STUDENT MINOR RESEARCH PROJECT

ENERGY RESOURCES

BY

III B. Sc Students

UNDER THE GUIDENCE OF

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DEPARTMENT OF PHYSICS

Sri Y.N College (Autonomous)

(Accredited by NAAC with “A” Grade)

Narsapuram-534275

West Godhavari District, AP

MAY , 2022

DECLARATION

I hereby declare that the work described in this students minor research project has been carried out entirely by B. Sc students in the Department of Physics ,SRI Y.N college , Narsapur and further that it has not been submitted earlier either wholly or in part ,to any University or Institution.

III B. Sc Students.

Name of the students	Signature
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3. K. PRASANTH	3.
4. B. PEDDI RAJU	4.
5. T.M.N.D.PRASAD	5.
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(Dr. L. Malleswara Rao)

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SRI Y. N. COLLEGE (AUTONOMOUS)
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DEPARTMENT OF PHYSICS
NARSAPUR - 534 275, W.G. Dt.

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13/6/2022

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I wish to express my sincere thanks to Sri Bhargav , manager ONGC Solar photovoltaic power generation NAGARAM.

My grateful thanks to Dr. L. Malleswara Rao , Head of the department ,Sri. Y.N college , Narsapur for providing the facilities in the Department of Physics .I would like thanks to Dr.L. Malleswara Rao , Sri P. Rama Krishna Rao , Sri. Ch Sundar Singh , Sri M. Ranganayakulu , Sri A. Rajesh , Sri M. Sankar, Sri K. Naveen Kumar, Smt P. Rajeswari , Kum G. Suvarchala Devi ,Kum D. Jhansi Lakshmi, Kum. V. Durga Sandhya.

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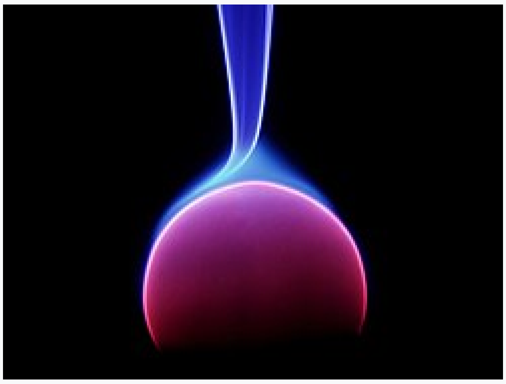
❖ Introduction

ENERGY

Energy is the capacity of a physical system to perform work. It is the ability to do work. Energy exists in several forms such as heat, kinetic or mechanical energy , light , potential energy, electrical or other forms.

Unit of energy is JOULE .



A plasma lamp, using electrical energy to create plasma light, heat, movement and a faint sound

Common symbols	*E*
SI unit	joule
Other units	kW·h, BTU, calorie, eV, erg, foot-pound
In SI base units	J = kg m^2 s^{-2}
Dimension	**M L^2 T^{-2}**

Mass and energy are closely related. Due mass energy valence, any object that has mass when stationary also has an equivalent amount of energy whose form is called rest energy, and any additional energy (of any form) acquired by the object above that rest energy will increase the object's total mass just as it increases its total energy. For example, after heating an object, its increase in energy could in principle be measured as a small increase in mass, with a sensitive enough scale.

Living organisms require energy to stay alive, such as the energy humans get from food and oxygen. Human civilization requires energy to function, which it gets from energy resources such as fossils fuels, nuclear fuels, or renewable energy. The processes of Earth's climate and ecosystem are driven by the radiant energy Earth receives from the Sun and the geothermal energy contained within the earth.

In a typical lightning strike, 500 mega joules of electric potential energy is converted into the same amount of energy in other forms, mostlylight energy, sound energy and thermal energy.

❖ HISTORY OF ENERGY

The word *energy* derives from the Ancient GREEK word *energeia*, 'activity, operation' ,which possibly appears for the first time in the work of Aristotle in the 4th century BC. In contrast to the modern definition, energiea was a qualitative philosophical concept, broad enough to include ideas such as happiness and pleasure.

