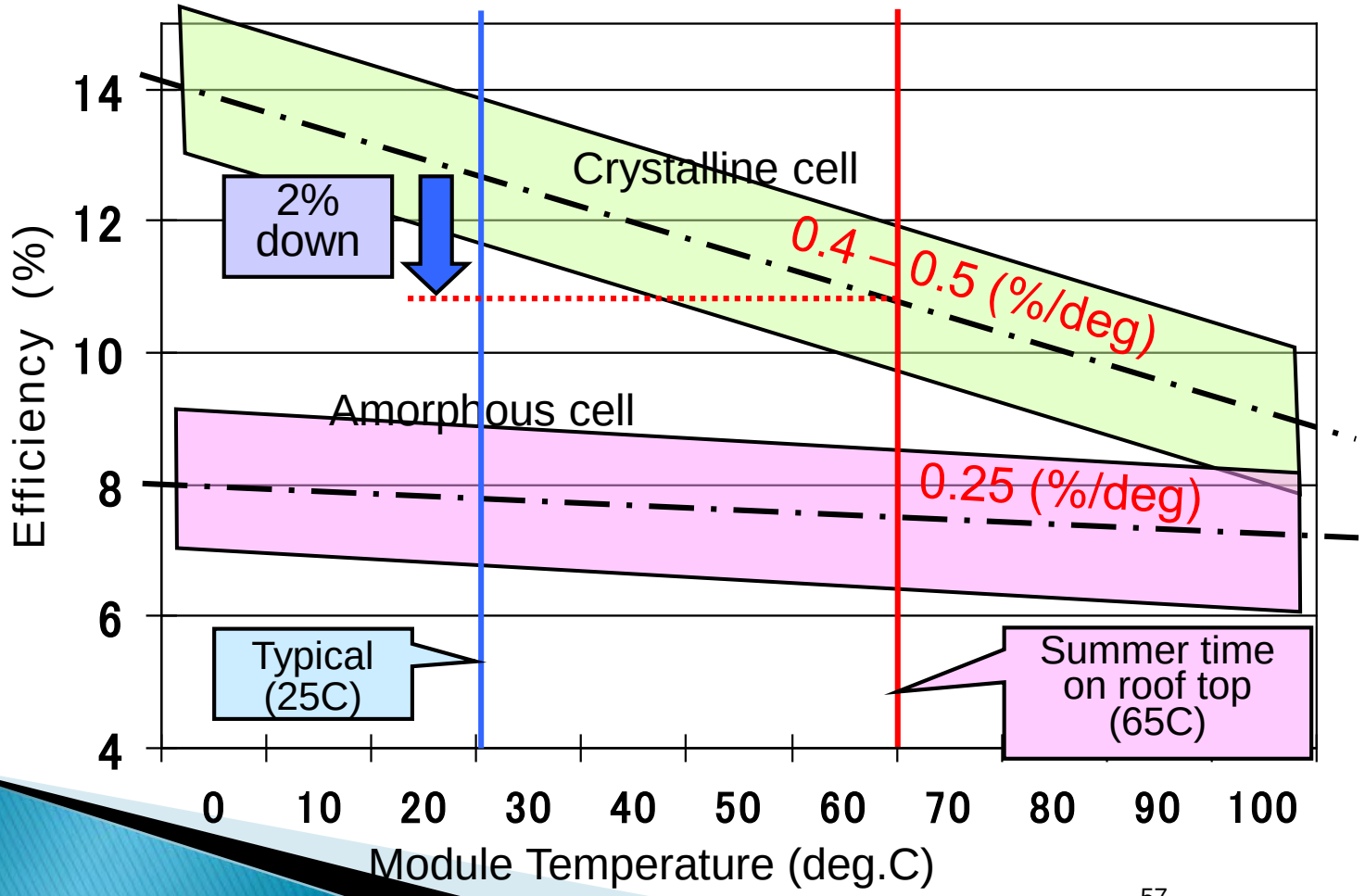
1-1-3. Installation example



Basic Characteristic

•When module temperature rises up, efficiency decreases.
•The module must be cooled by natural ventilation, etc.

