



**Benha University**

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# *Renewable Energy Systems*



By



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# Lecture (6)



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# Hydropower Energy

4



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# What is the Hydropower Energy?

5

- An Electrical energy created from water stored in huge dams.
- The energy created by the water released from these dams is transformed into electricity by hydro-electric turbines and generators.
- Hydropower supplies 19% of all electricity in the world.
- The most famous source of hydroelectric power is in the Snowy Mountains.
- It is less expensive than mining fossil fuels and does not contribute to the greenhouse effect

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# Advantages of Hydropower Energy

6

1. No greenhouse gases.
2. Energy generated can be increased or decreased depending on the needs of the community that uses it.
3. Hydroelectricity is one of the lowest cost forms of energy as it requires no fuel, low operating costs and little maintenance.
4. Water used is free.
5. It is one of the cleanest forms of energy.
6. Renewable source.

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# Disadvantages of Hydropower Energy

7

1. Building a dam destroys an area of landscape and changes the ecology downstream.
2. People living in village and towns that are in the valley to be flooded, must move out.
3. Dams have endangered some species of fish (fish population).

# How Hydropower Energy Works?

8

1. Hydropower plants capture the energy of falling water to generate electricity.
2. A turbine converts the kinetic energy of falling water into mechanical energy.
3. Then a generator converts the mechanical energy from the turbine into electrical energy, as known as **hydropower** or **hydroelectric power**.

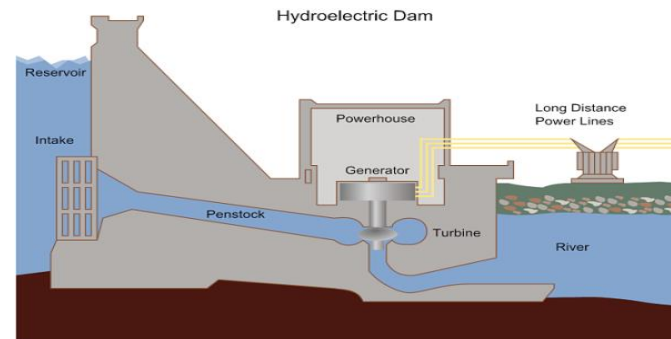


# Hydropower Energy Application

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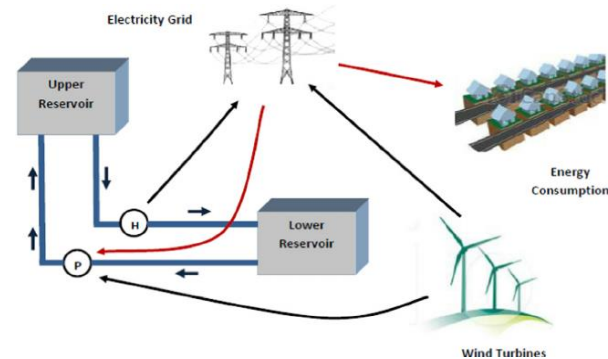
## Applications of hydropower

### 1. Electricity generation.



### 2. Energy storage

The main use of pumped hydro storage is for grid energy storage. Electric utilities are the main customers of this technology using



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### 3. **Agriculture**

Hydropower was used in ancient times for producing flour from grain and was also used for sawing timber and stone, raised water into irrigation canals.

### 4. **Industry**

Hydropower was used earlier for some industrial applications such as driving the bellows in small blast furnaces.

# Geothermal Energy

11

Geothermal



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# What is the Geothermal Energy?

12

- Energy from the heat of the earth. It has been used for thousands of years in some countries for hot water, cooking and heating.
- It can also generate electricity using steam produced from heat found beneath the surface of the earth.
- It is not common yet though experimental and pilot geothermal power generation is being explored.
- Several meters under the earth surface the temperature is between  $10^{\circ}\text{C}$  and  $16^{\circ}\text{C}$ , in winter this heat can be brought to buildings with pipes.

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13

- The country with the greatest geothermal energy production is USA, there is the biggest dry steam field, the heaters with an annual capacity of 750 MW.

# Advantages of Geothermal Energy

14

1. The operating costs are low.
2. It is not dependent on the weather conditions.
3. Geothermal plant virtually produces no emission.
4. Huge quantity of energy available.
5. Moderate net energy and high efficiency at accessible sites.

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## Disadvantages of geothermal energy

15

1. Geothermal power stations are expensive to build.
2. The generation of geothermal energy creates noise pollution and releases noxious smells.
3. Can run out of steam.
4. There is always a danger of eruption of volcano.

# How Geothermal Energy Works?

16

1. Geothermal energy converts thermal energy to electricity.
2. At a geothermal energy plant, drilling must take place to access hot rocks below the earth's surface.
3. The heat from the rocks is used to convert liquid to steam.
4. The steam is used to turn turbines which are connected by a shaft to a generator, which converts the rotational energy into electrical energy.



# Types of Geothermal Energy

17

- Geothermal energy plants utilize either an open loop or closed loop system to harness geothermal energy so that it can be used for electricity.

