ENERGY

ENERGY UNITS

- Energy: The ability to do work (make something happen)
  - Joule (J)
  - Calorie (cal)
    - The calories on food packages are really kcal
  - Electron Volt (eV)
  - British Thermal Unit (btu)
  - Kilowatt hours (kW·h)

1 cal	4.184 J
1 eV	1.620×10^{-19} J
1 btu	1055 J
1 kW·h	3.600×10^{6} J

- Your body gets 8,000 J (1,900 cal = 1.9 kcal) of energy from eating a peanut.
- 60 J of energy are need per second to keep a 60 W appliance running.
- 1 gallon of gas produces 1.32×10^{8} J of energy or enough energy to keep a 60 W appliance running for 25 days.

WORK

- Work (J)
- Work is always a change in energy. How much energy it took to do _____.

POWER

- Power ($watt\left(\frac{J}{s}\right)$ energy per time)
  - Mechanical Power
    - $P = F \times v$
      - F = Force (weight $F = mg$ g $= 9.8\ \frac{m}{s^2}$)
      - v = velocity
  - Electrical Power
    - $P = I \times V$
      - I = current
      - V = voltage

Appliance	Power
T.V.	120 W
Computer and Monitor	270 W
Washing Machine	425 W
Refrigerator	725 W
Dishwasher	1,800 W
Dryer	3,400 W

- The hoover dam on average produces 4.5×10^4 W per hour.

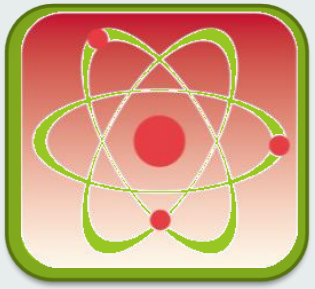
TYPES OF ENERGY

Potential

- Gravitational
- Stored Mechanical
- Chemical
- Nuclear
- Electrical
- Sound

Kinetic

- Motion
- Electrical
- Radiant
- Thermal
- Sound



GRAVITATIONAL
POTENTIAL ENERGY

- Energy from position.
- $E = mgh$
  - g=9.8$\frac{m}{s^2}$
  - h=height
  - m=mass
- Examples of gravitational energy:

MOTION
KINETIC ENERGY

- Energy from motion.
- $E = \frac{1}{2}mv^2$
  - m=mass
  - V=velocity
- Examples of motion energy:

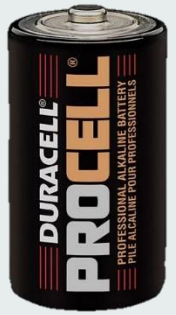
ENERGY TRANSFER

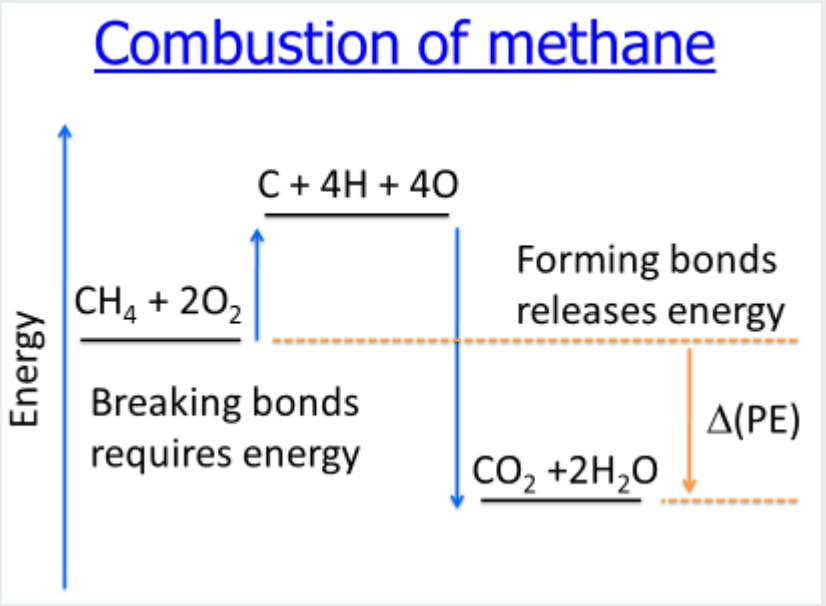
- Law of conservation of energy
  - Energy cannot be created or destroyed

CHEMICAL
POTENTIAL ENERGY

- Energy that can be released if a chemical reaction occurs.

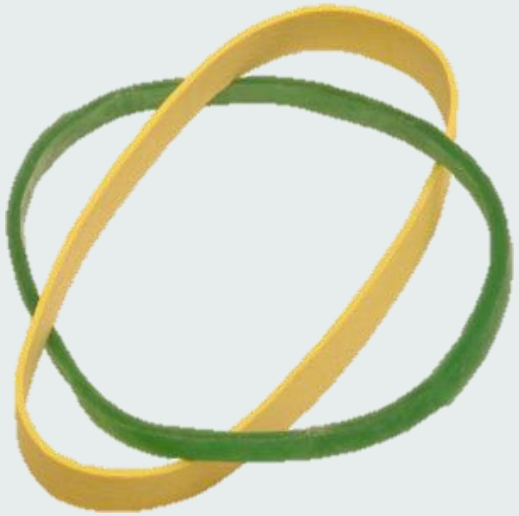
- Combustion
  - $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ ΔH=-10,941 $\frac{kJ}{mol}$
- Examples of chemical energy:





STORED MECHANICAL
POTENTIAL ENERGY

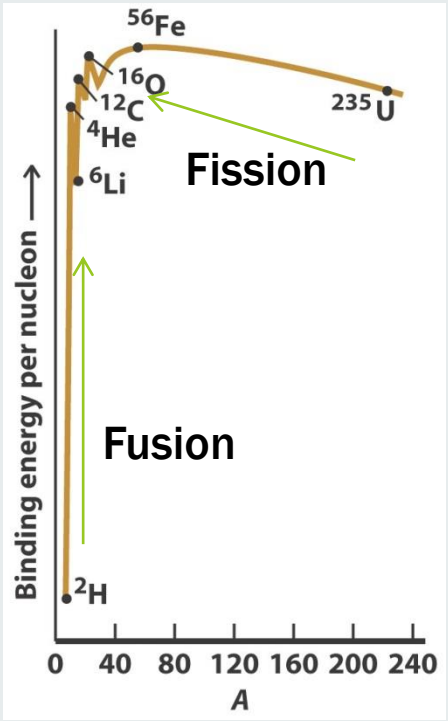
- Energy stored in object by tension.
  - Spring
    - $E = \frac{1}{2}kx^2$
      - K = spring constant
      - x = distance from at rest position
  - Stretched rubber band



- Examples of stored mechanical energy:

NUCLEAR
POTENTIAL ENERGY

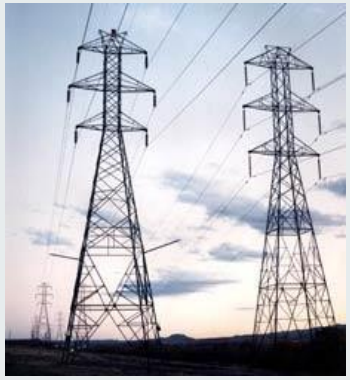
- The energy stored inside the nucleus of an atom.
  - $pm_p + nm_n \neq m_{nuclus}$
  - $E = mc^2$
    - m = mass
    - c = speed of light $3.00\times10^8 \frac{m}{s}$