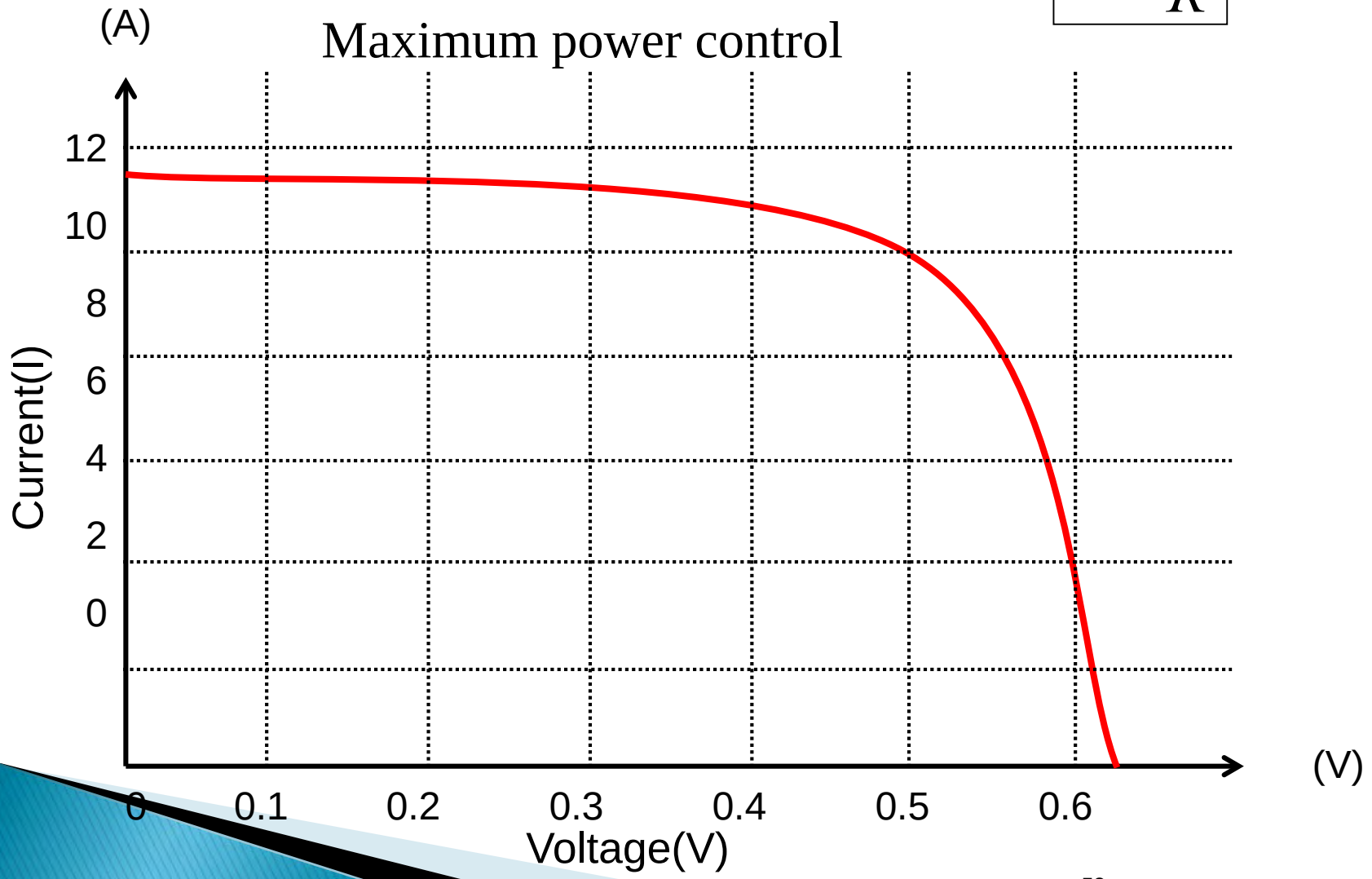
- **Temperature and efficiency**



Case sturdy

$$I = \frac{V}{R}$$

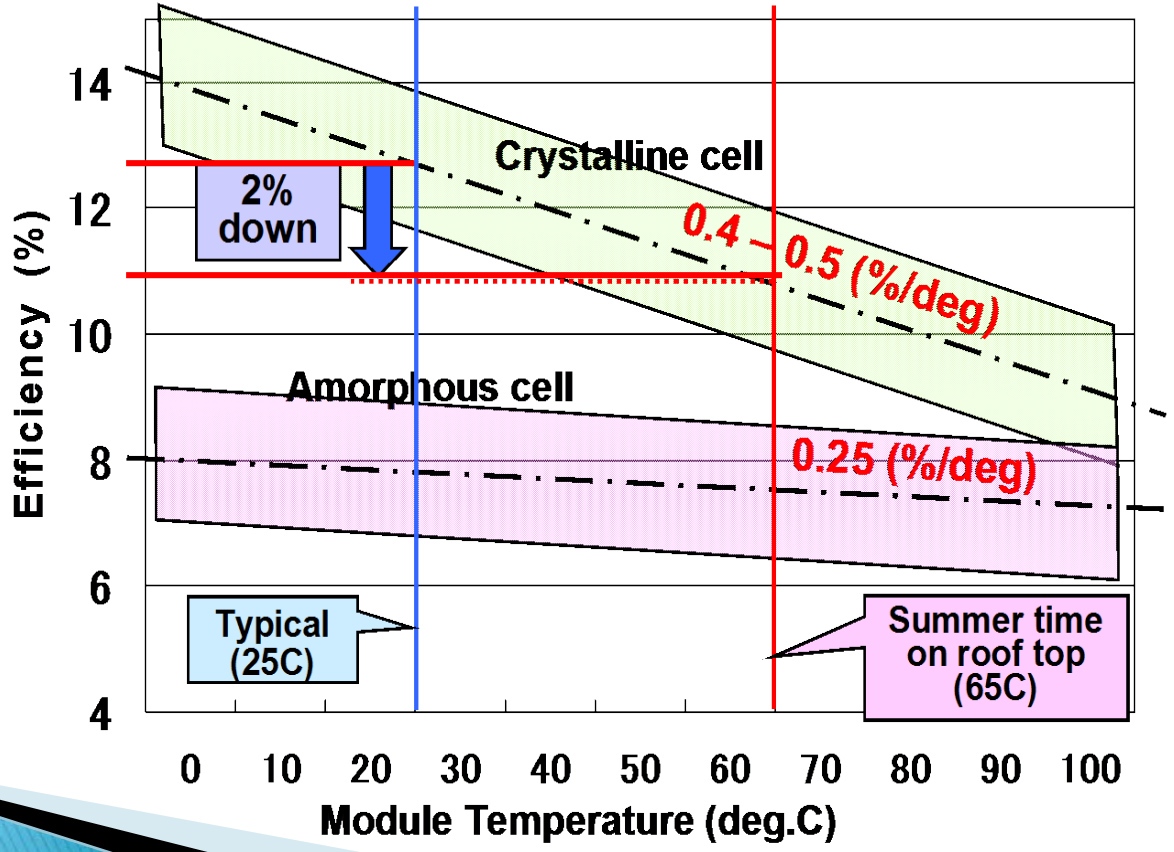
I/V curve of current insolation.



Case sturdy

Q: There is 50 kW Crystalline PV system.
If surface temperature rises from 25ºC to 65ºC, How much the capacity will be?

2.Temperature vs. Efficiency



Solar Technologies

- Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy.

- Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy.

Solar Technologies

- Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

- Active solar technologies increase the supply of energy and are considered supply side technologies, while passive solar technologies reduce the need for alternate resources and are generally considered demand side technologies.

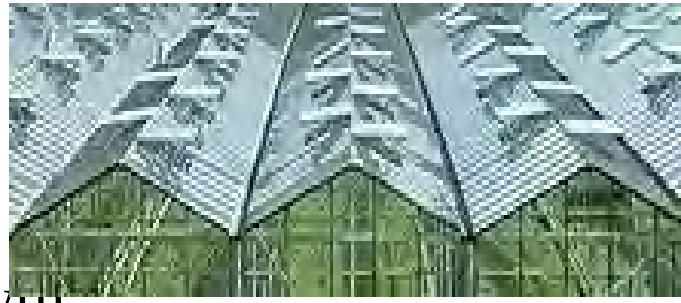
APPLICATIONS OF SOLAR ENERGY

- A partial list of solar applications includes space heating and cooling through solar architecture, potable water via distillation and disinfection, daylighting, solar hot water, solar cooking, and high temperature process heat for industrial purposes.

- To harvest the solar energy, the most common way is to use solar panels.

Agriculture and Horiculture

- Agriculture and horticulture seek to optimize the capture of solar energy in order to optimize the productivity of plants.
- Applications of solar energy in agriculture aside from growing crops include pumping water, drying crops, brooding chicks and drying chicken manure
- More recently the technology has been embraced by vinters, who use the energy generated by solar panels to power grape presses.
- Greenhouses convert solar light to heat, enabling year-round production and the growth (in enclosed environments) of specialty crops and other plants not naturally suited to the local climate.



Solar lighting

- Daylighting systems collect and distribute sunlight to provide interior illumination.
- Hybrid solar lighting is an active solar method of providing interior illumination.
- Solar thermal technologies can be used for water heating, space heating, space cooling and process heat generation
- Solar hot water systems use sunlight to heat water.

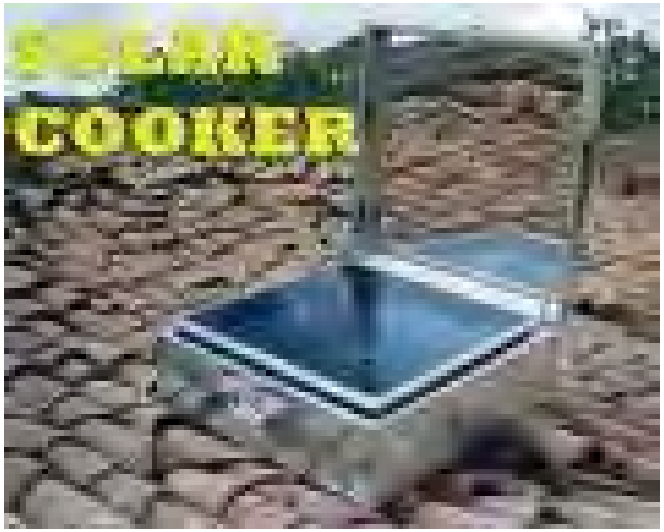
Water Treatment

- Solar distillation can be used to make saline or brackish water potable
- Solar water disinfection (SODIS) involves exposing water-filled plastic polyethylene terephthalate (PET) bottles to sunlight for several hours
- It is recommended by the World Health Organization as a viable method for household water treatment and safe storage
- Solar energy may be used in a water stabilisation pond to treat waste water without chemicals or electricity.

Solar water heater

Solar Cooking

- Solar cookers use sunlight for cooking, drying and pasteurization. They can be grouped into three broad categories: box cookers, panel cookers and reflector cookers
- A basic box cooker consists of an insulated container with a transparent lid.



- Panel cookers use a reflective panel to direct sunlight onto an insulated container and reach temperatures comparable to box cookers.

- Reflector cookers use various concentrating geometries (dish, trough, Fresnel mirrors) to focus light on a cooking container.

The Solar Bowl in Auroville, India,

Process Heat

- **Solar concentrating technologies such as parabolic dish, trough and Scheffler reflectors can provide process heat for commercial and industrial applications.**
- **Evaporation ponds are shallow pools that concentrate dissolved solids through evaporation.**
- **Clothes lines, clotheshorses, and clothes racks dry clothes through evaporation by wind and sunlight without consuming electricity or gas.**

STEP parabolic dishes used for steam production and electrical generation.