## 1. **Open loop system**

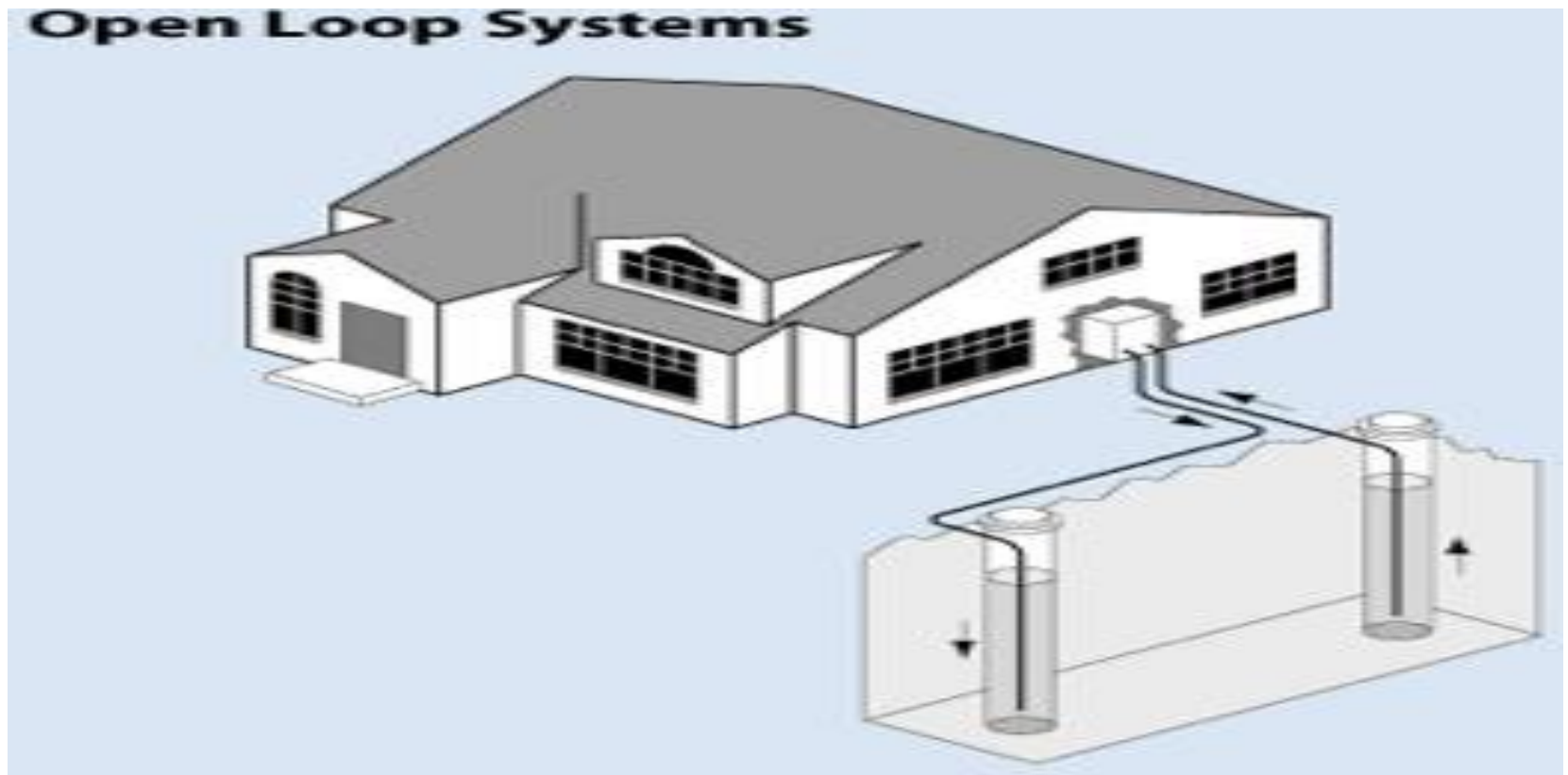
- A. With this type of system, water is pumped down to hot rocks deep in the earth's crust through a pipe.
- B. Underground, the water leaves the pipe, where heat from the rocks boils it into steam.
- C. The steam travels through cracks in the rocks and goes back to the surface through pipe which is connected to a turbine.

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18

- D. After the steam hits the turbine, it is released into the atmosphere.