In the late 17th century, Gottfried Leibniz proposed the idea of the Latin: *viva*, or living force, which defined as the product of the mass of an object and its velocity squared; he believed that total *vis viva* was conserved. To account for slowing due to friction, Leibniz theorized that thermal energy consisted of the motions of the constituent parts of matter, although it would be more than a century until this was generally accepted. The modern analog of this property, kinetic energy , differs from *vis viva* only by a factor of two. Writing in the early 18th century, Emilie du Chatelet proposed the concept of conservation of energy in the marginalia of her French language translation of Newton's principia mathematica, which represented the first formulation of a conserved measurable quantity that was distinct from momentum, and which would later be called "energy".

In 1807, Thomas Young was possibly the first to use the term "energy" instead of *vis viva*, in its modern sense. Gustave-Gaspard Coriolis described "kinetic energy" in 1829 in its modern sense, and in 1853, William Rankine coined the term "potential energy". The law of conservation of energy was also first postulated in the early 19th century, and applies to any isolated system. It was argued for some years whether heat was a physical substance, dubbed the caloric, or merely a physical quantity, such as momentum. In 1845 James Prescott Joule discovered the link between mechanical work and the generation of heat.

These developments led to the theory of conservation of energy, formalized largely by William Thomson (Lord Kelvin) as the field of thermodynamics. Thermodynamics aided the rapid development of explanations of chemical processes by Rudolf Clausius, Josiah Willard Gibbs, and Walther Nernst. It also led to a mathematical formulation of the concept ofentropy by Clausius and to the introduction of laws of radiant of energy by Jožef Stefan. According to Noether's theorem, the conservation of energy is a consequence of the fact that the laws of physics do not change over time. Thus, since 1918, theorists have understood that the law of conservation of energy is the direct mathematical consequence of the translational symmetry of the quantity conjugate to energy, namely time.

Thomas Young, the first person to use the term "energy" in the modern sense.

❖ ***Forms of energy***

Energy can also be defined as capability to produce motion. In a more general way , the energy is needed to produce force or work, charge shape are the form of object etc. Energy exists in various forms in the nature. Examples of these are light energy, heat energy, mechanical energy, gravitational energy, electrical energy, sound energy , chemical energy, nuclear energy or atomic energy etc. Law of conservation of energy states that "Energy can neither be created nor be destroyed. Each forms of energy can be converted or changed into other forms of energy by using a suitable setup."

Major forms are kinetic energy and potential energy.

- Kinetic energy is the energy in moving objects or mass .
  Ex. Mechanical energy , electrical energy etc.
- Potential energy is any form of energy that has stored potential that can be put future use.

  Ex. Mechanical energy, nuclear energy , chemical energy etc

- **Thermal energy**

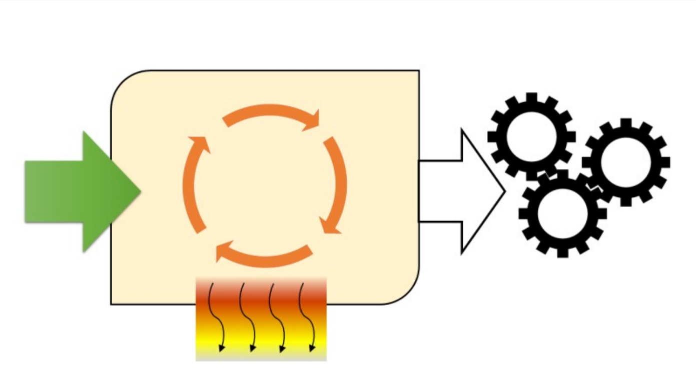
Thermal energy is the energy a substance or system has related to its temperature. The energy of moving or vibrating molecules. Example the solar radiation to cook food.

Thermal energy is the main forms of energy by which electrical energy is generated. Many available resources of energy cannot be used directly. We have to transform them into usable form of energy. This resources are first converted into thermal energy and then , the thermal energy can be used directly or in directly by transforming into other form of energy. For example coal is burnt to produce stream (thermal energy). And then steam is used to produce mechanical energy and finally mechanical is used to produce electrical energy by using generator.

