

GENERATING ELECTRICITY AT A POWER PLANT

Unit Essential Question:

- ☆ How are Earth's energy resources used to generate electricity?
- ☆ What are the advantages and disadvantages of using each energy resource to generate electricity?

Presentation Objectives:

- Define the Law of Conservation of Energy.
- Describe the turbine and generator in all power plants.
- Describe the processes where each energy resource is transformed into electrical energy.
- Identify the energy transformation that occurs in each of the power plants.

THE SCIENCE BEHIND ENERGY TRANSFORMATIONS

Q1


- **Law of Conservation of Energy**
 - Scientific Law that states:
 - The total amount of energy in a closed system is **constant**.
 - In other words...

Energy is neither created nor destroyed.

It is either TRANSFERRED or TRANSFORMED!

MAKING PREDICTIONS #1

Q2

- Fossil fuels, such as coal and petroleum, are the most common resources used to generate electricity.
- 
- Using what you have learned, predict what energy transformations occur in a fossil fuel power plant.

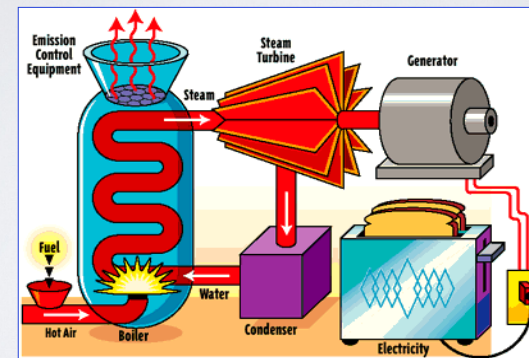
Chemical Nuclear Electrical Thermal
 Radiant Mechanical Gravitational

? → ? → ? → ?

FOSSIL FUEL POWER PLANTS

Q3

- Three Major Components
 - **Furnace, Turbine, and Generator**



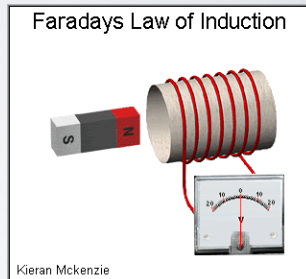
Let's take a tour of a fossil fuel power plant!

THE GENERATOR

Q4

- **Magnetic Induction**
 - Discovered in 1831 by **Michael Faraday**.
 - When a coil of copper wire is moved in a magnetic field, charge in the wires move.

A generator is simply a **coil of wire** and a **magnet**!



- Magnetic field must be continuously changing.
 - **The coil of wire or magnet must move!**

THE GENERATOR

- To generate enough electrical energy, you want...

A large number of coils!

A large coil diameter!

A fast moving magnet!

A strong magnet!

A thicker wire!



THE TURBINE

Q5

- A turbine is a **fan-like device** made from thousands of blades that are connected to the magnet by a shaft.
- As the turbine rotates it moves the magnet inside the coils of wire to generate electricity.



ID the Energy Transformation

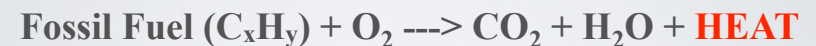
? → ?

Mechanical → **Electrical**

THE FURNACE

Q6

- In the boiler, fossil fuels undergo the process of combustion.

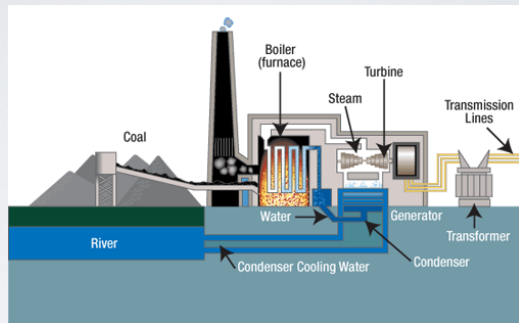


- The heat is used to boil the water moving through the pipes.
 - This creates **steam** which turns the **turbine**, which turns the **magnet** in the generator.