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19

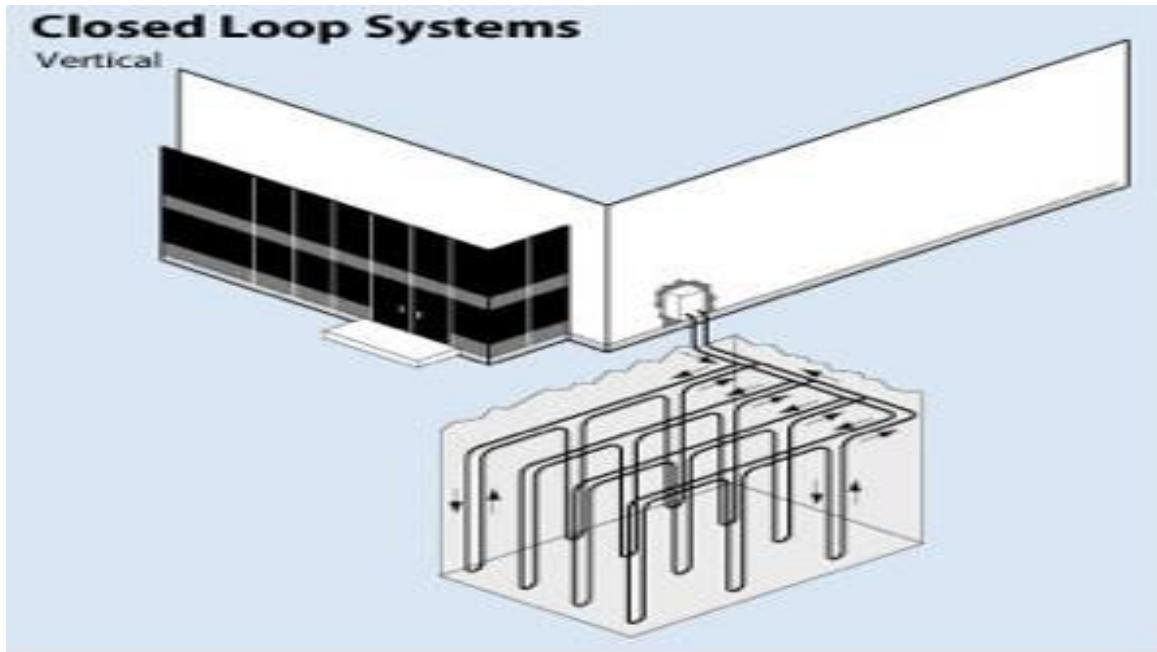
## 2. Closed loop system

- A. The difference between a closed loop and an open loop system is that the steam remains enclosed in pipes through the entire process.
- B. Water, or a liquid with a lower boiling point than water, is piped to hot rocks beneath the surface of the earth where it is converted to steam.
- C. The steam is not released to naturally rise to the surface, as it would be in an open loop. It travels to turn the turbine through a pipe, so it is not exposed to pollutants.

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20

- D. Instead of being released into the atmosphere, the steam is condensed back into a liquid and pumped back underground for reheating.

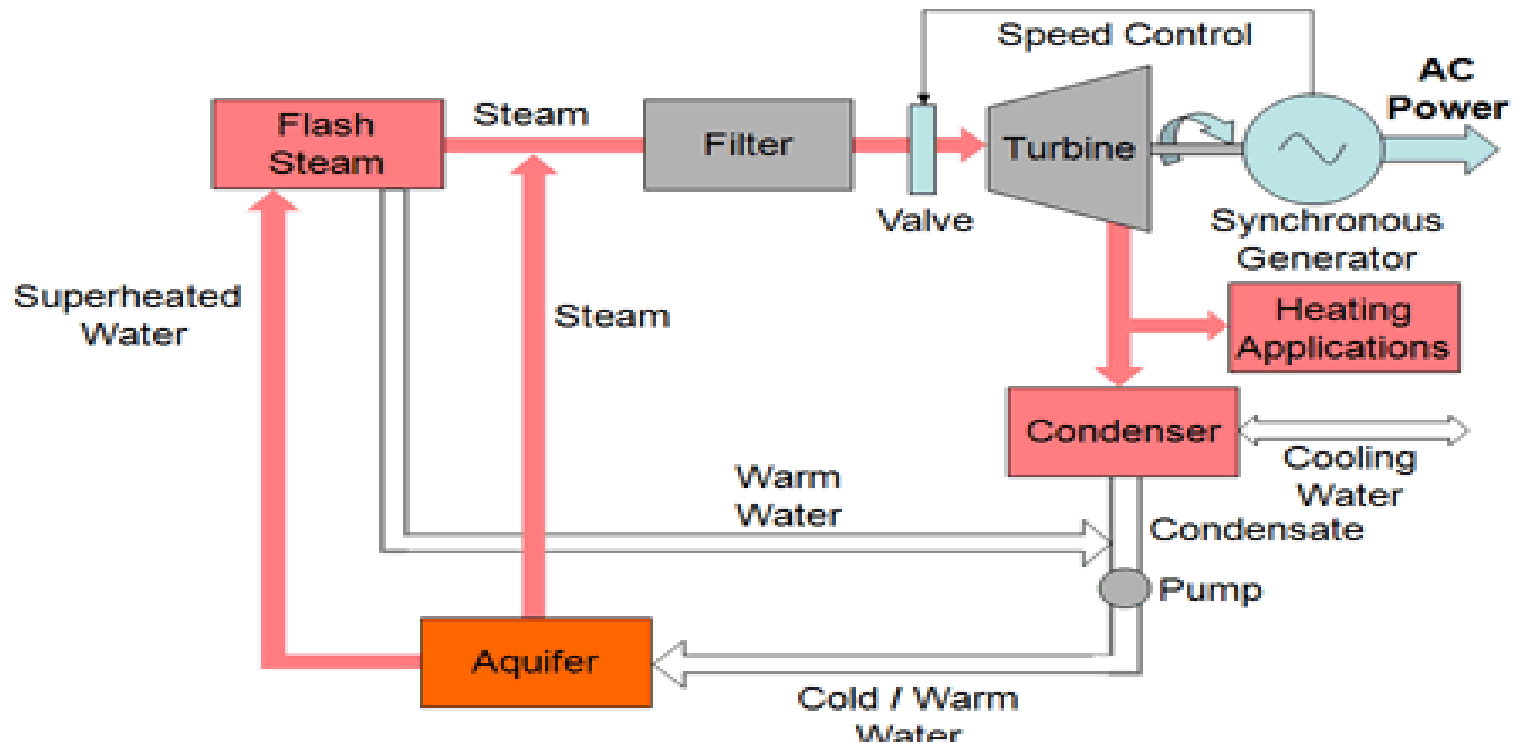


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# Geothermal Energy Application