- ## Mechanical energy

In physical sciences, **mechanical energy** is the sum of potential energy and kinetic energy. The principle of conservation of mechanical energy states that if an isolated system is subject only to conservative forces, then the mechanical energy is constant. If an object moves in the opposite direction of a conservative net force, the potential energy will increase; and if the speed (not the velocity) of the object changes, the kinetic energy of the object also changes. In all real systems, how ever, non conservative forces , such as frictional forces, will be present, but if they are of negligible magnitude, the mechanical energy changes little and its conservation is a useful approximation. In elastic collisions, the kinetic energy is conserved, but in inelastic collisions some mechanical energy may be converted into thermal energy. The equivalence between lost mechanical energy (dissipation)and an increase.

Many devices are used to convert mechanical energy to or from other forms of energy, e.g. an electric motor converts electrical energy to mechanical energy, an electric generator converts mechanical energy into electrical energy and a heat engine converts heat to mechanical energy.



An example of a mechanical system: A satellite is orbiting the Earth influenced only by the conservative gravitational force; its mechanical energy is therefore conserved. The satellite's acceleration is represented by the green vector and its velocity is represented by the red vector. If the satellite's orbit is an ellipse the potential energy of the satellite, and its kinetic energy, both vary with time but their sum remains constant.

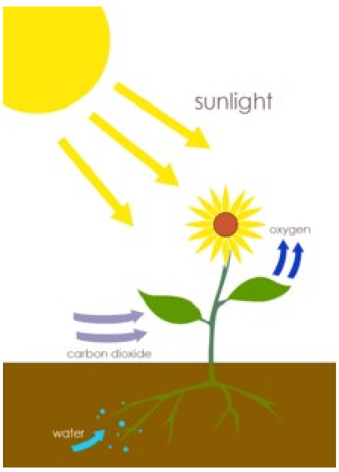
In physical sciences, **mechanical energy** is the sum of potential energy and kinetic energy. The principle of conservation of mechanical

- # Chemical energy

Chemical energy is the energy of chemical substances that is released when they undergo a chemical reaction and transform into other substances. Some examples of storage media of chemical energy include batteries, food, gasoline, and oxygen gas. Breaking and re-making of chemical bonds involves energy, which may be either absorbed by or evolved from a chemical system.

Energy that can be released or absorbed because of a reaction between chemical substances is equal to the difference between the energy content of the products and the reactants, if the initial and final temperature is the same. This change in energy can be estimated from the bond energies of the reactants and products. It can also be calculated from molecules the internal energy of formation of the reactant, and the internal energy of formation of the product molecules. The internal energy change of a chemical process is equal to the heat exchanged if it is measured under conditions of constant volume and equal initial and final temperature, as in a closed container such as a bomb calorimeter. However, under conditions of constant pressure, as in reactions in vessels open to the atmosphere, the measured heat change is not always equal to the internal energy change, because pressure-volume work also releases or absorbs energy. (The heat change at constant pressure is equal to the enthalpy change, in this case the enthalpy of reaction, if initial and final temperatures are equal).

Chemical potential energy is a form of potential energy related to the structural arrangement of atoms or molecules. This arrangement may be the result of chemical bonds within a molecule or interactions between them. Chemical energy of a chemical substance can be transformed to other forms of energy by a chemical reaction. For example, when a fuel is burned, the chemical energy of molecular oxygen is converted to heat.[Green plants transform solar energy to chemical energy (mostly of oxygen) through the process of photo synthesis, and electrical energy can be converted to chemical energy and vice versa through electro chemical reactions.



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- **Electrical energy**

. **Electrical energy** is energy derived as a result of movement of electrically charged particles. When used loosely, *electrical energy* refers to energy that has been converted *from* electric potential energy. This energy is supplied by the combination of electric current and electric potential that is delivered by an electrical circuit (e.g., provided by an electric power utility). At the point that this electric potential energy has been converted to another type of energy, it ceases to be electric potential energy. Thus, all electrical energy is potential energy before it is delivered to the end-use. Once converted from potential energy, electrical energy can always be called another type of energy (heat, light, motion, etc.).

