

M01. Introduction to Energy and Bioenergy

- ✦ Forms of energy
- ✦ Basic physical aspects of energy

1. Forms of Energy



✦ The most common forms of energy are

- Heat – the energy of moving particles in any substance
- Electricity - the energy of electrons moving along a conductor

✦ Further forms of energy are

- Light
- Radio waves
- Mechanical
- Sound

- ✦ Is the energy of moving particles (molecules and atoms) in gaseous, liquid and solid matter

- ✦ is generated
 - by burning fuels as wood, oil, biogas, natural gas, gasoline or diesel
 - by solar radiation
 - by the earth's core e.g. hot springs, geothermal drillings
 - from electricity passing through a heating element

- ✦ is used for
 - heating air and water in homes and offices etc.
 - melting and shaping materials like metals and plastics
 - cooking
 - transportation (combustion engines)

✦ is the energy of electrons moving through a conductor

✦ is generated

- by photovoltaic panels
- by alternator or dynamo generators
- from batteries
- using hydrogen fuel cells
- from friction (static electricity)

✦ is used to

- turn motors
- generate heat
- run computers
- run communication systems and data transmission

- ✦ is radiant energy in the form of photons

- ✦ is generated
 - by the sun
 - by using fluorescent and incandescent light bulbs
 - from light emitting diodes
 - from lasers
 - by burning fuels like wood, oil, biogas, natural gas

- ✦ is used to
 - illuminate working and living spaces
 - do laser surgery
 - do communication and advertising, such as illuminated signs
 - do data transmission, e.g. on fiber optic networks

✦ is electromagnetic energy

✦ is generated

- by radio transmitters
- by microwave emitters

✦ is used to

- Cook in microwave ovens
- do voice communication, e.g. radio and cell phones
- radar navigation

- ✦ Is the force of moving objects

- ✦ is generated
 - by falling water at hydro-electricity facilities
 - by motors
 - by springs and elastic bands

- ✦ is used to
 - move automobiles, aircrafts and other forms of transportation
 - operate many home appliances and tools
 - generate electricity

- ✦ is vibrations passing through gaseous, liquid, or solid matter

- ✦ is generated
 - by using speakers
 - by vibrating surfaces, e.g. drumhead
 - by springs and elastic bands

- ✦ is used with
 - musical instruments
 - sonar navigation
 - communication

- ✦ are commonly called the resources and linked technologies of energy sources with a limited availability, i.e. their replacement takes hundreds of thousands or millions of years or is not possible at all
- ✦ Fossil sources are coal, lignite, natural gas, crude oil
- ✦ The use of fossil sources lead to the emission of carbon dioxide and hence contribute to climate change, actually are the main source of it
- ✦ Uranium the source of nuclear energy has an approximate deposit of 200 years
- ✦ The storage of spent nuclear fuel rods is yet unclear in most places but cause a security problem for some thousand years

- ✦ is re-supplied in short-term, usually less than one year
- ✦ its resources derive from wind, water, sun light, and as an intermediate product biomass
- ✦ Renewable energies are
 - Solar energy either as electricity from PV or heat from collectors
 - Wind energy as electricity
 - Moving water as electricity
 - Biomass energy to provide energy resources for heat, electricity, and as fuel for engines

2. Basic physical aspects of energy

- ✦ A force is a push, pull, or twist
 - Force = mass * acceleration ($F = m * a$)
 - if a equals g (gravity) then F is the gravitation
 - The SI unit of force is Newton (N) or $\text{kg} \cdot \text{m} / \text{s}^2$

- ✦ Energy is the ability to do work
 - The SI unit of energy is Joule (J)

- ✦ Work is a force acting over a distance to move an object
 - Work = force * distance ($W = F * l$)
 - Work has the same unit as energy
 - The SI unit of work is Joule (J) or $\text{N} \cdot \text{m}$

- ✦ Power is how fast (or the rate at which) work is done
 - Power = work / time ($P = W / t$)
 - Power = energy used / time ($P = E / t$)
 - The SI unit of power is Watt or J/s or $\text{N} \cdot \text{m} / \text{s}$

- ✦ is the ability to do work
 - i.e. it is an intrinsic value and we can speak of the energy contained in a fuel

- ✦ The energy content of a biomass can be measured by its complete combustion (in a bomb calorimeter)
 - If we consider the biomass to be absolute water free we obtain the higher heating value HHV or heat of combustion which is the energy released by burning the dry matter, i.e. all educts and products are regarded at standard conditions
 - If we consider that before burning the biomass we first have to evaporate the water contained in the biomass we obtain the lower heating value LHV of a biomass
 - Both values are given in J/kg or J/L (liquids) or J/m³ (gases)

- ✦ The basic SI unit of energy is Joule (J) which equals $N \cdot m$
- ✦ The SI unit of power is Watt (W) and for larger installations one uses kilowatt (kW), Megawatt (MW) or Giga-Watt (GW)
- ✦ As one can rearrange $P = E / t$ to $E = P \cdot t$ one obtains as a common unit for energy (as well as work) Watt seconds (Ws)
- ✦ As 1 Ws is a small quantity one often uses instead Watt hours (Wh) or kilowatt hours (kWh), megawatt hours (MWh), or gigawatt hours (GWh)
- ✦ Also 1 J is a very small quantity and often are used millions (megajoule), billions (gigajoule), trillions (terajoule), or even quadrillions (petajoule) of Joules as unit
- ✦ $1 \text{ kWh} = 3600 \text{ Ws} = 3600 \text{ J} = 3.6 \text{ kJ}$
- ✦ $1 \text{ MWh} = 3.6 \text{ MJ}$
- ✦ $1 \text{ GJ} = 277.78 \text{ kWh}$
- ✦ $1 \text{ PJ} = 277,777.78 \text{ MWh}$
- ✦ $1 \text{ MJ} = 277,777,777.78 \text{ MWh}$

Thank you

gogreenbelize@gmail.com

+501.622.0980

Valley of Peace
P.O. Box 154
San Ignacio
Belize
Central America



Valley of Peace
P.O.Box 154, San Ignacio
Belize, Central America
+501.622.0980
Gogreenbelize@gmail.com
www.gogreenandsolar.com