21

## 1. Electricity Production.



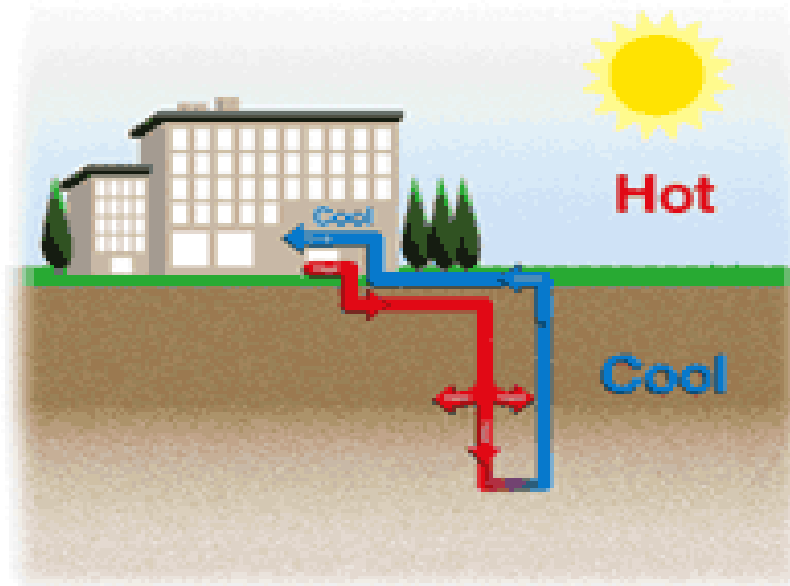
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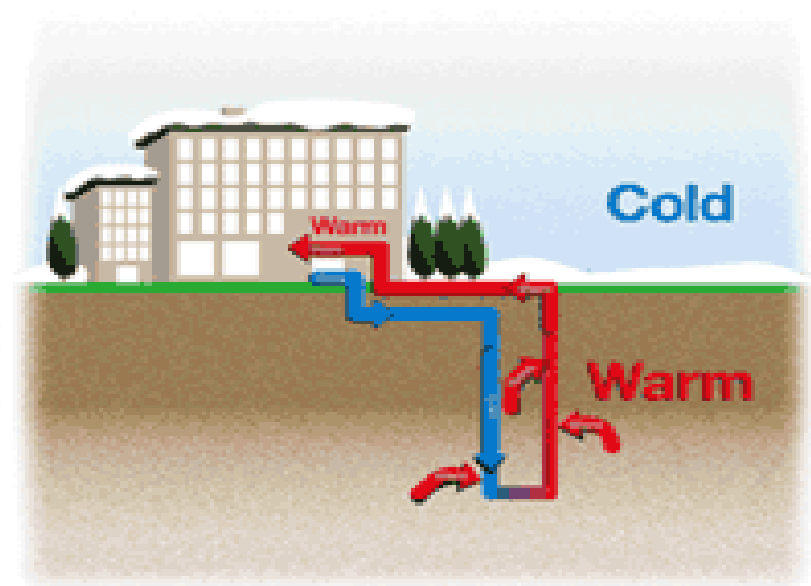
22

## 2. Heating purpose

SUMMER



WINTER



# Biomass Energy

23



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# What is the Biomass Energy?

24

- Biomass is used to produce Biofuel.
- The most common material for biofuels are photosynthetic plant, a plant specially grown to be used for biofuel manufacturing is known as an **energy crop**.
- Energy which comes from landfill – or rubbish dumps.
- It includes energy from both animal and plant matter.
- Landfill gas is created when the waste you throw away starts rotting in the ground.



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25

- This gas would normally just seep through the ground and into the atmosphere, contributing to environmental problems, like the greenhouse effect.
- It can be captured and processed to create electricity.
- It is collected, dried, and filtered to get rid of any waste particles.
- It is then fed through pipes to a gas generator that burns the gas to create electricity.

# Types of Biomass Energy

26

## 1. Biodiesel

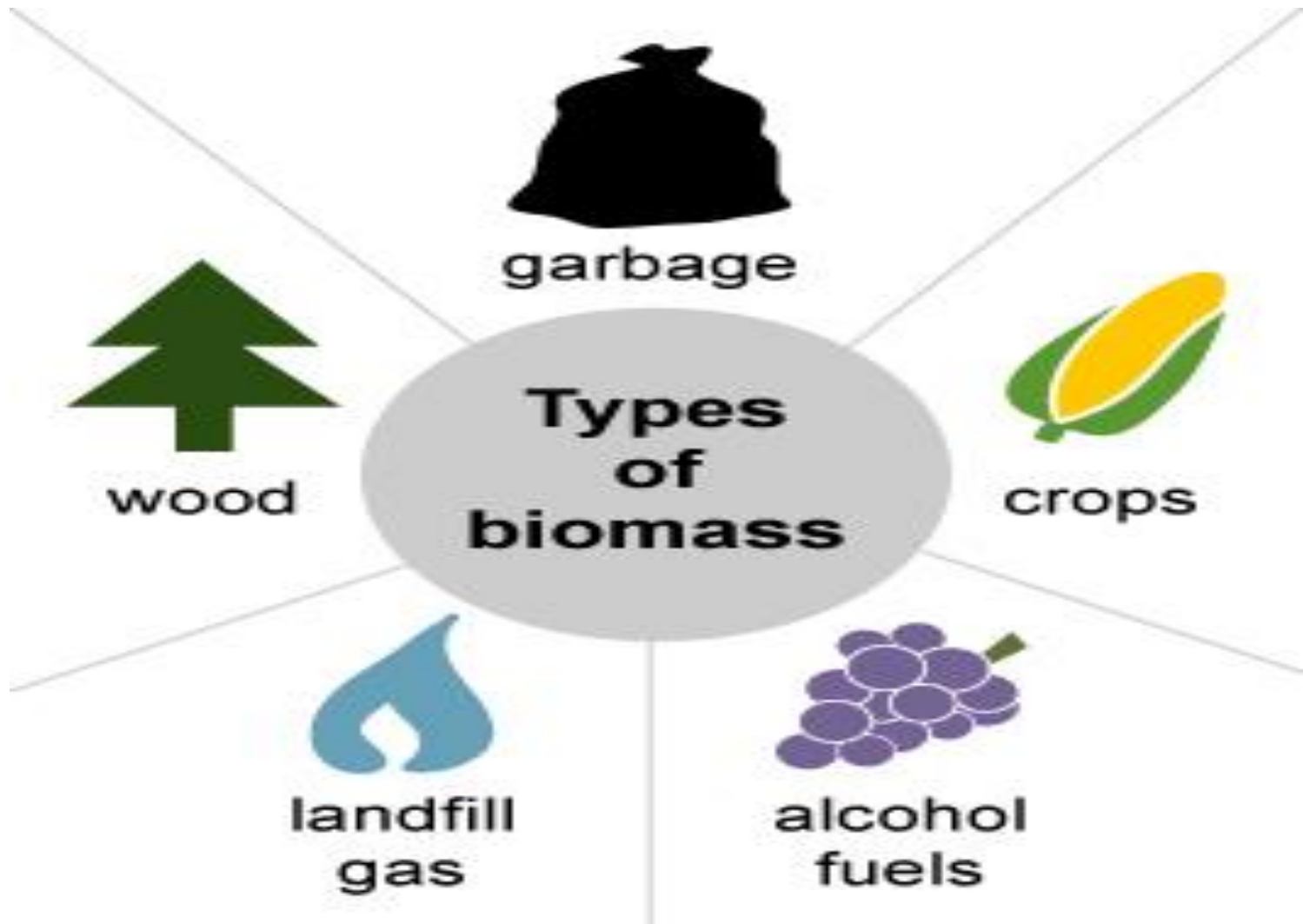
It's the common and made from oils that extracted from sunflower, soy, animal product.