Electrical generation (solar power)

- Solar power is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP). CSP systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. PV converts light

Experimental solar power

- A solar pond is a pool of salt water (usually 1–2 m deep) that collects and stores solar energy.
- The pond consisted of layers of water that successively increased from a weak salt solution at the top to a high salt solution at the bottom.
- This solar pond was capable of producing temperatures of 90 ° C in its bottom layer and had an estimated solar-to-electric efficiency of two percent.
- Thermoelectric, or "thermovoltaic" devices convert a temperature difference between dissimilar materials into an electric current

Solar chemical

- Solar chemical processes use solar energy to drive chemical reactions. These processes offset energy that would otherwise come from an alternate source and can convert solar energy into storable and transportable fuels. Solar induced chemical reactions can be divided into thermochemical or photochemical
- Another approach uses the heat from solar concentrators to drive the steam reformation of natural gas thereby increasing the overall hydrogen yield compared to conventional reforming methods
- Thermochemical cycles characterized by the decomposition and regeneration of reactants present another avenue for hydrogen production.

Solar vehicles

- Some vehicles use solar panels for auxiliary power, such as for air conditioning, to keep the interior cool, thus reducing fuel consumption
- A solar balloon is a black balloon that is filled with ordinary air.
- Solar sails are a proposed form of spacecraft propulsion using large membrane mirrors to exploit radiation pressure from the Sun.

SOLAR ENERGY PROS

- Solar panels give off no pollution
- Solar energy produces electricity very quietly.
- It has the ability to harness electricity in remote locations that are not linked to a national grid.
- Very efficient in large areas of the globe.
- Solar panels can be installed on top of many rooftops
- It is affordable in the long run.
- The use of solar energy to produce electricity allows the user to become less dependent on the worlds fossil fuel supplies.

SOLAR ENERGY Cont:

- The major con of solar energy is the initial cost of solar cells.
- Solar energy is only able to generate electricity during daylight hours. This means for around half of each day, solar panels are not producing energy for your home.
- The weather can affect the efficiency of solar cells.
- Pollution can be a con of solar energy, as pollution levels can affect a solar cells efficiency, this would be a major con for businesses or industry wishing to install solar panels in heavily polluted areas, such as cities.

Environmental Effects of Solar Energy

- **Carbon Emissions**
- **Renewable Energy**
- **Abundant Components**
- **Cadmium**
- **Space Considerations**

MEDICAL USES OF SOLAR ENERGY

- These include, disinfection and sterilization without the use of chemicals. Ultraviolet light is also used to destroy bacteria and viruses.
- It stimulates the immune system and has shown good results in killing blood borne pathogens.
- Some microorganisms destroyed by ultraviolet light are bacillus anthracis, salmonella or food poisoning, shigella dysentariae or dysentery, bacteriophage or E. coli, hepatitis and influenza.
- Ultraviolet light can be combined with other therapies.
- Some kinds of skin conditions can improve with the exposure of ultraviolet light.

Solar Energy Health Effects on Humans

- These are:
  - Electromagnetic Radiation From Solar Panels
  - Silicon Dust from Solar Panels
  - Exposure to Electrical and Chemical Components of Solar Heat Systems
  - The Future of Solar Energy

- The body produces vitamin D from sunlight (specifically from the UVB band of ultraviolet light), and excessive seclusion from the sun can lead to deficiency unless adequate amounts are obtained through diet.
- On the other hand, excessive sunlight exposure has been linked to all types of skin cancer caused by the ultraviolet part of radiation from sunlight or sunlamps

- A lack of sunlight, on the other hand, is considered one of the primary causes of seasonal affective disorder (SAD), a serious form of the "winter blues". SAD occurrence is more prevalent in locations further from the tropics, and most of the treatments (other than prescription drugs) involve light therapy
- A recent study indicates that more exposure to sunshine early in a person's life relates to less risk from multiple sclerosis (MS) later in life

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WIND ENERGY

WIND ENERGY

- How Wind Power Is Generated
- Wind Turbines
- Wind Turbine Types
- Turbine Components
- Turbine Configurations
- Wind Turbine Size and Power Ratings
- Wind Energy Resources in the United States
- Advantages and Disadvantages

- **Wind power** is the conversion of wind energy into a useful form of energy, such as using: wind turbines to make electricity, windmills for mechanical power, windpumps for water pumping or drainage, or sails to propel ships.

- Wind power, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation and uses little land.

- Any effects on the environment are generally less problematic than those from other power sources. As of 2011, 83 countries around the world are using wind power on a commercial basis.

- As of 2010 wind energy was over 2.5% of total worldwide electricity usage, growing at more than 25% per annum.

- The monetary cost per unit of energy produced is similar to the cost for new coal and natural gas installations. Although wind power is a popular form of energy generation, the construction of wind farms is not universally welcomed due to aesthetics.

Types of Wind energy

- **Wind Energy is an indirect form of solar energy which can be used continuously unlike solar energy.**
- **Wind energy classified in two types**
- **1. Planetary winds**
- **2. Local winds.**

Planetary winds are cause due to greater heating of earth's surface near the equator as compared to solar heating near the south & north poles.

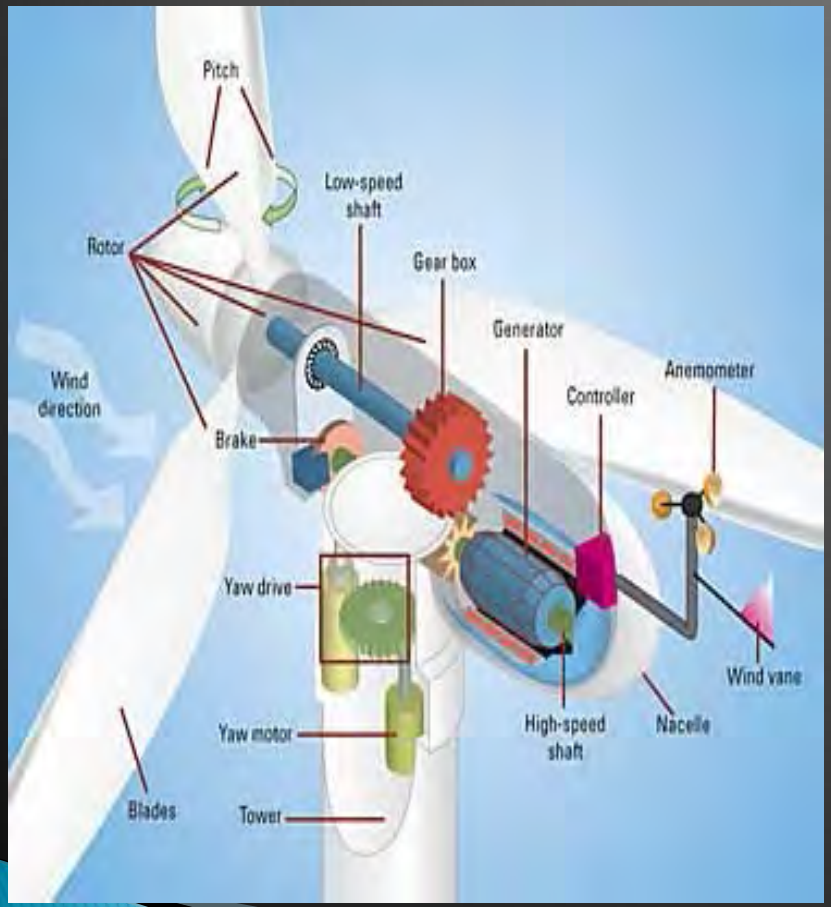
Local winds are caused due to differential heating of land & water in coastal areas these are also caused due to uneven heating in hills & mountain along the slopes.

- Wind is a form of solar energy. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth.
- Wind flow patterns are modified by the earth's terrain, bodies of water, and vegetative cover.
- This wind flow, or motion energy, when "harvested" by modern wind turbines, can be used to generate electricity.

How Wind Power Is Generated

- The terms "wind energy" or "wind power" describe the process by which the wind is used to generate mechanical power or electricity.
- Wind turbines convert the kinetic energy in the wind into mechanical power.
- This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity to power homes, businesses, schools, and the like.

WIND TURBINES



- *Wind turbines, like aircraft propeller blades, turn in the moving air and power an electric generator that supplies an electric current.*

- **Simply stated, a wind turbine is the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity.**

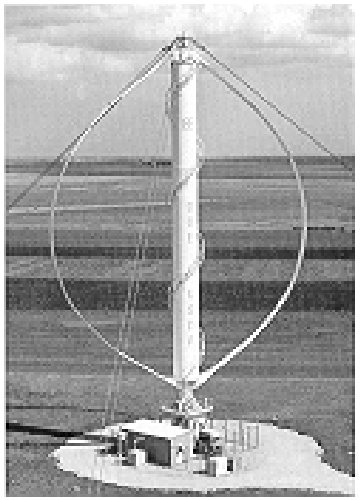
Type of win turbine

Turbines can be categorized into two over arching classes based on the orientation of the rotor.