SO, HOW DOES THE FOSSIL FUEL POWER PLANT WORK?


Q7



Chemical Energy → Thermal Energy → Mechanical Energy → Electrical Energy

MAKING PREDICTIONS #2

Q8

- An alternative to fossil fuels that is still very common are minerals, such as uranium. 
- Using what you have learned, predict what energy transformations occur in a nuclear power plant.

Chemical Nuclear Electrical Thermal
Radiant Mechanical Gravitational

? → ? → ? → ?

NUCLEAR FISSION

Q9

- During nuclear fission, a uranium nucleus is hit with a neutron, which causes it to split into smaller nuclei, more neutrons.

Uranium + neutron → HEAT + neutrons + new atoms

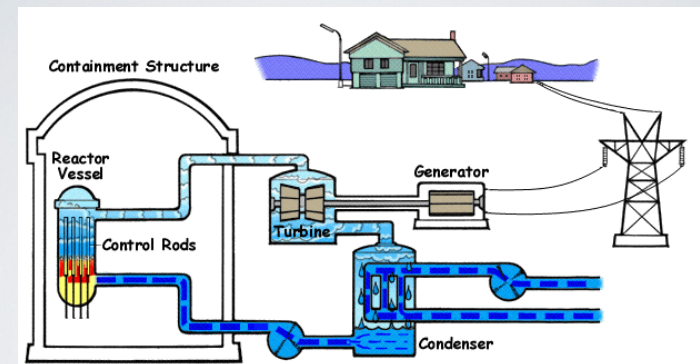


$$E = \Delta mc^2$$

Mass that is lost is transformed into a lot of heat energy!

HOW CAN WE USE THIS HEAT TO GENERATE ELECTRICITY?

Q10

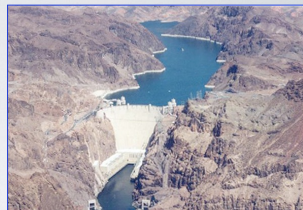


Nuclear Energy → Thermal Energy → Mechanical Energy → Electrical Energy

MAKING PREDICTIONS #3

Q11

- Hydroelectric plants, such as the one at the Hoover Dam or Niagara Falls, also require water to generate electricity.



- Using what you have learned, predict what energy transformations occur in a hydroelectric power plant.

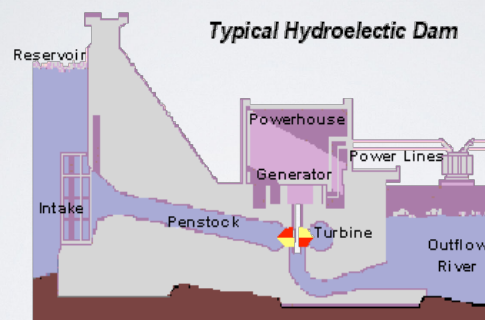
Chemical Nuclear Electrical Thermal
 Radiant Mechanical Gravitational

? → ? → ?

BUT THERE'S NO BOILER!

Q12

- Hydroelectric power plants have a dam that prevents a river from flowing.



- In a hydroelectric dam, the starting energy is...
 - Gravitational Energy!**

WATER, WATER EVERYWHERE!

Q13

- The **water** goes down through the turbine passage and turns the the turbine.
 - Remains in liquid form instead of turning to **steam!**
- The turbine turns the magnet in the coil of wire in the generator, which generates electricity.

Gravitational Energy → **Mechanical Energy** → **Electrical Energy**

MAKING A PREDICTION #4

Q14

- Wind power plants are another alternative to generate electricity.
 - Known as wind farms



- Using what you have learned, predict what energy transformations occur in a wind power plant.