## 2. Biogas

It is produced by the biological breakdown of organic matter in the absence of oxygen. They can be used to generate heat, electric or mechanical energy.

## 3. Bioalcohol

it is produced with the help of fermentation inducing microorganisms, that is widely used instead of petrol to power cars in **brazil**.



# Advantages of Biomass Energy

28

1. Minimizes overdependence on traditional electricity.
2. Biomass energy sources are bountiful in supply.
3. Reduces amount of waste in landfills.
4. It's carbon neutral (the carbon emitted to the environment from biomass fuels is the amount that was absorbed by plants in their life cycle).
5. It is a renewable form of energy because the organic materials used to produce it are never-ending.

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# Disadvantages of Biomass Energy

29

1. It increases methane gases, which are also harmful to the earth's ozone layer.
2. Uncontrolled biomass production can result in deforestation.
3. Requires a great deal of water.

# What is the use of Biomass Energy

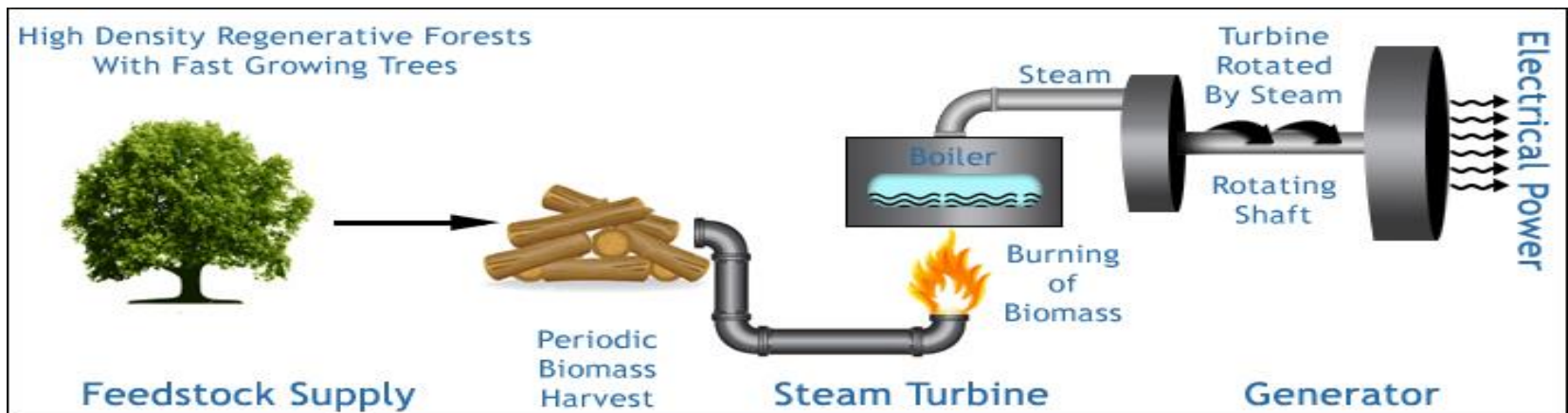
30

## 1. For producing heat energy:

Any thing from the nature which can burn to heat like (coal, wood, and mustard oil).

## 2. For producing electricity:

Using method is same as oil. Burn it and get energy either for a state or a house.



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3. Used in homes for heating or cooking.
4. Industrial applications like lumber mills, naturally produce organic waste.

# Activity: Comparison Between Renewable Energy Sources

32

Renewable energy	Power generated by	Production cost	Installation cost	Infinite renewable energy available	Efficient renewable energy
<b>Solar</b>	Sun				
<b>Wind turbine</b>	Wind				
<b>Hydroelectric</b>	Water				
<b>Geothermal</b>	Earth				
<b>Biomass</b>	Plant and animal waste				

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# Activity

33

1. What are the expected Targets for 2020 Egyptian Plan ?
2. Can these be achieved?
3. What forms of renewable energy will deliver these targets?

