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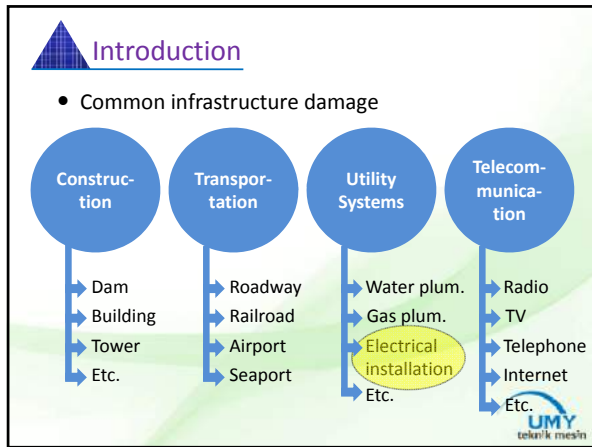
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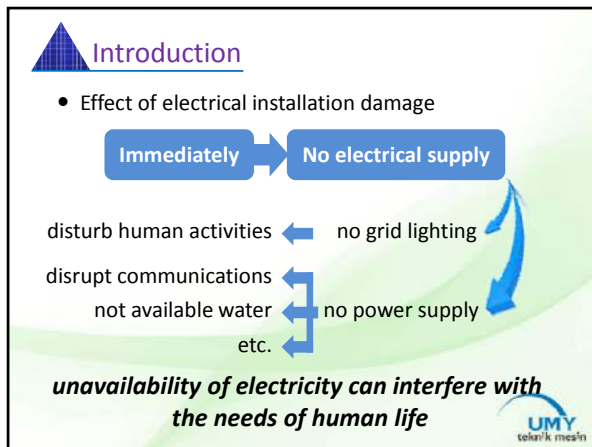
PHOTOVOLTAIC SYSTEM AS
AN ALTERNATIVE EMERGENCY ENERGY
SUPPLY IN DISASTER AREA

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Introduction

- From where electrical energy is obtained?

The diagram shows a blue circle labeled 'Conventional Systems' with a large red 'X' over it. To its right is another blue circle labeled 'Non-Conventional Systems'. An arrow points from the 'Non-Conventional Systems' circle down to a blue box labeled 'New and Renewable Energy'. The UMY logo is in the bottom right corner.

Introduction

- Source of energy

The flowchart starts with 'Energy Sources' at the top. It branches into two main categories: 'Conventional Non-Renewable Depleted Energy' and 'Non-conventional Renewable Non-Depleted Energy'.
 - 'Conventional Non-Renewable Depleted Energy' branches into 'Terrestrial', which further divides into 'Nuclear' and 'Fossil'. 'Fossil' includes 'Oil', 'Coal', and 'Gas'.
 - 'Non-conventional Renewable Non-Depleted Energy' branches into 'Terrestrial' and 'Extraterrestrial'.
 - 'Terrestrial' includes 'Biomass', 'Wind', 'Water', and 'Geothermal'. 'Water' includes 'Tidal', 'OTEC', 'Wave', and 'Hydro power'.
 - 'Extraterrestrial' includes 'Sun', 'Moon', 'Meteor', and 'Cosmic rays'.
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Introduction

- Distribution & utilization of energy

The flowchart shows energy sources and their utilization:
 - 'Direct reflection (short wave) $(0.25 \times 10^{18} \text{ kW})$ ' and 'Solar energy on the earth $(1.75 \times 10^{17} \text{ kW})$ ' lead to 'Artificial'.
 - 'Indirect reflection (long wave) $(0.83 \times 10^{17} \text{ kW})$ ' leads to 'Natural'.
 - 'Artificial' branches into 'Photoelectric' and 'Heat'.
 - 'Photoelectric' includes 'Photovoltaic', 'Photochemical reaction (industry)', and 'Electrolysis and ionization (Domestic, agriculture)'.
 - 'Heat' includes 'Solar furnace (Industry)', 'Heat engine (Power station)', 'Drying (Agriculture, industry)', 'Cooking (Domestic, field)', 'Refrigeration (low grade)', 'Distillation (Water manufacturing)', and 'Heating (domestic, pool, green house)'.
 - 'Natural' branches into 'Photosynthesis' and 'Climate and Ocean'.
 - 'Photosynthesis' includes 'Power station (Industry)', 'Oxide (Domestic)', 'Hydrogen production (Industry)', and 'Photochemical reaction (Industry)'.
 - 'Climate and Ocean' includes 'Hydro-power (power station)', 'Wind power (power station, water)', 'Thermal power (power generation, field)', and 'Current power (river)'.
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Introduction

- Renewable energy sources

Photovoltaic (PV)

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Introduction

Photovoltaic systems can be used as an alternative emergency energy supply in disaster area

Compared to another renewable energy sources, PV systems:

- have a much cheaper price investment
- are more easily brought to the location
- have a modular size characteristics
- are suitable for domestic use
- can be installed instantly

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Photovoltaic Technology

- Understanding of photovoltaic
 - Etymology
 - Greece language : *photos* \Rightarrow light
 - Italian physicist: *Volta* \Rightarrow the concept of electric voltage
 - Language
 - Light and electricity
 - Science
 - Converting sunlight containing electromagnetic energy into electrical energy directly

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Photovoltaic Technology

- Fusion reaction
 - The sun contains immense energy derived from the fusion reaction
 - The chain of fusion reaction

Key:

- proton
- neutron
- positron
- ν neutron
- γ photon

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Photovoltaic Technology

- The origin of electromagnetic energy
 - Hydrogen to helium conversion

Neutron → Proton + Kinetic energy + gamma rays + etc

Hydrogen → Helium + Elektromagnetic energy

$m = 4 \times 1,00723$ mass unit $m = 4,00151$ mass unit

$\Delta m = 0,02741$ mass unit, or equivalent $\approx 5 \times 10^9$ kg/s

Remember, $E = mc^2$

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Photovoltaic Technology

- Solar cell
 - Generally consists of a layer of glass, a negative electrode, antireflective coating, n-type semiconductor, p-type semiconductor and the positive electrode

Contact grid

AR-coating

n-type region

Junction

p-type region

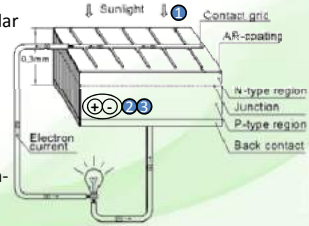
Back contact

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Photovoltaic Technology

- Mechanism of photovoltaic effect

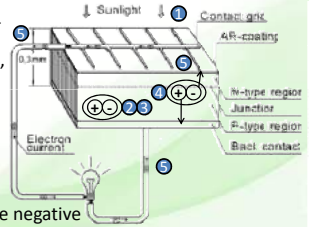
1. Sunlight strike the solar cell
2. Photon with large energy is absorbed
3. Photon absorption resulting in the formation of electron-hole pairs



Photovoltaic Technology

- Mechanism of photovoltaic effect

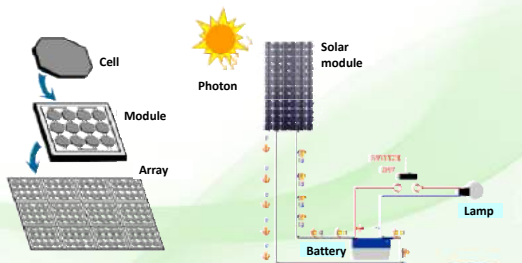
4. The pairs of electron-hole formed near the p-n junction, electron and hole will be separated due to the electricity field in the p-n junction.



5. Electrons are accommodated by the negative electrode and then electrons can flow into a positive electrode when installed load (occurring currents)

Photovoltaic Technology

- Photovoltaic effect device



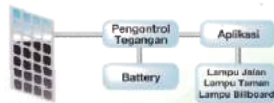
Photovoltaic Systems

- Advantages:
 - ✓ available free and abundant in nature
 - ✓ environmentally friendly (free to air pollution)
 - ✓ not noisy (free of noise pollution)
 - ✓ no moving parts
 - ✓ easy installation, operation and maintenance
 - ✓ particularly suitable for areas far from grid connection
- Disadvantages:
 - ✓ high initial cost
 - ✓ low energy efficiency
 - ✓ heavily dependent on natural conditions

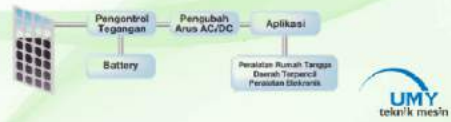


Photovoltaic Systems

- Type of PV systems based on electric current output
1. DC system



2. AC system



Photovoltaic Systems

- Type of PV systems based on the need of energy storage
1. Without battery



2. With battery



Photovoltaic Systems

- Application of DC systems (without battery)

Solar car model



Solar pumping system



Photovoltaic Systems

- Application of DC systems (off-grid/standalone)

Solar street light



Solar home system



Solar refrigerator



Photovoltaic Systems

- Application of AC systems (on-grid)



Solar Home System

- Definition
 - ▷ Solar power generation systems for household scale (abbreviated SHS)
 - ▷ PV systems are used as a power supply, especially at night time



Solar Home System

- SHS in Indonesia

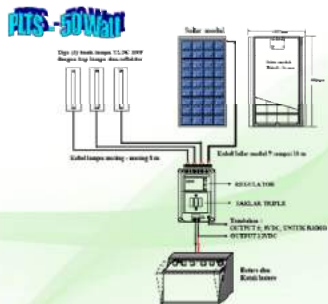


- ▷ Since 1988, Indonesia has started using solar energy through the rural electrification program by applying SHS. The government's target is to install one million units of SHS
- ▷ The goal of the program is to provide energy in areas not reached by the electricity network to improve people's lives




Solar Home System

- Scheme of component




Solar Home System

- Main components and its functions
 - ▷ Solar module
 - Convert solar energy into electrical energy (direct current) directly





The diagram shows two types of solar modules: Monocrystalline (a single dark blue square) and Polycrystalline (a larger square with a grid of smaller blue squares). Arrows point from the labels to the respective modules.





Solar Home System

- Main components and its functions (cont.)
 - ▷ Battery Charge Regulator (BCR)
 - ✓ Regulate the current in and out of battery to the load
 - ✓ Disconnecting the battery charging when it is 'full' (state of charge, SOC = 100%)
 - ✓ Break the current when the conditions of energy usage to the lower limit battery capacity (depth of discharge, DOD)

Solar Home System

- Main components and its functions (cont.)
 - ▷ Battery
 - ✓ Storing electrical energy generated by the solar modules
 - ✓ As a source of electricity used at night time

Solar Home System

- Main components and its functions (cont.)
 - ▷ Inverter
 - ✓ Convert a direct current to alternating current



Solar Home System

- Supporting components

1. Frame



2. Wire



3. Battery box



4. Accessories



5. Lamp box



Solar Home System

- SHS components in one package of SHS



Solar Home System

- Tools required for installation



Conclusion

Photovoltaic system are more attractive as an alternative emergency energy supply in disaster area