Vertical Axis

Horizontal Axis

Vertical Axis Turbines



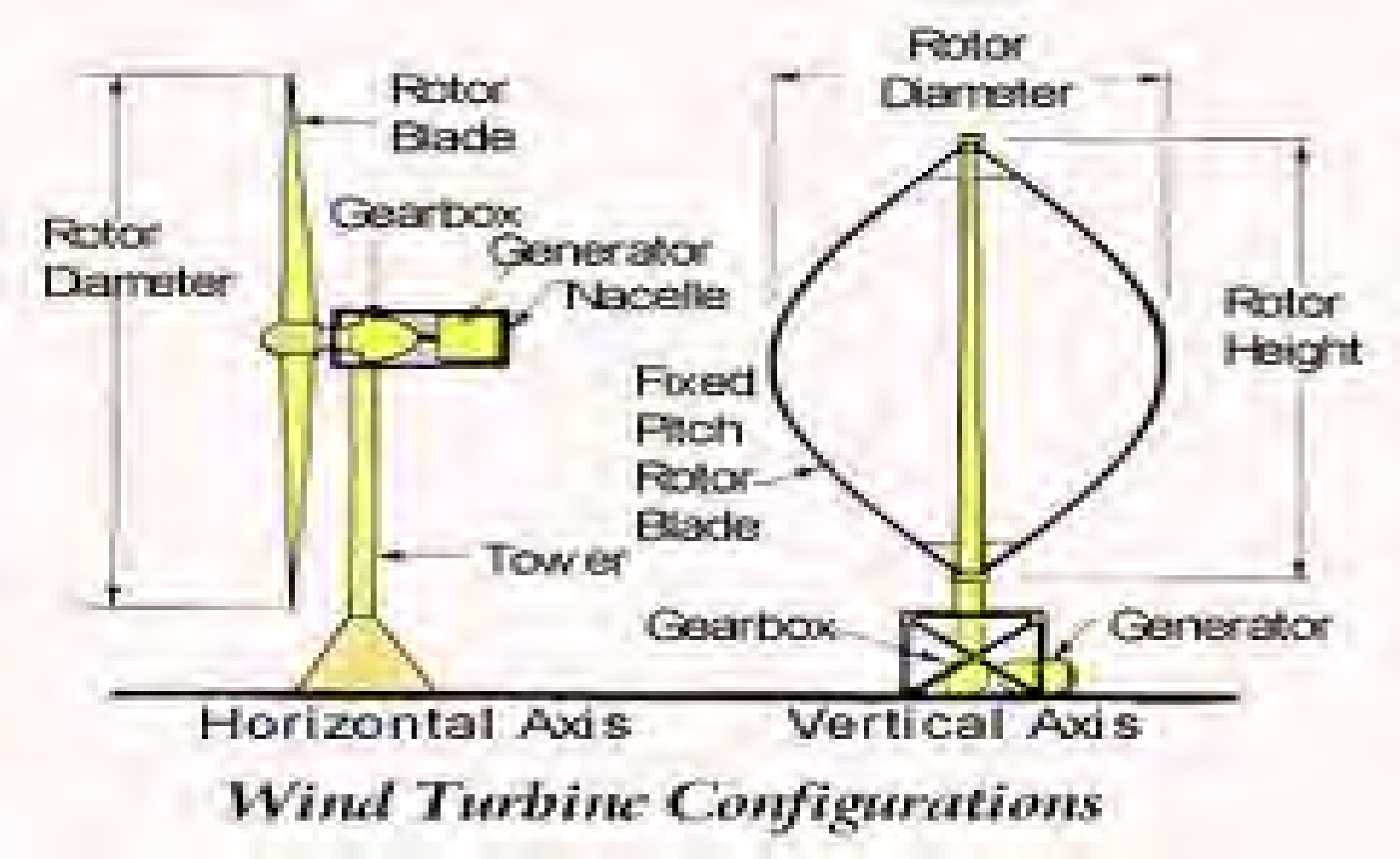
Advantages

- Omnidirectional
  - Accepts wind from any angle
- Components can be mounted at ground level
  - Ease of service
  - Lighter weight towers
- Can theoretically use less materials to capture the same amount of wind

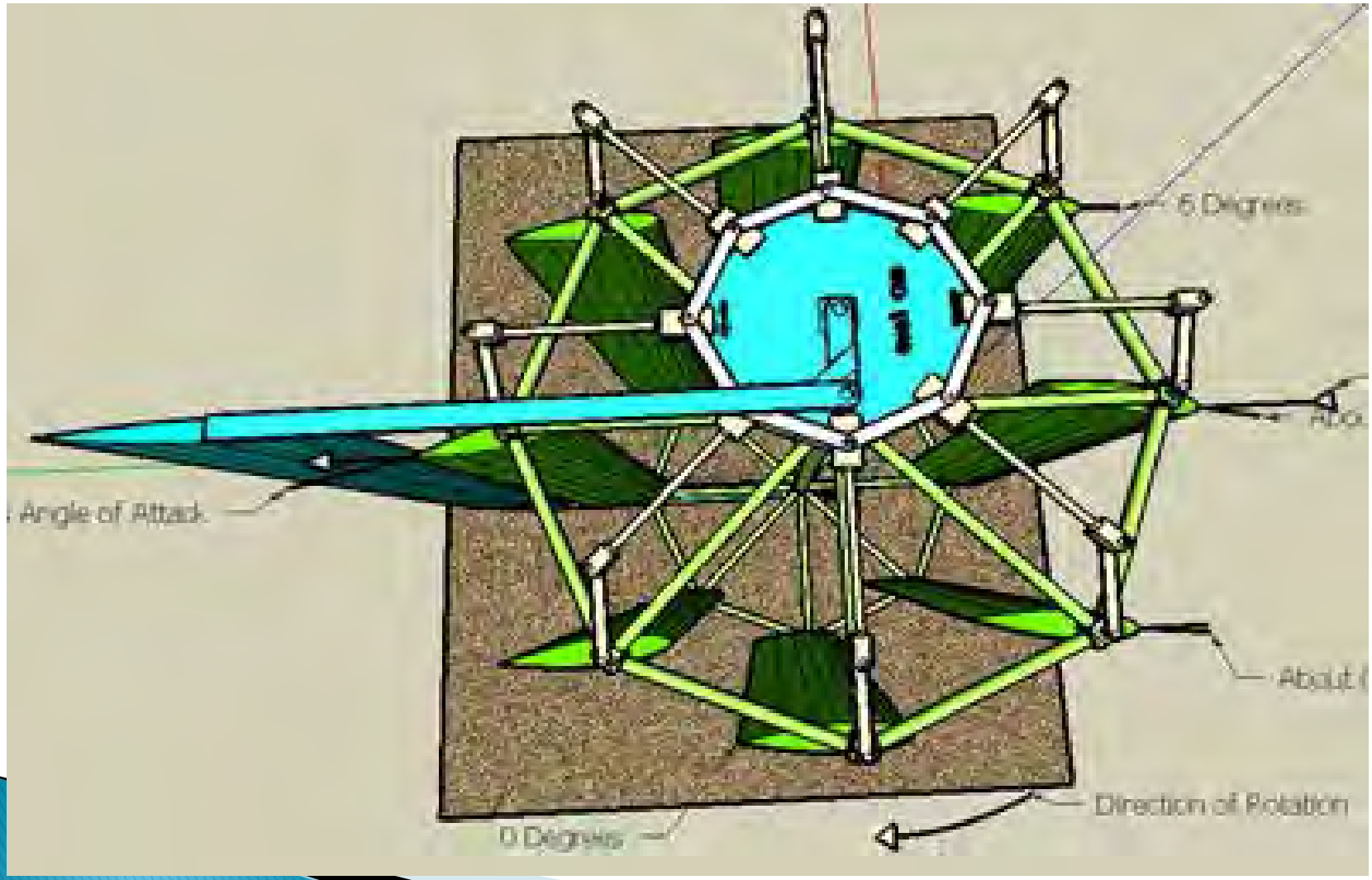
Disadvantages

- Rotors generally near ground where wind poorer
- Centrifugal force stresses blades
- Poor self-starting capabilities
- Requires support at top of turbine rotor
- Requires entire rotor to be removed to replace bearings
- Overall poor performance and reliability
- Have never been commercially successful