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# Hybrid System

# Hybrid Renewable Energy Systems

35

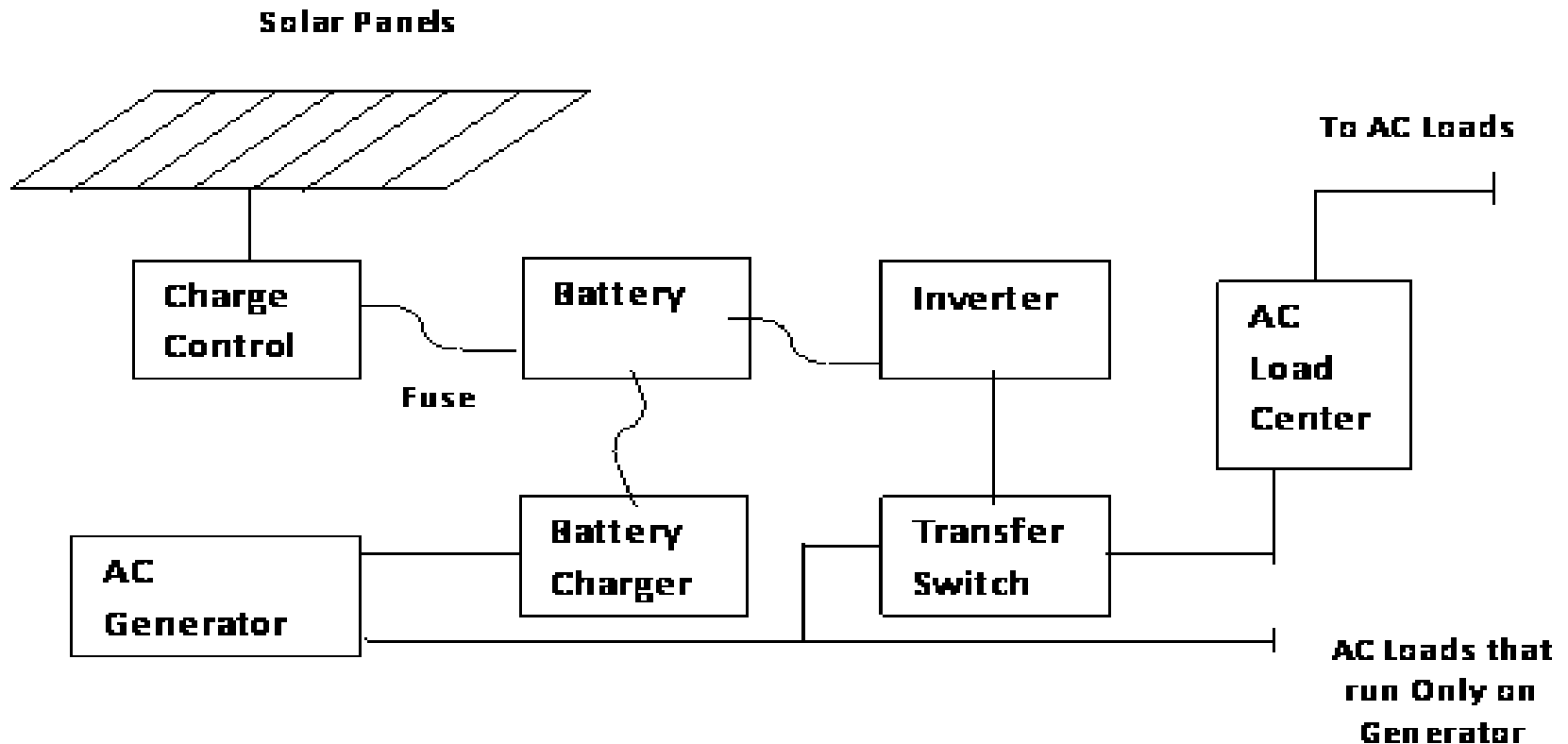
- **Hybrid Renewable Energy Systems (HRES)** are becoming popular as stand-alone power systems for providing electricity in remote areas due to advances in renewable energy technologies.
- A hybrid energy system, or hybrid power, usually consists of two or more renewable energy sources used together to provide increased system efficiency as well as greater balance in energy supply.

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# Examples for Hybrid System