- Examples of nuclear energy
  - Fission (Breaking atoms apart)
    - $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n$
      - releases $3.5\text{x}10^{-11}$ J per reaction (2.1×10^{13} J per mole)
    - Fission is what happens in nuclear reactors. Although pollutant are produced, radio active waste is left over.
  - Fusion (Joining atoms together)
    - 6D → 2^4He + 2p + 2n
      - releases 3×10^8 kJ per each gram D
    - These are the type of reactions that go on in the sun.
    - In order to get fusion to happen on earth we need to be at high temperatures (10^8 K)

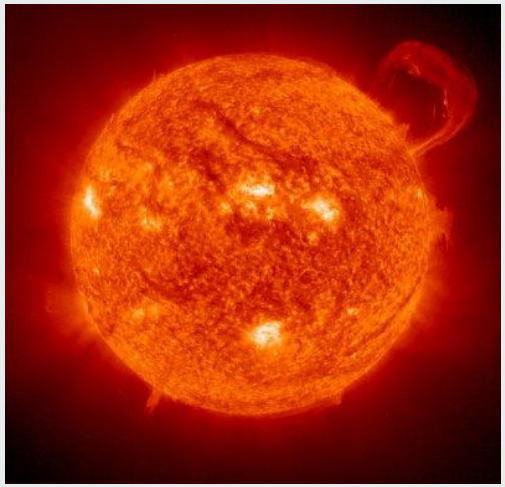
ELECTRICAL
POTENTIAL OR KINETIC ENERGY

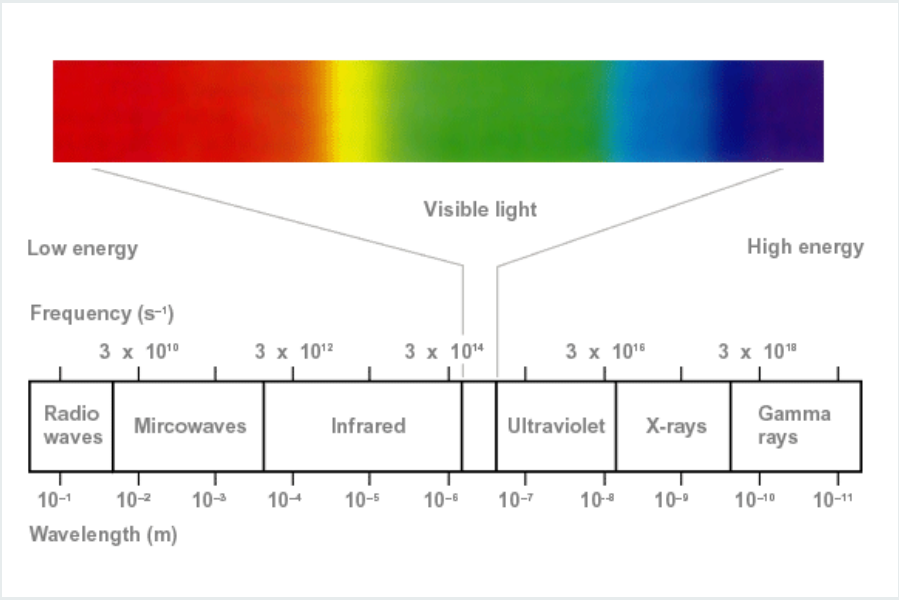
- Potential
  - The energy associated with the attractive force between 2 oppositely charged particles
    - $E = \frac{1}{4\pi\varepsilon^{\circ}}\frac{q_1 q_2}{r_{12}}$
      - ε˚ = vacuum permittivity 8.85 × 10^{-12} $\frac{C^2}{J \cdot m}$
      - q = charge
      - r = separation
- Kinetic
  - The energy generated from the flow of electrical change (electrons)
    - $E = VIt$
      - V = voltage
      - I = current
      - t = time
- Examples of electrical energy:



RADIANT
KINETIC ENERGY

- The energy in electromagnetic waves.
  - $E = h\nu$
    - h plank's constant 6.626×10^{-34} J·s
    - Frequency $\nu = \frac{c}{\lambda}$
      - c speed of light $3.00\times10^{8}\frac{m}{s}$
      - λ wavelength



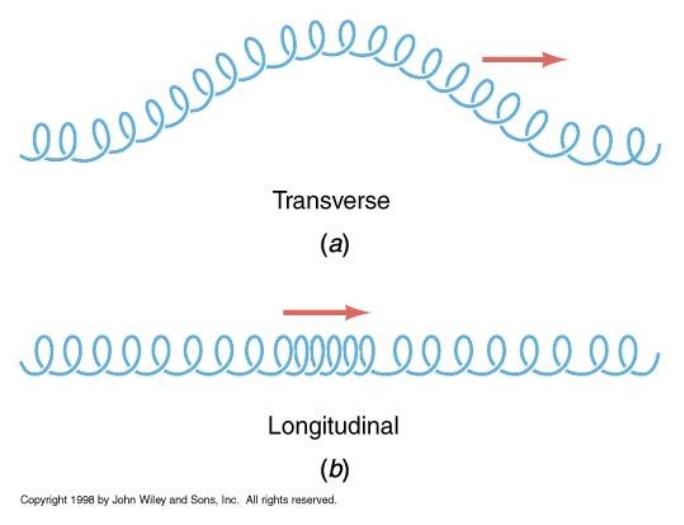


- Examples of radiant energy:

SOUND
KINETIC AND POTENTIAL ENERGY

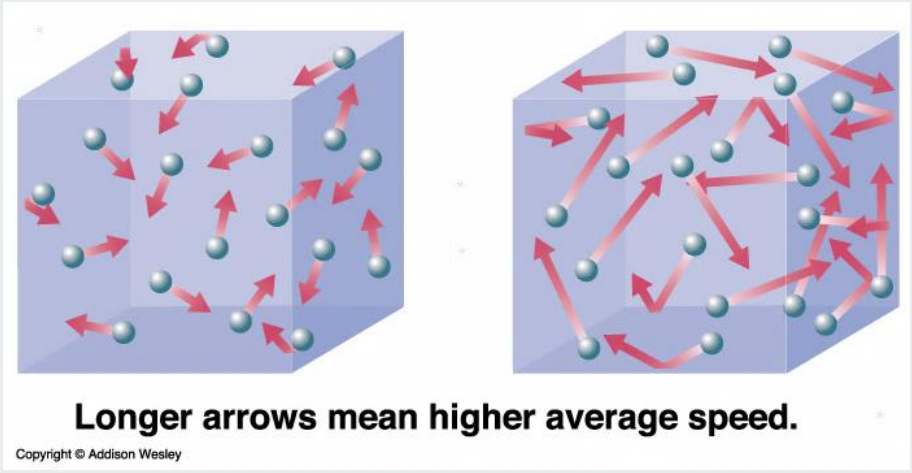
- The energy that is moved through substances with longitudinal waves.
  - $E = \frac{a^2 \rho}{2\pi f}$ (E in this expression is energy density or energy per area)
    - a = particle acceleration
    - ρ = air density
    - f = frequency of sound

- Examples of sound energy:



THERMAL
KINETIC ENERGY

- Energy that is caused by heat.
  - When thermal energy is applied atoms/molecules move faster.
  - $E = f\frac{1}{2}kT$
    - f = degrees of freedom
    - k = Boltzmann's constant $1.381\times10^{-23}\ \frac{J}{K}$
    - T = temperature



- Examples of thermal energy:

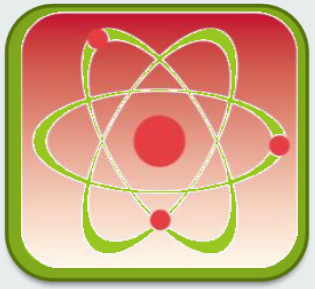
TYPES OF ENERGY

Potential

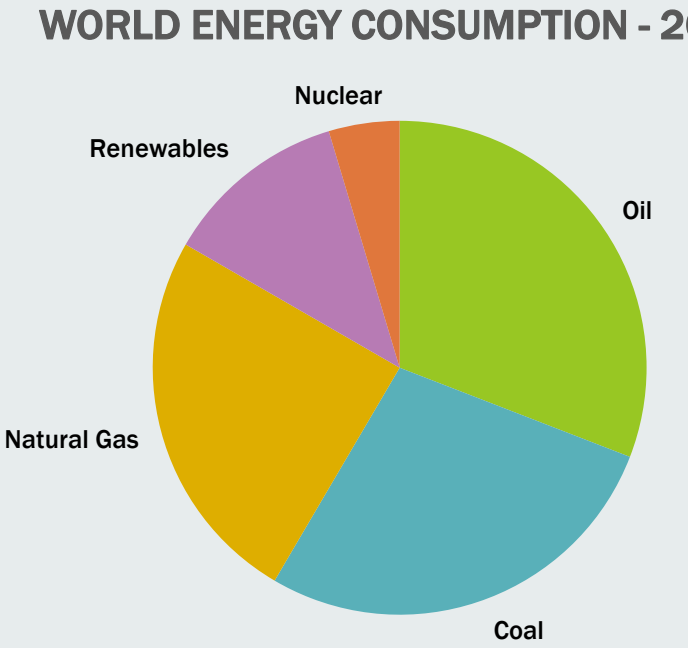
- Gravitational
- Stored Mechanical
- Chemical
- Nuclear
- Electrical
- Sound

Kinetic

- Motion
- Electrical
- Radiant
- Thermal
- Sound



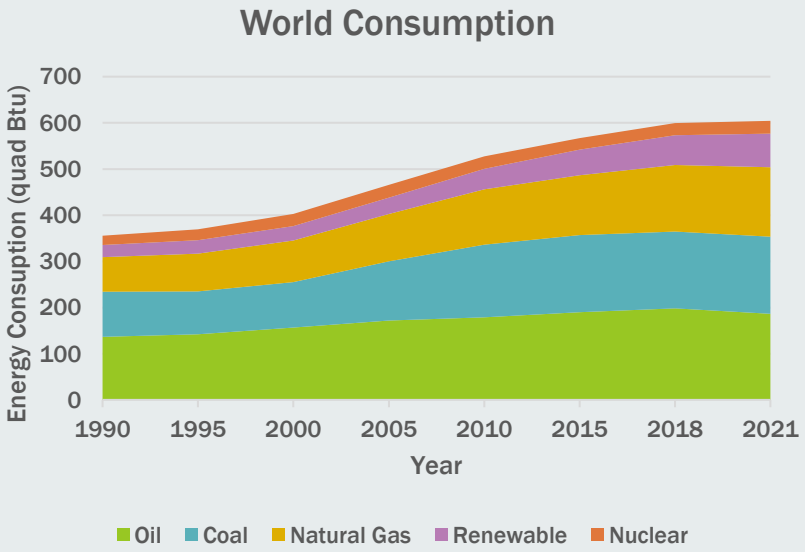
WORLD ENERGY
2021

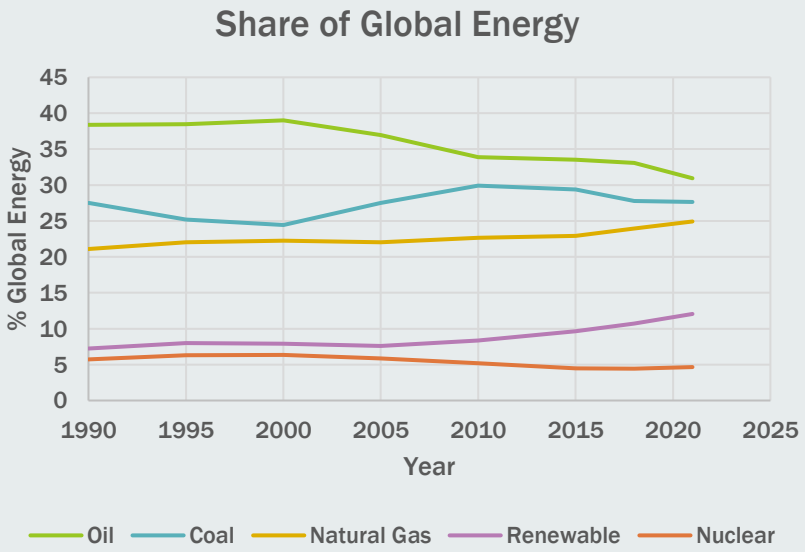


Source of Energy	Percent
Oil	31%
Coal	28%
Natural Gas	25%
Renewables	12%
Nuclear	5%

https://www.eia.gov/international/data/world/world/total-energy

WORLD ENERGY
2021





Source of Energy	Percent Change Since 2018	Percent Change Since 1990
Oil	-6.9%	-24.0%
Coal	-0.5%	0.48%
Natural Gas	3.7%	15.2%
Renewables	11.0%	39.8%
Nuclear	4.9%	-23.1%

https://www.eia.gov/international/data/world/world/total-energy

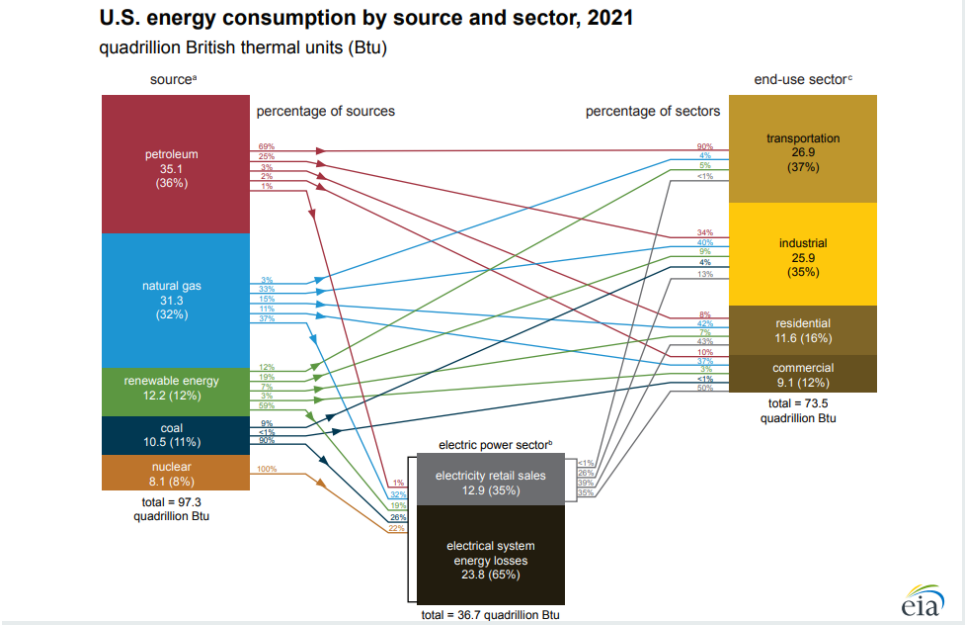
WORLD ENERGY
2018

Country	Energy Consumption (Quadrillion Btu)
China	147.6
United States	101.2
Russia	33.3
India	31.3
Japan	19.2
Canada	15.2
Germany	14.9
Brazil	13.8
Korea, South	12.4
Iran	11.7