Wind Turbine Types

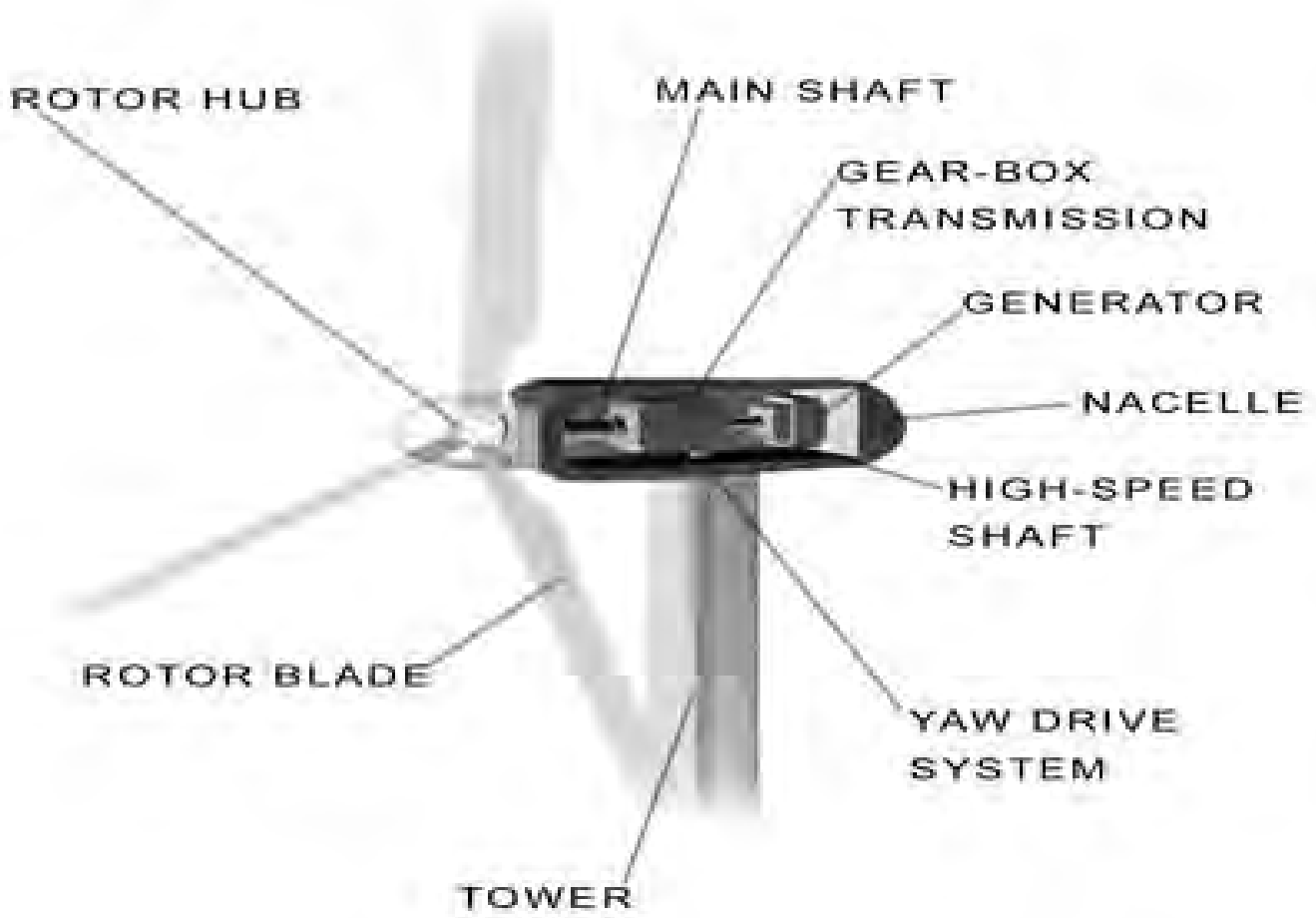


VERTICAL AXIS TURBINE

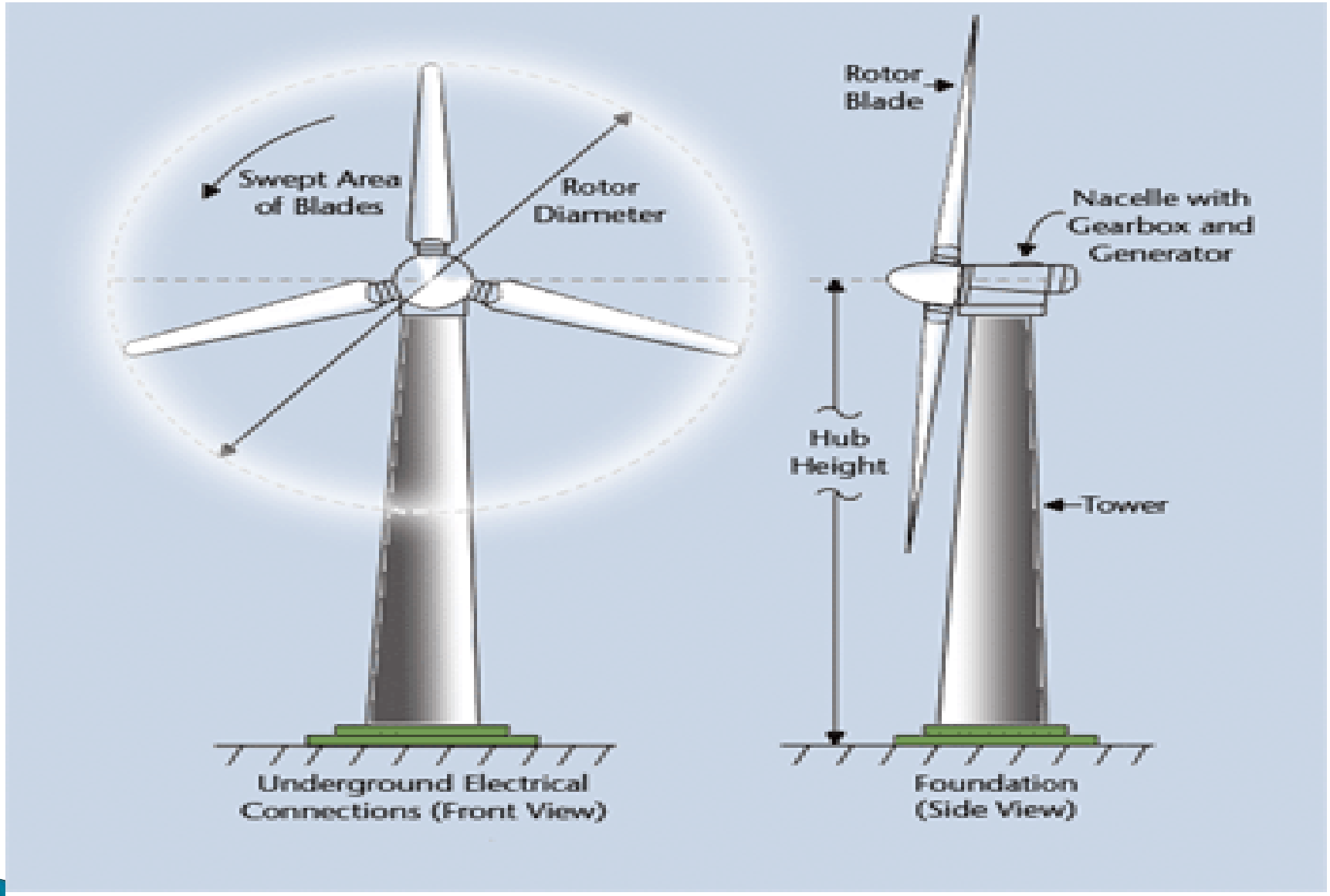


- Modern wind turbines fall into two basic groups; the horizontal-axis variety, like the traditional farm windmills used for pumping water, and the vertical-axis design, like the eggbeater-style Darrieus model, named after its French inventor. Most large modern wind turbines are horizontal-axis turbines.