Electrical energy is usually sold by the kilowatt hour (1 kW·h = 3.6 MJ) which is the product of the power in kilowatts multiplied by running time in hours. Electric utilities measure energy using an electricity meter, which keeps a running total of the electric energy delivered to a customer.

- **Hydro energy**

Hydropower (from Greek: "water"), also known as **water power**, is the use of falling or fast-running water to produce electricity or to power machines. This is achieved by converting the gravitational potential or kinetic energy of a water source to produce power. Hydropower is a method of sustainable energy production.

Since ancient times, hydropower from watermills has been used as a renewable energy source for irrigation and the operation of mechanical devices, such as gristmills, sawmills , text tiles mills, trip hammers, dock cranes, domestic lifts, and ore mills. A troupe, which produces compressed air from falling water, is sometimes used to power other machinery at a distance.

Hydropower is now used principally for hydro electric power generation, and is also applied as one half of an energy storage system known as pumped storage hydro electricity.

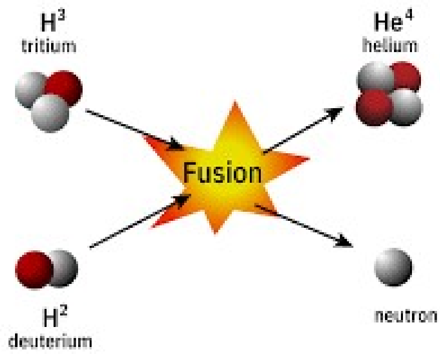
Hydropower is an attractive alternative to fossil fuels as it does not directly produce carbon dioxide or other atmospheric pollutants and it provides a relatively consistent source of power. Nonetheless, it has economic, sociological, and environmental downsides and requires a sufficiently energetic source of water, such as a river or elevated lake. International institutions such as the World bank view hydropower as a low-carbon means for economic development .

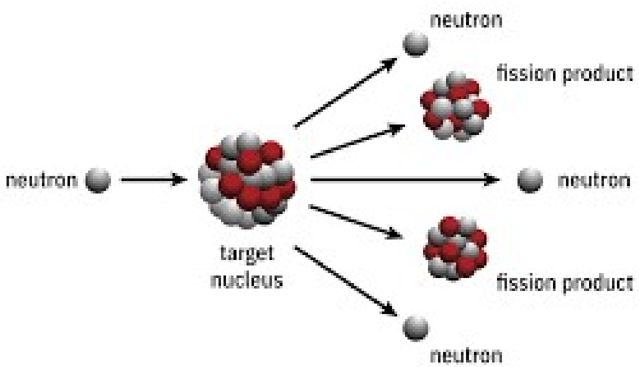
- # Nuclear energy

Nuclear energy is the energy that holds together the nucleus of atoms. Atoms are the most simple blocks that make up matter. Every atom has in its center a very small nucleus. Normally, nuclear energy is hidden inside the atoms. However, some atoms are radioactive and send off part of their nuclear energy as radiation.Radiation is given off from the nucleus of unstable isotopes of radioactive substances.

Nuclear energy can also be freed in two other ways: nuclear fusion and nuclear fission. Nuclear fusion is the combining of two light atoms into a heavier one and nuclear fission is the splitting of a heavy atom. Both ways make big amounts of energy. They sometimes take place in nature. Fusion is the source of heat in the sun. Fission is also used in nuclear power plants to makeelectricity. Both fusion and fission can be used in nuclear weapons Nuclear power generates a number of radioactive by-products, including tritium, cesium, krypton, neptunium and forms of iodine some of which can be dangerous for millions of years.