Country	Energy Consumption/person (MBtu)
Qatar	704
Iceland	681
Singapore	649
Trinidad and Tobago	642
United Arad Emirates	481
Bahrain	460
Brunei	425
Canada	427
Kuwait	398
Luxembourg	316
United States (#11)	309

http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=44&pid=44&aid=2

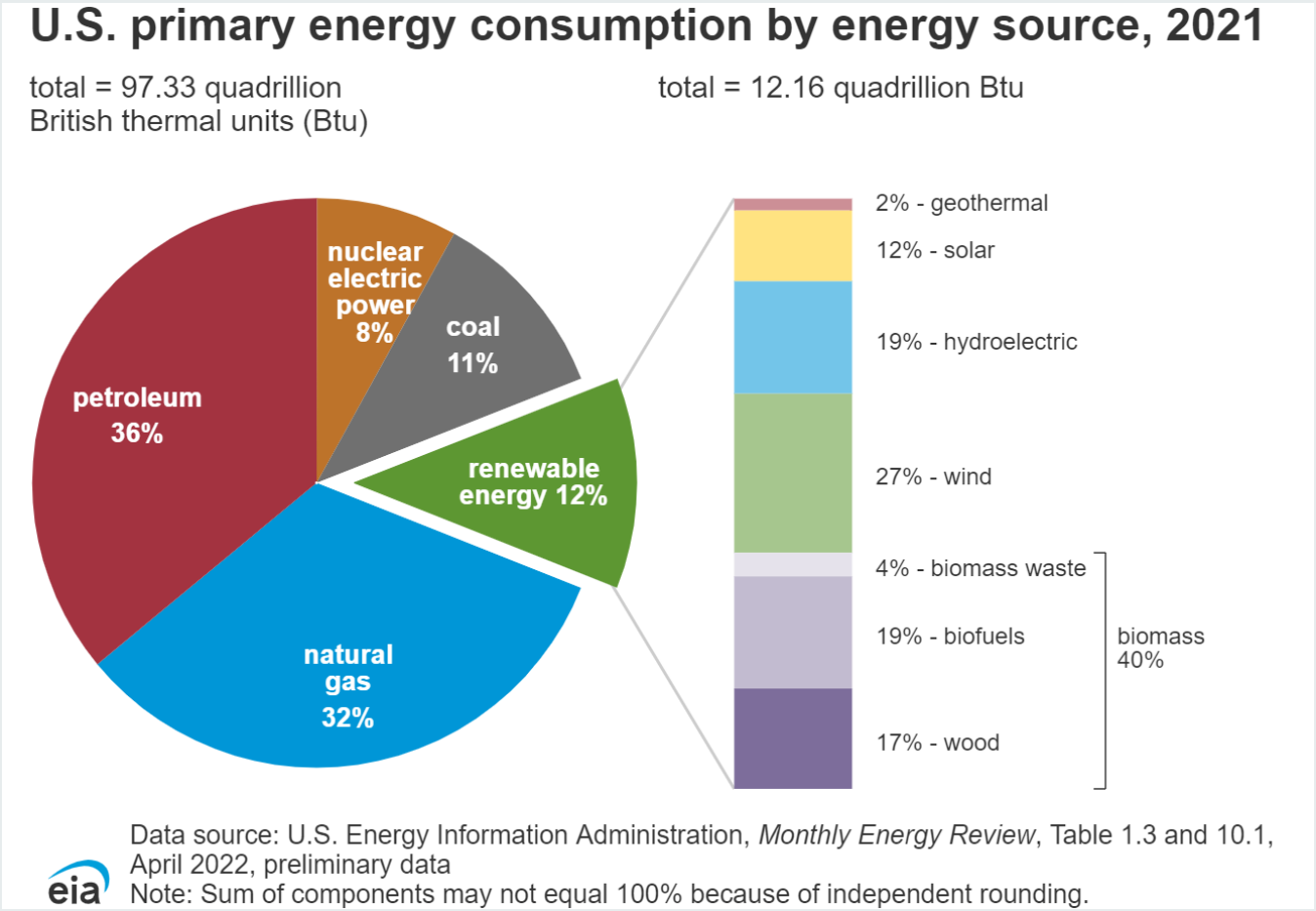
US ENERGY



Source of Energy	% World 2021	% US 2021	% US 2009
Petroleum	31%	36%	37%
Natural Gas	28%	32%	25%
Coal	25%	12%	21%
Renewable	12%	11%	8%
Nuclear	5%	8%	9%

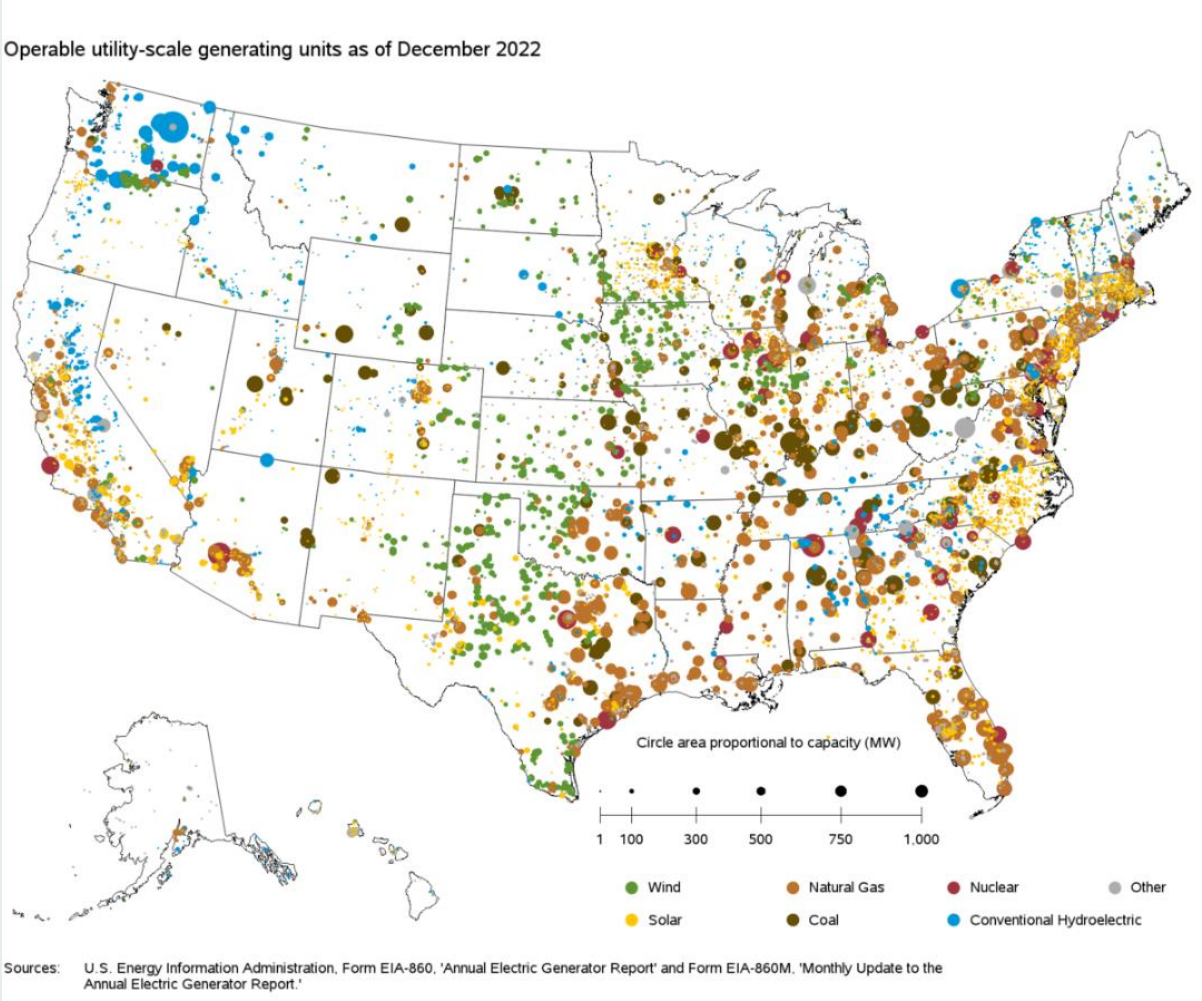
https://www.eia.gov/energyexplained/us-energy-facts/
http://www.eia.gov/totalenergy/data/monthly/

US ENERGY



https://www.eia.gov/energyexplained/us-energy-facts/

US ENERGY


Operable utility-scale generating units as of December 2022
Circle area proportional to capacity (MW)
1
100
300
500
750
1,000
Wind
Natural Gas
Nuclear
Other
Solar
Coal
Conventional Hydroelectric
Sources: U.S. Energy Information Administration, Form EIA-860, 'Annual Electric Generator Report' and Form EIA-860M, 'Monthly Update to the Annual Electric Generator Report.'