36

## 1. Solar Photovoltaic - Diesel Generator Hybrid System.



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37

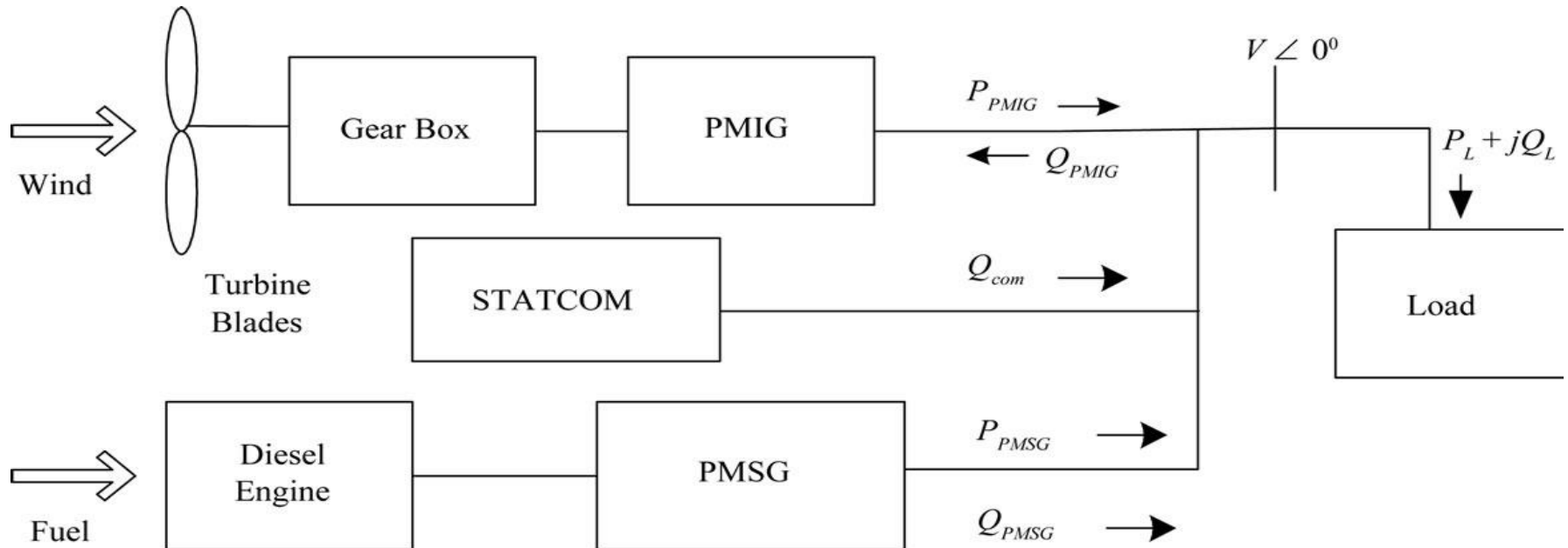
- This system combines two energy sources, the sun and a diesel generator, where the generator supplies excess load and recharge the battery during overcasts.
- The hybrid system is meant for backup power in case of a power shortage.
- It also reduces downtime during maintenance or repairs since the system on its own.

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38

## 2. Wind - Diesel Generator Hybrid System.



- **(PMIG):** permanent-magnet induction generator.
- **(PMSG):** permanent-magnet synchronous generator.

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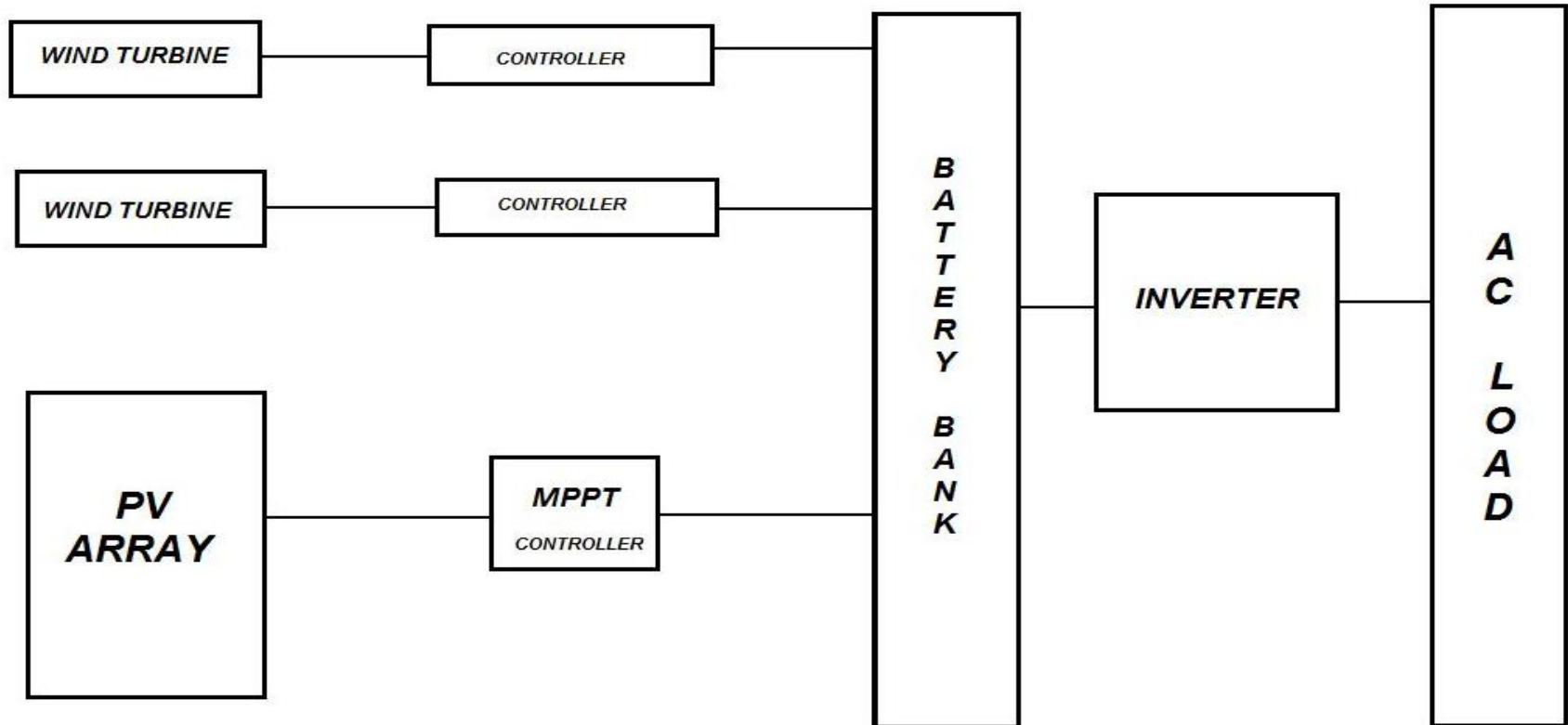
39

- The reactive power control of an wind-diesel hybrid power system.
- A **PMIG** has been considered for the generation of electric power from wind turbine.
- A **PMSG** is connected with the diesel.
- **STATCOM** is used for providing variable reactive power required by the system.
- A complete dynamic model of the system has been derived to study the effect of load disturbances and input wind power disturbances.