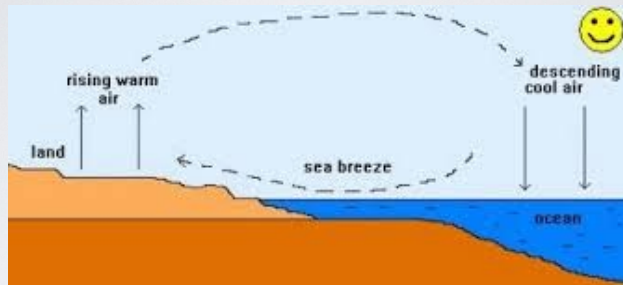
Chemical Nuclear Electrical Thermal
 Radiant Mechanical Gravitational

? → ? → ? → ?

WHAT CAUSES THE WIND?

Q15

- Wind is **moving air** that is created by **uneven heating** of the Earth's surface by the **sun!**



Identify the Energy Transformation

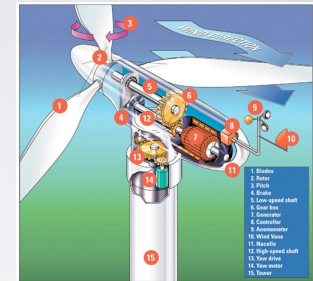
? → ?

Radiant → **Thermal**

WIND TURBINES

Q16

- Wind moves the propellers of the wind turbine, which is connected to a generator.
- Turbines are built high up because **the wind is faster!**
- **Less friction up high!**



About as tall as a **20 story building!**

Radiant Energy → **Thermal Energy** → **Mechanical Energy** → **Electrical Energy**

MAKING A PREDICTION #5

Q17

- Geothermal power plants are another alternative to generate electricity.
- Using what you have learned, predict what energy transformations occur in a geothermal power plant.



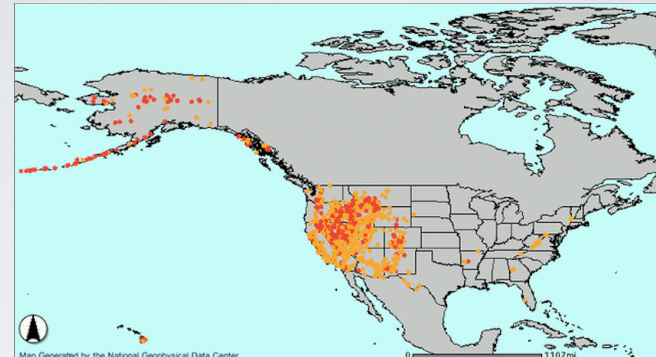
Chemical Nuclear Electrical Thermal
 Radiant Mechanical Gravitational

? → ? → ?

BOY IS IT HOT DOWN THERE!

Q18

- A geothermal reservoir occurs when **magma** comes close to the surface it heats the **groundwater**.



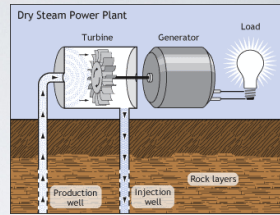
- Mostly found in the **Western States**, **Hawaii**, and **Alaska**.

GEOTHERMAL PLANTS

Q19

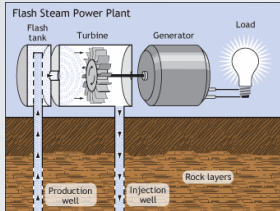
Dry Steam

- Steam comes directly from the ground.



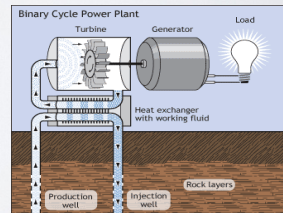
Flash Steam

- Hot water is changed into steam using pressure differences.



Binary Steam

- Heat is transferred from the water to another fluid which becomes a gas.



USING THAT HEAT!

Q20

- In all cases, the heat is used to create steam or gas, which are used to turn a turbine.
- The turbine is connected to a generator.