COMMUNITY CHOICE AGGREGATION

Central Coast Community Energy

Plans

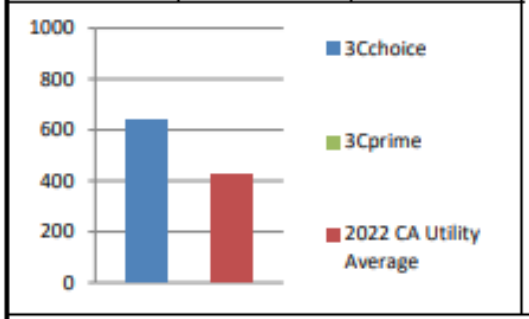
- 3Cchoice – 31% renewable
  - Default
- 3Cprime – 100% renewable
  - $0.008 $/KWhr
  - Extra $4-5 per month

https://cal-cca.org/powered/ https://3cenergy.org/

CENTRAL COAST COMMUNITY ENERGY

2022 POWER CONTENT LABEL
(Central Coast Community Energy)
https://3cenergy.org

Greenhouse Gas Emissions Intensity (lbs CO_2e/MWh)		
3Cchoice	3Cprime	2022 CA Utility Average
637	0	422



Energy Resources	3Cchoice	3Cprime	2022 CA Power Mix
Eligible Renewable[1]	**35.8%**	**100.0%**	**35.8%**
Biomass & Biowaste	1.4%	0.0%	2.1%
Geothermal	12.0%	0.0%	4.7%
Eligible Hydroelectric	0.0%	0.0%	1.1%
Solar	12.5%	50.0%	17.0%
Wind	9.8%	50.0%	10.8%
Coal	**0.0%**	**0.0%**	**2.1%**
Large Hydroelectric	**5.9%**	**0.0%**	**9.2%**
Natural Gas	**0.0%**	**0.0%**	**36.4%**
Nuclear	**0.0%**	**0.0%**	**9.2%**
Other	**0.0%**	**0.0%**	**0.1%**
Unspecified Power[2]	**58.3%**	**0.0%**	**7.1%**
TOTAL	**100.0%**	**100.0%**	**100.0%**
Percentage of Retail Sales Covered by Retired Unbundled RECs[3]**:**	**0%**	**0%**	

[1]The eligible renewable percentage above does not reflect RPS compliance, which is determined using a different methodology.
[2]Unspecified power is electricity that has been purchased through open market transactions and is not traceable to a specific generation source.
[3]Renewable energy credits (RECs) are tracking instruments issued for renewable generation. Unbundled renewable energy credits (RECs) represent renewable generation that was not delivered to serve retail sales. Unbundled RECs are not reflected in the power mix or GHG emissions intensities above.

For specific information about this electricity portfolio, contact:	**Central Coast Community Energy (831) 641-7222**
For general information about the Power Content Label, visit:	https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program

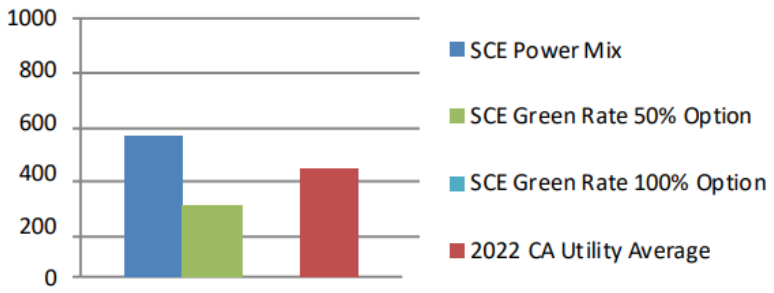
https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure/power-content-label

SOUTHERN CA EDISON

2022 POWER CONTENT LABEL
Southern California Edison
www.sce.com

Greenhouse Gas Emissions Intensity (lbs CO_2e/MWh)

SCE Power Mix	SCE Green Rate 50% Option	SCE Green Rate 100% Option	2022 CA Utility Average
552	275	0	422



Energy Resources	SCE Power Mix	SCE Green Rate 50% Option	SCE Green Rate 100% Option	2022 CA Power Mix
Eligible Renewable[1]	**33.2%**	**66.7%**	**100.0%**	**35.8%**
Biomass & Biowaste	0.1%	0.0%	0.0%	2.1%
Geothermal	5.7%	2.9%	0.0%	4.7%
Eligible Hydroelectric	0.5%	0.3%	0.0%	1.1%
Solar	17.0%	58.6%	100.0%	17.0%
Wind	9.8%	4.9%	0.0%	10.8%
Coal	**0.0%**	**0.0%**	**0.0%**	**2.1%**
Large Hydroelectric	**3.4%**	**1.7%**	**0.0%**	**9.2%**
Natural Gas	**24.7%**	**12.3%**	**0.0%**	**36.4%**
Nuclear	**8.3%**	**4.2%**	**0.0%**	**9.2%**
Other	**0.1%**	**0.0%**	**0.0%**	**0.1%**
Unspecified Power[2]	**30.3%**	**15.1%**	**0.0%**	**7.1%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Percentage of Retail Sales Covered by Retired Unbundled RECs[3]**:**	**3%**	**1%**	**0%**	

[1]The eligible renewable percentage above does not reflect RPS compliance, which is determined using a different methodology.

[2]Unspecified power is electricity that has been purchased through open market transactions and is not traceable to a specific generation source.

[3]Renewable energy credits (RECs) are tracking instruments issued for renewable generation. Unbundled renewable energy credits (RECs) represent renewable generation that was not delivered to serve retail sales. Unbundled RECs are not reflected in the power mix or GHG emissions intensities above.

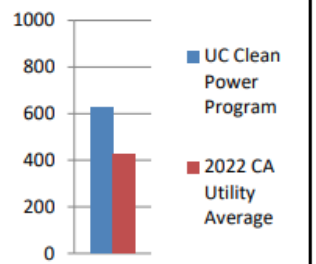
For specific information about this electricity portfolio, contact:	**Southern California Edison 1-800-655-4555**
For general information about the Power Content Label, visit:	https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program

https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure/power-content-label

UC REGENTS

2022 POWER CONTENT LABEL
The Regents of the University of California

Greenhouse Gas Emissions Intensity (lbs CO_2e/MWh)	
UC Clean Power Program	2022 CA Utility Average
623	422



Energy Resources	UC Clean Power Program	2022 CA Power Mix
Eligible Renewable[1]	**23.3%**	**35.8%**
Biomass & Biowaste	0.0%	2.1%
Geothermal	0.0%	4.7%
Eligible Hydroelectric	0.0%	1.1%
Solar	23.3%	17.0%
Wind	0.0%	10.8%
Coal	**0.0%**	**2.1%**
Large Hydroelectric	**2.5%**	**9.2%**
Natural Gas	**0.0%**	**36.4%**
Nuclear	**8.1%**	**9.2%**
Other	**0.0%**	**0.1%**
Unspecified Power[2]	**66.0%**	**7.1%**
TOTAL	**100.0%**	**100.0%**
Percentage of Retail Sales Covered by Retired Unbundled RECs[3]**:**	**26%**	

[1]The eligible renewable percentage above does not reflect RPS compliance, which is determined using a different methodology.