Turbine Components



- blade or rotor, which converts the energy in the wind to rotational shaft energy;
- a drive train, usually including a gearbox and a generator; a tower that supports the rotor and drive train
- other equipment, including controls, electrical cables, ground support equipment, and interconnection equipment.



Drawing of the rotor and blades of a wind turbine, courtesy of ESN

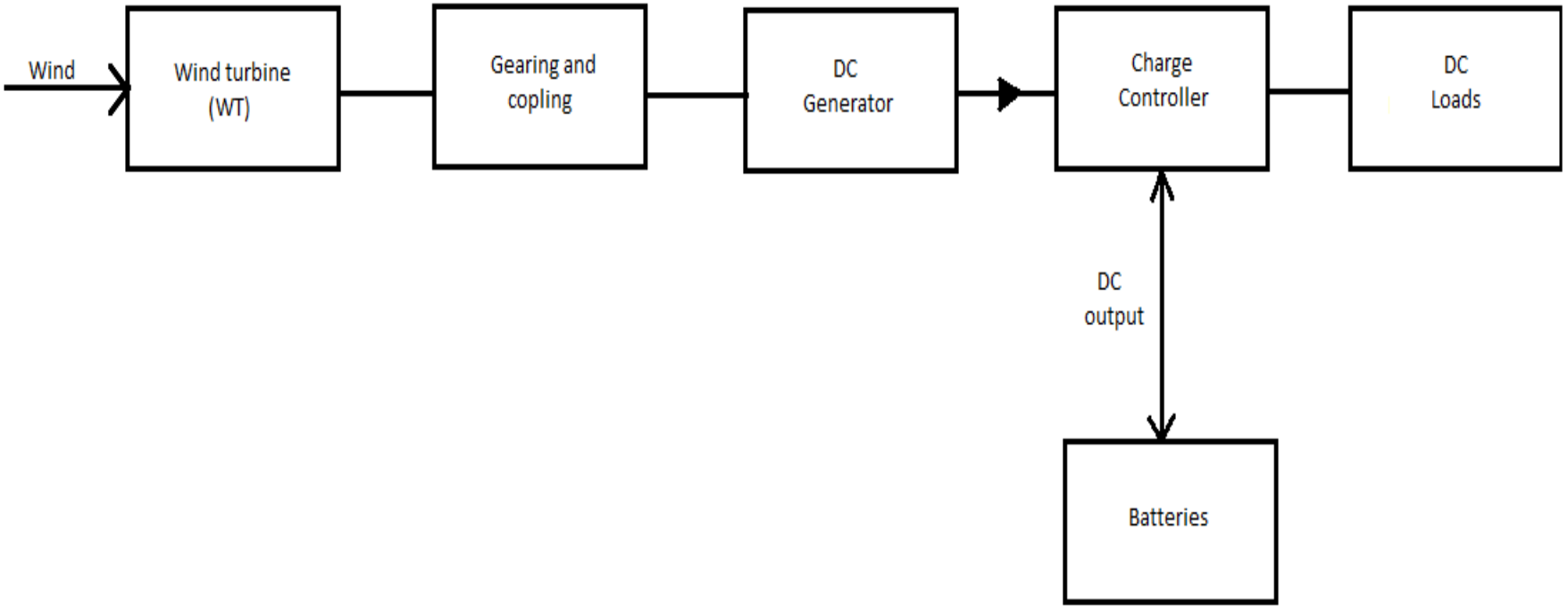
Turbine Configurations

Electricity from these turbines is fed into a utility Wind turbines are often grouped together into a single wind power plant, also known as a wind farm, and generate bulk electrical power.grid and distributed to customers, just as with conventional power plants.

Wind Turbine Size and Power Ratings

- Wind turbines are available in a variety of sizes, and therefore power ratings. The largest machine has blades that span more than the length of a football field, stands 20 building stories high, and produces enough electricity to power 1,400 homes.

- A small home-sized wind machine has rotors between 8 and 25 feet in diameter and stands upwards of 30 feet and can supply the power needs of an all-electric home or small business. Utility-scale turbines range in size from 50 to 750 kilowatts. Single small turbines, below 50 kilowatts, are used for homes, telecommunications dishes, or water pumping.



Converted to DC power by a DC generator & charges the batteries.

- Power is supplied to DC loads or by the batteries. The charge controller is used for controlling the charge/discharge of batteries. The systems can be used as standalone system for charging the batteries or for power supply in remote areas.

Total wind power

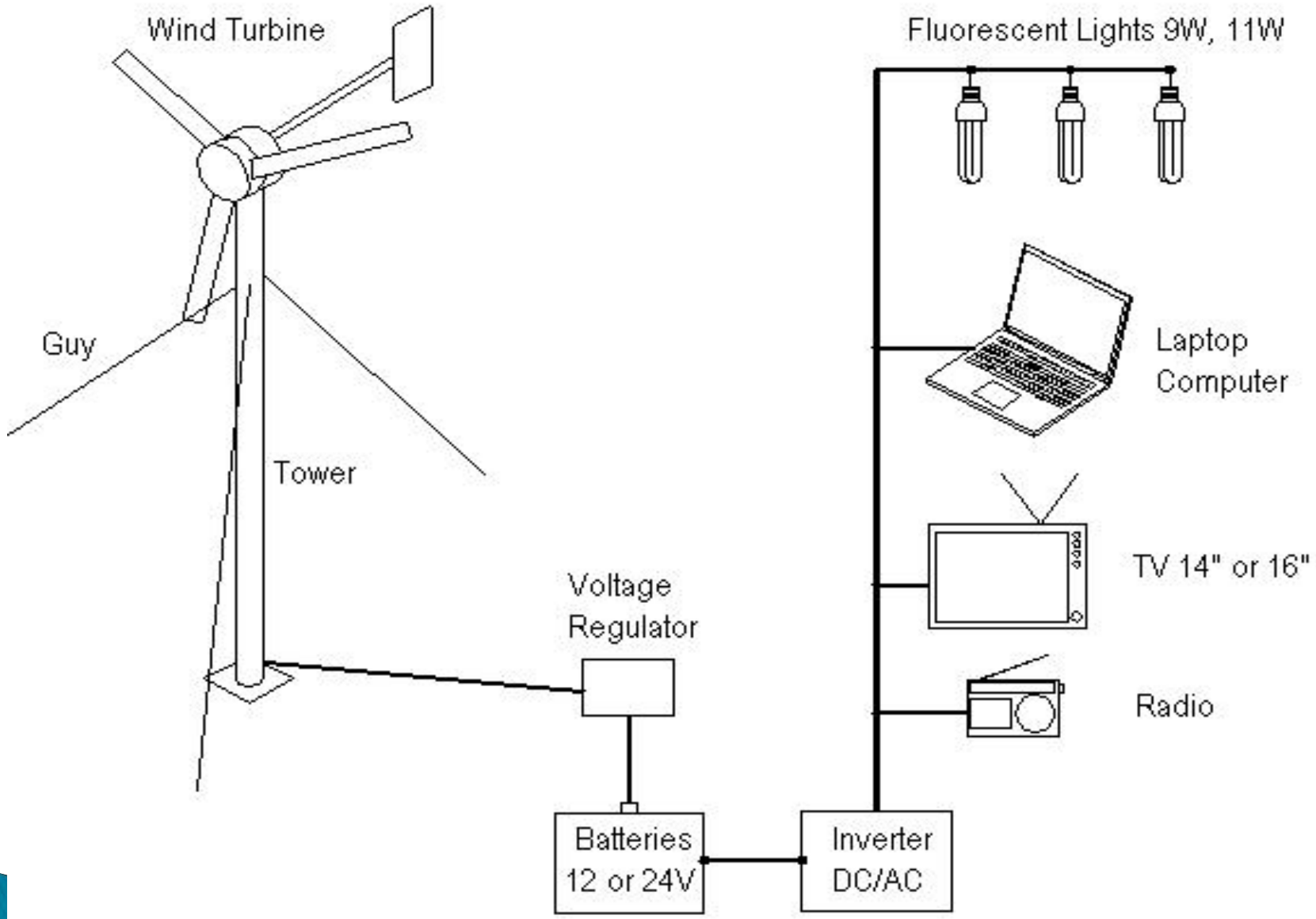
- If the incoming rate of kinetic energy of a flowing wind

$$KE_i = 1/2\ mV_i^2 \quad \text{i.e.} \quad P_{tot} = m\ (V_i^3/2)$$

Where V_i is the incoming wind velocity and m is the mass flow rate.