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40

## 3. Wind - Photovoltaic Hybrid System.



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41

- Solar-wind hybrid power system is the combined power generating system by wind mill and solar energy panel.
- It also includes a battery which is used to store the energy generated from both the sources.
- Using this system power generation by windmill when wind source is available and generation from PV module when light radiation is available can be achieved.
- Both units can be generated power when both sources are available.
- By providing the battery uninterrupted power supply is possible when both sources are idle.

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# Challenged Faced Hybrid System

42

- The renewable energy sources need innovative technology to harness more amount of useful power from them.
- The manufacturing cost of renewable energy sources needs a significant reduction because the high capital cost leads to an increased payback time.
- It should be ensured that there should be minimal amount of power loss in the power electronic devices.
- The storage technologies need to increase their life-cycle through inventive technologies.

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# Why Hybrid System?

43

- Hybrid system is a better option for construction of modern electrical grids.
- Fuel saving (up to 50%).
- Lower pollution.
- Saving in maintenance.
- Silent system.
- Connection to other power supply.

# Electric Energy Consumption

44

- Increasing demand-side efficiency is one of the cost effective options to help lower future demands and reduce potential supply shortages, improve energy security, and mitigate harmful emissions without compromising economic development.

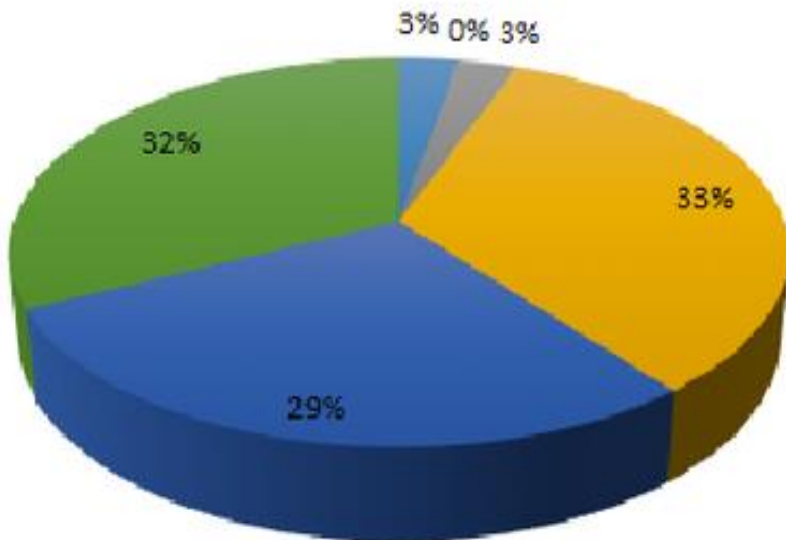
- Energy efficiency gained a prominent role at the political level with the formulation of a quantitative target to save 20% of today's consumption by 2020.

# How Much Energy is needed in Egypt?

46

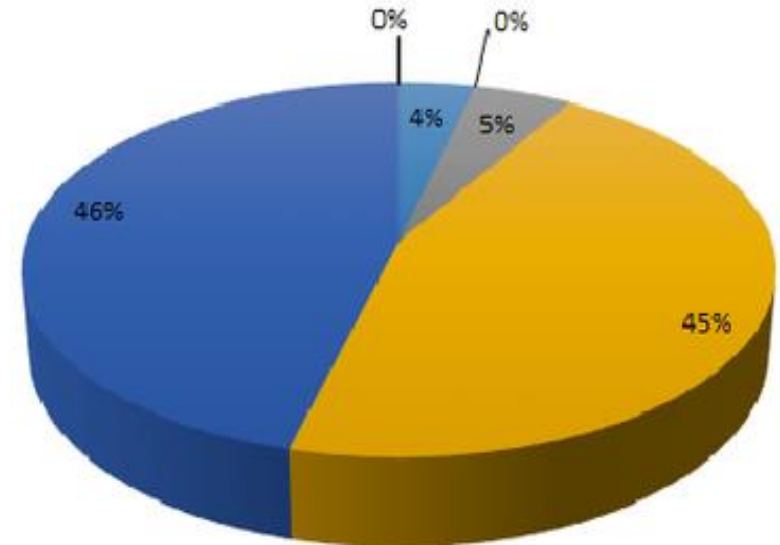
## Energy Consumption (future)

■ comercial ■ Government ■ Agriculture  
■ Household ■ Industry ■ Public Light



## Energy Consumption (past)

■ comercial ■ government ■ agriculture  
■ household ■ industry ■ public lighting



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# Solutions to Reduce Energy Consumption

47

- Egypt's current consumption rates are unsustainable. Amidst the backdrop of broader economic instability and uncertainty, government officials and private investors are pressing for a comprehensive energy plan.
- Make plans to balance energy consumption and production, as well as increasing efforts to diversify Egypt's energy sources.
- One potential solution to Egypt's energy shortages may lie in renewable energies.

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