[2]Unspecified power is electricity that has been purchased through open market transactions and is not traceable to a specific generation source.

[3]Renewable energy credits (RECs) are tracking instruments issued for renewable generation. Unbundled renewable energy credits (RECs) represent renewable generation that was not delivered to serve retail sales. Unbundled RECs are not reflected in the power mix or GHG emissions intensities above.

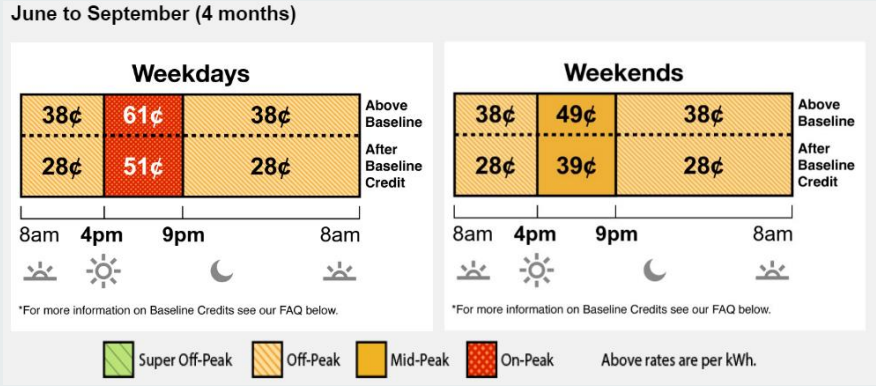
The unbundled RECs retired in association with UC Clean Power Program's portfolio were procured from eligible renewable sources such as solar, wind, hydroelectric, biowaste, biomass, or geothermal energy. For additional information on unbundled RECs retired in association with the UC Clean Power Program please reach out via email at UC_ESP@ucop.edu.

For specific information about this electricity portfolio, contact:	**The Regents of the University of California 510-287-3360**
For general information about the Power Content Label, visit:	https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program

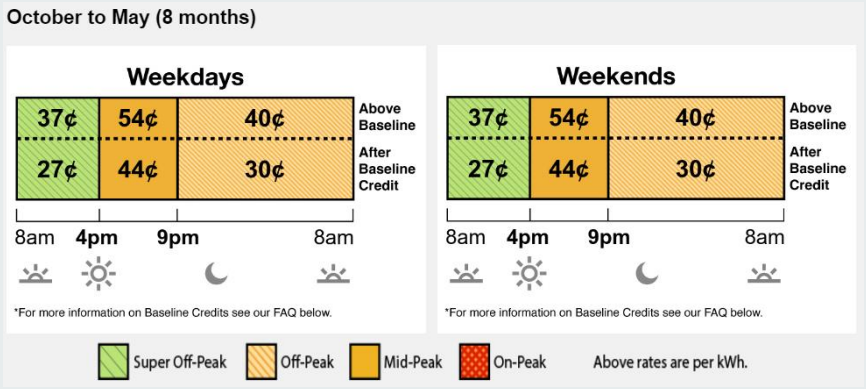
TOU

Highest rates: Summer Weekdays 4-9 p.m.
Daily Basic Charge: $0.03 per day
Minimum Daily Charge: $0.35 per day
Baseline Credit: $0.10 per kWh up to your monthly baseline allocation
For example, if your monthly allocation is 200 kWh, you'd see a $20 credit on your bill.
*Additional baseline allocation applies for Heat Pump Water Heater customers at this rate.

Summer

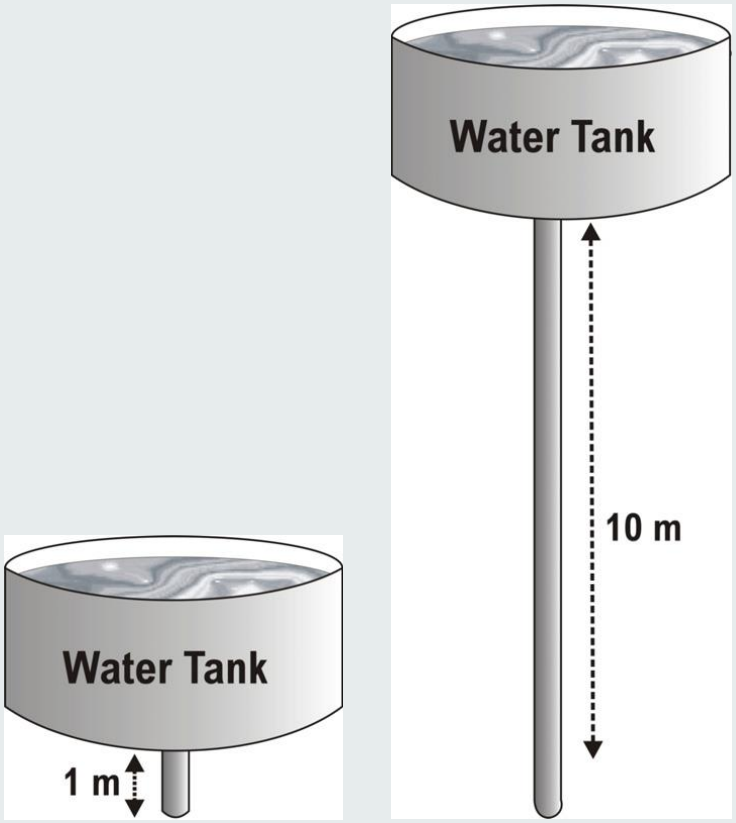


Winter



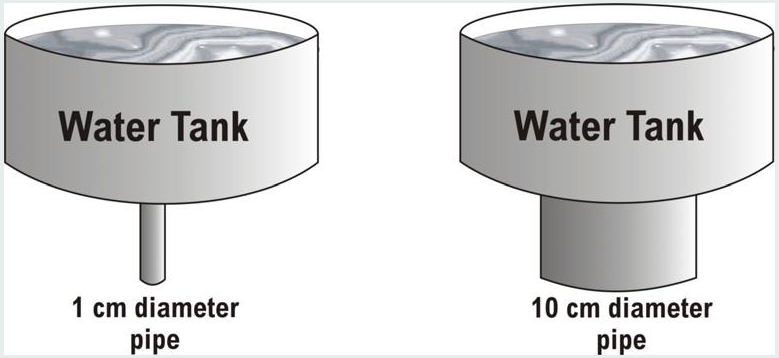
https://www.sce.com/residential/rates/Time-Of-Use-Residential-Rate-Plans