- That total power of a wind stream is directly proportional to the cube of its flowing velocity, wind density and the intercepted cross sectional area.

$$P_{tot} = \tfrac{1}{2}\ \rho\ AV_i^3$$


Wind Turbine
Guy
Tower
Voltage
Regulator
Batteries
12 or 24V
Inverter
DC/AC
Fluorescent Lights 9W, 11W
Laptop
Computer
TV 14" or 16"
Radio

Advantages and Disadvantages of Wind-Generated Electricity

- A Renewable Non-Polluting Resource :
- Wind energy is a free, renewable resource, so no matter how much is used today, there will still be the same supply in the future. Wind energy is also a source of clean, non-polluting, electricity. Unlike conventional power plants, wind plants emit no air pollutants or greenhouse gases

- According to the U.S. Department of Energy, in 1990, California's wind power plants offset the emission of more than 2.5 billion pounds of carbon dioxide, and 15 million pounds of other pollutants that would have otherwise been produced.
- It would take a forest of 90 million to 175 million trees to provide the same air quality.

- If wind generating systems are compared with fossil-fueled systems on a "life-cycle" cost basis (counting fuel and operating expenses for the life of the generator), however, wind costs are much more competitive with other generating technologies because there is no fuel to purchase and minimal operating expenses

Environmental Concerns

- Although wind power plants have relatively little impact on the environment compared to fossil fuel power plants, there is some concern over the noise produced by the rotor blades, aesthetic (visual) impacts, and birds and bats having been killed (avian/bat mortality) by flying into the rotors.
- Most of these problems have been resolved or greatly reduced through technological development or by properly siting wind plants.

Supply and Transport Issues :

- The major challenge to using wind as a source of power is that it is intermittent and does not always blow when electricity is needed.
- Wind cannot be stored (although wind-generated electricity can be stored, if batteries are used), and not all winds can be harnessed to meet the timing of electricity demands.
- Further, good wind sites are often located in remote locations far from areas of electric power demand (such as cities).

- Finally, wind resource development may compete with other uses for the land, and those alternative uses may be more highly valued than electricity generation.
- However, wind turbines can be located on land that is also used for grazing or even farming.

Hydro Electric Power

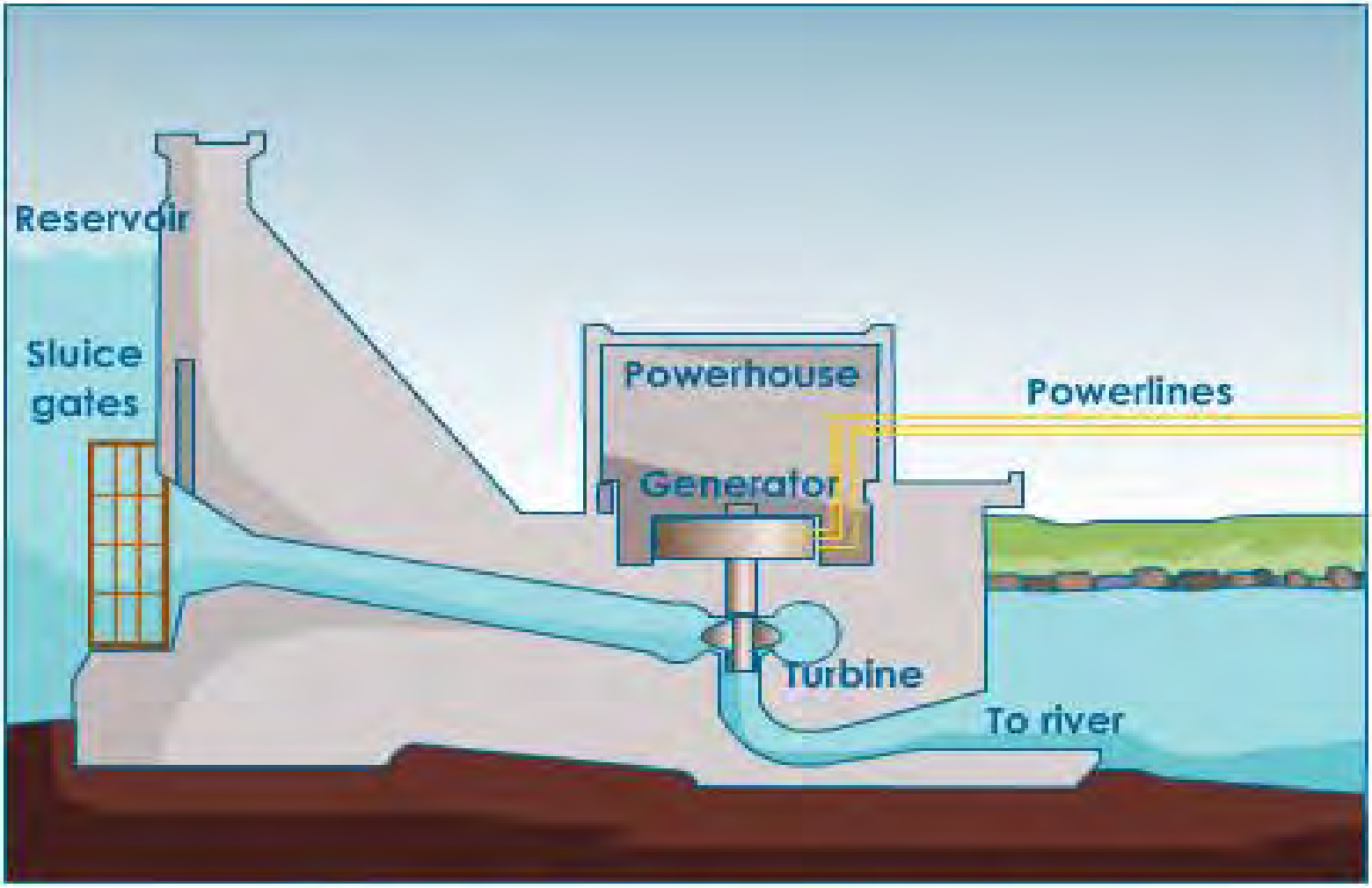
YEYWA hydro power dam at Mandalay devision in Myanmar

Hydro Turbine

- Current Status of Utilization of Small Hydro Turbine in Myanmar
- Hydro-turbine technology
- Small Hydro Power Potential in Myanmar
- Small Hydro Power Applications in Myanmar
- Small Hydro power Research in Myanmar

Introduction

- Hydroelectric power (hydropower) systems convert the kinetic energy in flowing water into electric energy.
- Falling or flowing water turns a propeller like piece called a turbine.
- The turbine turns a metal shaft in an electric generator which produces electricity.