Thermal Energy → Mechanical Energy → Electrical Energy

MAKING A PREDICTION #6

Q21

- Solar plants are another alternative to generate electricity.



- Using what you have learned, predict what energy transformations occur in a solar power plant.

Chemical Nuclear Electrical Thermal
 Radiant Mechanical Gravitational

? → ? → ? → ?

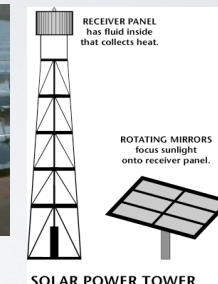
SOLAR THERMAL PLANTS

Q22

- Sun's energy is collected using reflectors of different shapes.



Parabolic trough



- Heat changes a fluid into a gas, which turns a turbine.

Radiant Energy → Thermal Energy → Mechanical Energy → Electrical Energy

SOLAR THERMAL PLANTS

Q23

- The **solar dish** works a little differently.



- The heat is used to power an engine that runs the generator.
- Trying to have them **desalinate water** while generating electricity.

Radiant Energy → Thermal Energy → Mechanical Energy → Electrical Energy

SOLAR POWER PLANTS!

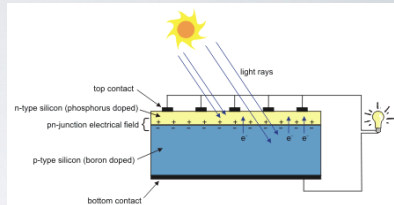


SOLAR POWER TOWER
PARABOLIC TROUGH
USED IN THE MOVIE SAHARA WITH MATTHEW
MCCONAUGHEY AND PENELOPE CRUZ

PHOTOVOLTAIC SOLAR FIELDS

Q24

- Photovoltaic cells convert the sun's energy directly to electrical energy.



Radiant Energy → Electrical Energy



MAKING A PREDICTION #7

Q25

- Biomass are another alternative to generate electricity.



- Using what you have learned, predict what energy transformations occur in a biomass power plant.

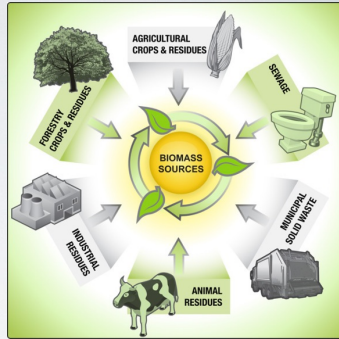
Chemical Nuclear Electrical Thermal
Radiant Mechanical Gravitational

? → ? → ? → ?

BIOMASS

Q26

- Developed from **organic** materials.
 - Scrap lumber
 - Forest debris
 - Crops
 - Manure
 - **Municipal Solid Waste (MSW)**



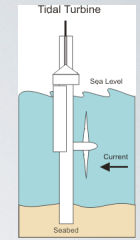
- Energy is accessed through **combustion**.
 - Uses energy to create steam that turns a turbine, which is connected to a generator.



OCEAN ENERGY

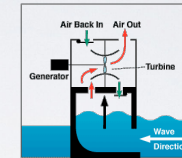
Q27

- **Tidal Energy**
 - Uses a barge which is similar to a **dam**.
 - As the water passes through it turns a turbine.



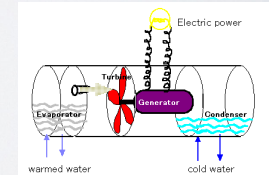
Tidal Energy

- **Wave Energy**
 - Use motion of the waves to turn a turbine.



Wave Energy

- **Ocean Thermal Energy Conversion**
 - Uses temperature differences from sea water to vaporize a fluid and turn a turbine.



OTEC

WHAT'S IT ALL ABOUT??

Q28

- It's all about **Energy Transformations!**
 - Once we have converted our starting energy into electrical energy, then we can convert it into other useable energy in our homes, such as **radiant, thermal, and sound energy**.