ELECTRICITY



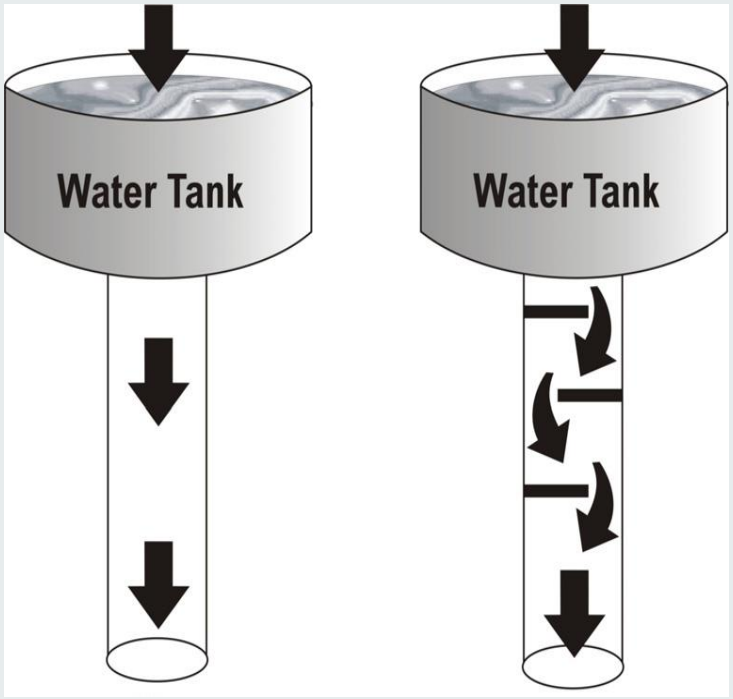
- Voltage (volt V): A measure of its electrical potential .
- Which water tower will have water that comes out at a greater pressure?
- What represents voltage?

ELECTRICITY



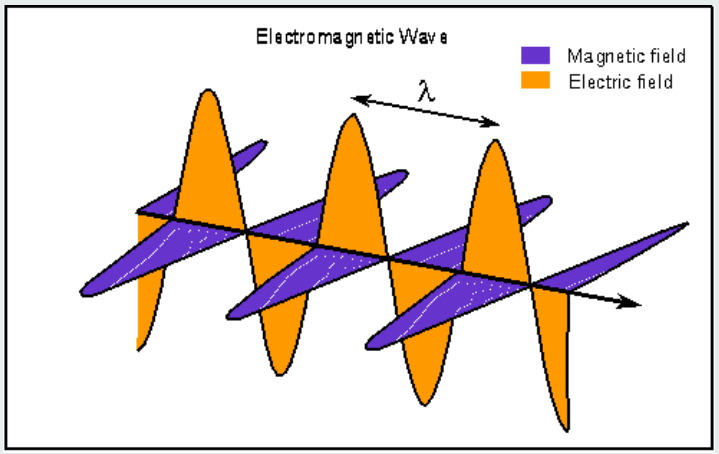
- Current (amps A): The rate of charge flow per time .
- Which water tower will have water come out at a faster rate?
- What represents current?
- Types of Current:

ELECTRICITY



- Resistance (ohms Ω): The amount of resistance a current will encounter.
- Which water tower will have the water encounter more resistance?
- What represents resistance?