A schematic view of a hydro power plant

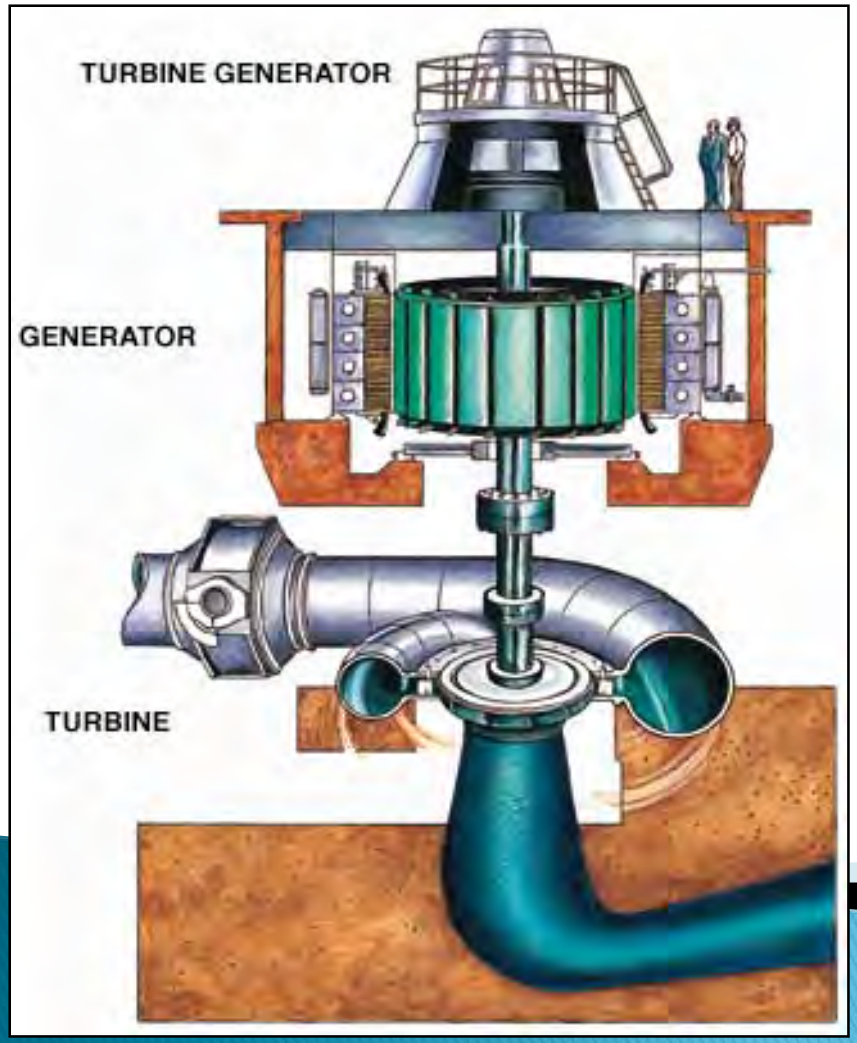
Advantages

- No fuel required
- No air pollution
- Can easily work during high peak daily loads
- Prevents floods

Disadvantages

- Disrupts the aquatic ecosystems
- Disruption of surrounding areas
- Requires large areas
- Large scale human displacement

How a Hydroelectric Power System Works?

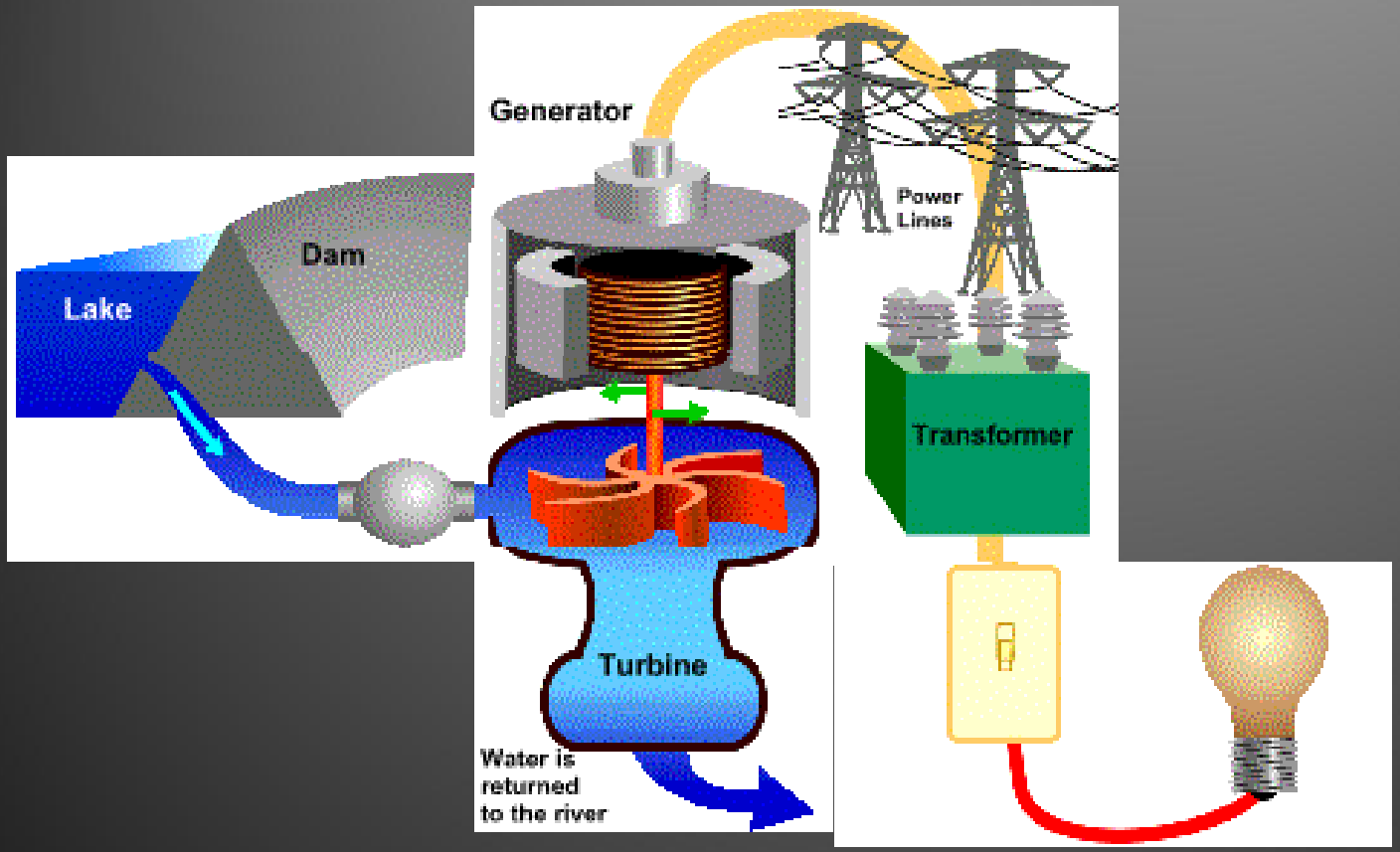


- Flowing water is directed at a turbine.
- The flowing water causes the turbine to rotate, converting the water's kinetic energy into mechanical energy.

- The mechanical energy produced by the turbine is converted into electric energy using a turbine generator.

- Inside the generator, the shaft of the turbine spins a magnet inside coils of copper wire.

- It is a fact of nature that moving a magnet near a conductor causes an electric current.


Generator
Power Lines
Dam
Lake
Transformer
Turbine
Water is returned to the river

Hydel scheme

1 .**Run-off Plants without Poundage**:

As name indicates this type of plant doesn't store water, the plant uses as water comes.

2. **Run-Off plants with Poundage**: Poundage permits storage of water during the off –peak period and use of this water during peak periods.

3. **Reservoir Plants**: A reservoir plant is that which has reservoir of such size as to permit carrying over storage from wet season to the next dry season.

4 .**Low head plants:** In this case small dam is built across the river to provide the necessary head. In such plants Francis type of turbines are used.

5. **Medium head plants:** The fore bay provided at the beginning of Penstock serves as water reservoir for such plants. In these plants water is generally carried out in open canals from reservoir to the Fore bay and then to the penstock.

6. **High head Plant**: This plants works above 500mtrs and Pelton wheel turbines are commonly used. In this plant water is carried out from the main reservoir by a tunnel up to surge tank and then from the surge tank to the power house in penstock.

7. **Base Load Plants**: These Plants are mainly depending on the nature of load. Is demand is more, this plants are used regularly and load factor of this plants are high.

8. **Peak load Plants:** These plants are mainly used during the peak load. Run-off river plants with poundage can be used as peak-load plants. reservoir plants with enough storage behind the dam can be used either as base load or as peak load plants as required.

9. **Pumped storage plants:** These plants are used when quantity of water available for generation is insufficient. If it is possible to pond at head water and tail water locations after passing through the turbine is stored in the tail race pond from where it may be pumped back to the Head water pond.