Nuclear energy production and use has been a controversial topic over the years. Nuclear energy can supply a very large amount of electrical power for use in cities, but the nuclear materials that make the electricity can be very dangerous for thousands or millions of years after they have been used. Countries have made decisions to use nuclear power based on their current energy demands as well as environmental conservation and carbon neutrality demands. Countries could venture into nuclear energy production to help meet the rising energy demand, to help conserve the environment by avoiding air pollution, and also as a long lasting replacement for the depleting fossil fuels sources of energy, but would have to ensure the ongoing safety of production and waste storage. There have been upgrades to reactor design to avoid nuclear energy accidents like those of Chernobyl and Fukushima, but accidents still continue to occur and ageing reactors are a safety concern. Countries using the nuclear energy production process to make dangerous weapons of mass destruction is a related concern.





❖ ***Energy resources***

- **Primary and secondary energy resources**

A **primary source** (also called an **original source**) is an artifact, document, diary manuscript, autobiography, recording, or any other source of information that was created at the time under study. It serves as an original source of information about the topic. Similar definitions can be used in library sources and other areas of scholarship, although different fields have somewhat different definitions. In journalism, a primary source can be a person with direct knowledge of a situation, or a document written by such a person.

Primary sources are distinguished from secondary sources, which cite, comment on, or build upon primary sources. Generally, accounts written after the fact with the benefit (and possible distortions) of hindsight are secondary. A secondary source may also be a primary source depending on how it is used. For example, a memoir would be considered a primary source in research concerning its author or about their friends characterized within it, but the same memoir would be a secondary source if it were used to examine the culture in which its author lived. "Primary" and "secondary" should be understood as relative terms, with sources categorized according to specific historical contexts and what is being studied.

- **Renewable and non renewable energy resources**

RENEWABLE ENERGY

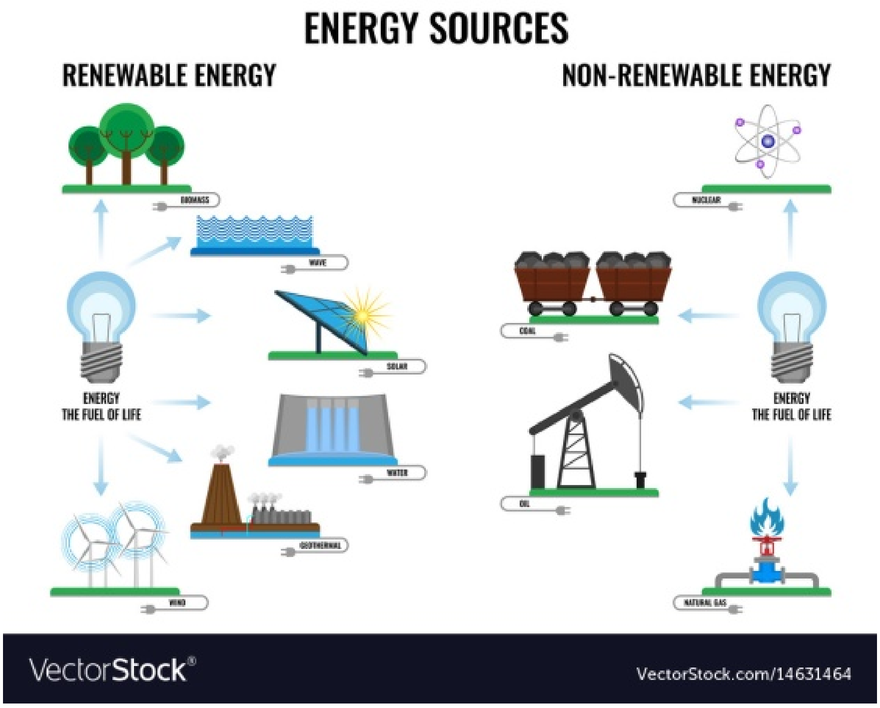
A natural resource which will replenish to replace the portion depleted by usage and consumption, either through natural reproduction or other recurring processes in a finite amount of time in a human time scale. When the recovery rate of resources is unlikely to ever A **renewable resource**, also known as a **flow resource**, is exceed a human time scale, these are called **perpetual resources**.Renewable resources are a part of Earth's natural environment and the largest components of its eco sphere. A positive life cycle assessment is a key indicator of a resource's sustainability.