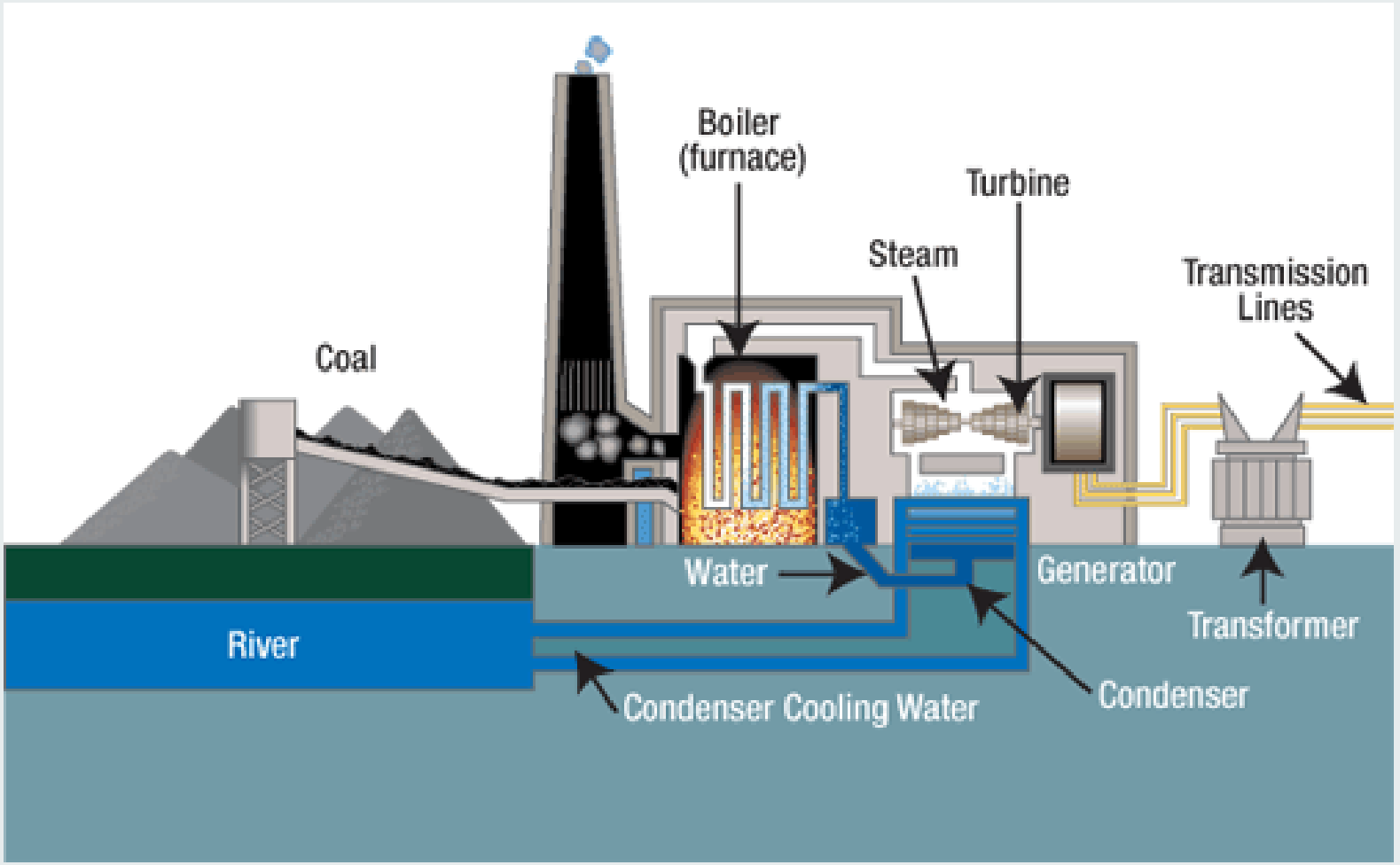
ELECTROMAGNETS



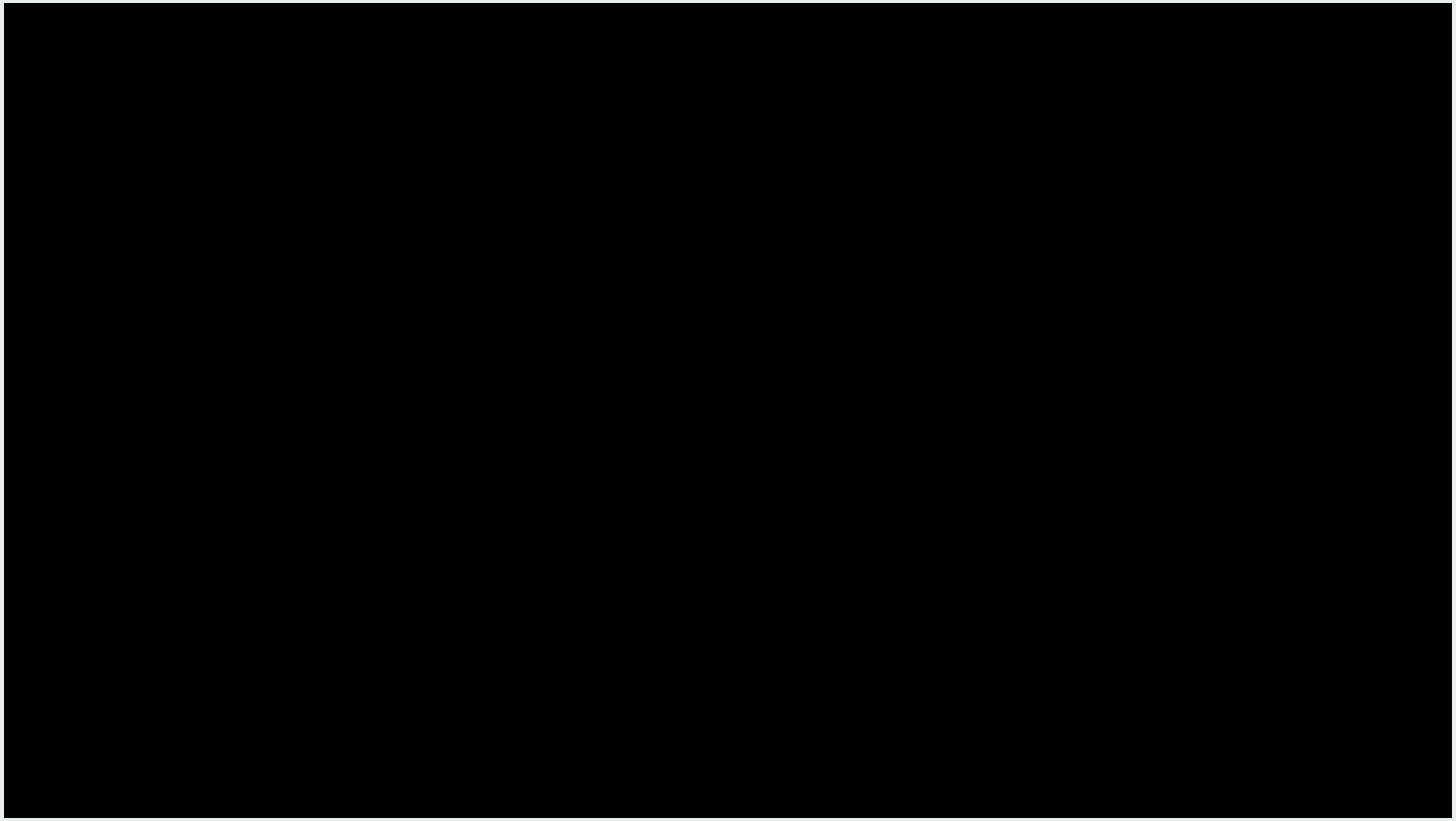
- A changing magnetic field induces a electric field.
- A changing electric field induces a magnetic field.

- Electromagnet: A temporary magnet whose effect is caused by an electric current.

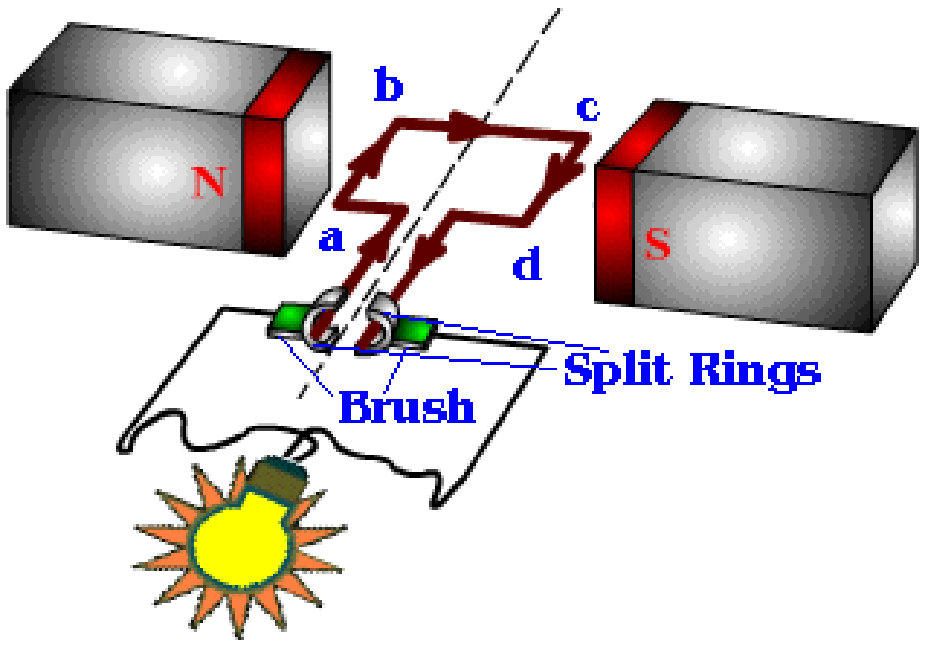
ELECTRICAL PLANTS



ELECTROMAGNETS

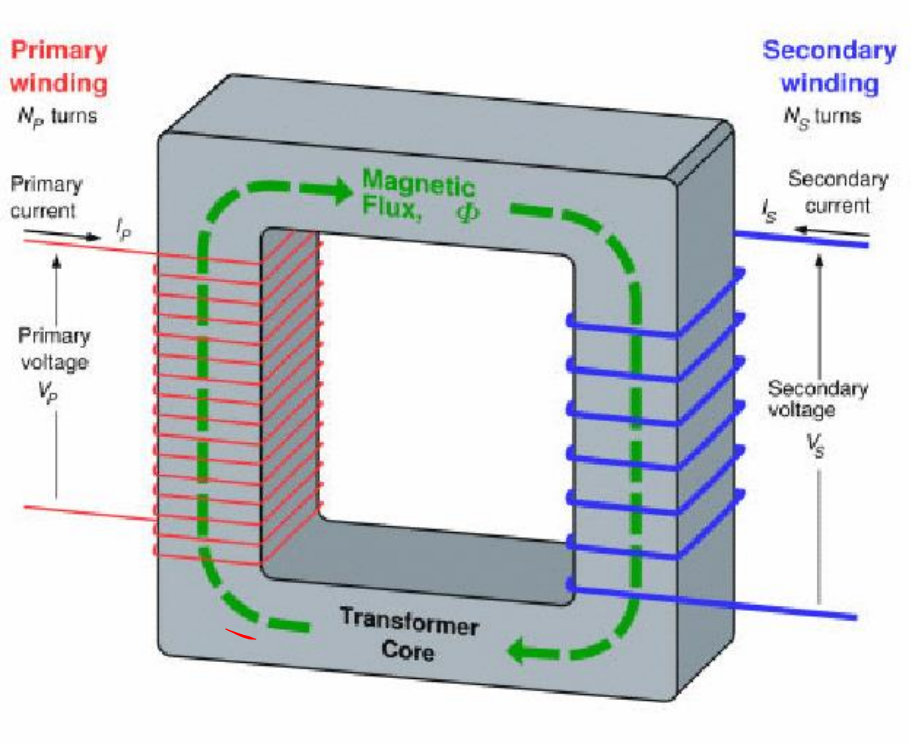


ELECTRICAL PLANTS



- The University of Colorado has computer simulations for different science concepts. Try this one on generators. http://phet.colorado.edu/en/simulation/generator

ELECTRICAL PLANTS



- Transformer: An electrical device by which alternating current of one voltage is changed to another voltage.
  - The greater the number of coils the greater the voltage.