Definitions of renewable resources may also include agricultural production, as in agricultural products and to an extent water resources. In 1962, Paul Alfred Weiss defined renewable resources as: "*The total range of living organisms providing man with life, fibers, etc...*"Another type of renewable resources is renewable energy resources. Common sources of renewable energy include solar, geothermal and wind power, which are all categorized as renewable resources. Fresh water is an example of renewable resources.

NON RENEWABLE ENERGY

A **non-renewable resource** (also called a **finite resource**) is a natural resource that cannot be readily replaced by natural means at a pace quick enough to keep up with consumption. An example is carbon-based fossil fuels. The original organic matter, with the aid of heat and pressure, becomes a fuel such as oil or gas. Earth minerals and metal ores, fossil fuels (coal, petroleum, natural gas) and ground water in certain aquifers are all considered non-renewable resources, though individual elements are always conserved (except in nuclear reactions, nuclear decay or atmospheric escape).

Conversely, resources such as timber (when harvested sustainably) and wind (used to power energy conversion systems) are considered renewable resources, largely because their localized replenishment can occur within time frames meaningful to humans as well.



❖ *Renewable energy resources*

Renewable energy resources are those resources which can be used to produce energy again and again and their supply is not affected by the rate of their consumption .

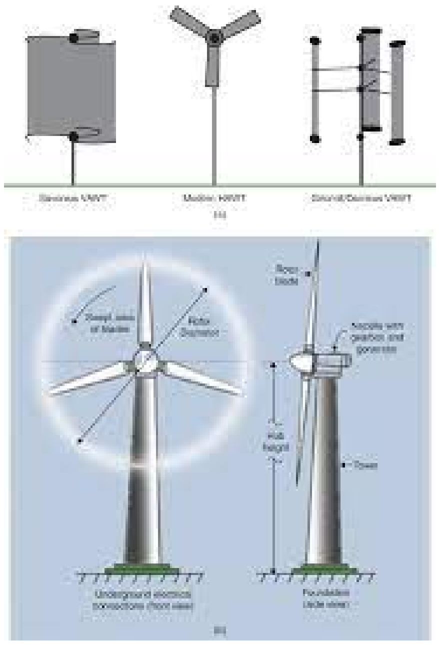
Ex. Solar energy, wind energy, ocean or thermal and tidal energy etc.

- ## Wind energy

Wind power or **wind energy** is mostly the use of wind turbines to generate electricity. Wind power is a popular, sustainable, renewable energy source that has a much smaller impact on the environment than burning fossil fuels. Historically, wind power has been used in sails, wind mills and wind pumps but today it is mostly used to generate electricity. Wind farms consist of many individual wind turbines, which are connected to the electric power transmission network New onshore wind forms are cheaper than new coal or gas plants, but expansion of wind power is being hindered by fissile fuel subsides. Onshore wind farms have a greater visual impact on the land scape than some other power stations. Small onshore wind farms can feed some energy into the grid or provide power to isolated off-grid locations offshore wind forms provide a steadier and stronger source of energy and have less visual impact. Although there is less offshore wind power at present and construction and maintenance costs are higher, it is expanding.

Wind power is variable renewable energy, so power-management techniques are used to match supply and demand, such as: wind hybrid power systems, hydro electric power or other dispatch able power sources, excess capacity, geographically distributed turbines, exporting and importing power to neighboring areas, or grid storage. As the proportion of wind power in a region increases the grid may need to be upgraded. WEATHER FORECASTING allows the electric-power network to be readied for the predictable variations in production that occur.

In 2021, wind supplied over 1800 TW h of electricity, which was over 6% of world electricity and about 2% of world energy. With about 100 GW added during 2021, mostly in China and the United States, global installed wind power capacity exceeded 800 GW. To help meet the Paris Agreement goals to limit climate change, analysts say it should expand much faster - by over 1% of electricity generation per year.



- # Ocean energy

Marine energy or **marine power** (also sometimes referred to as **ocean energy**, **ocean power**, or **marine and hydrokinetic energy**) refers to the energy carried by ocean waves, tides, salinity, and ocean temperature differences. The movement of water in the world's oceans creates a vast store of kinetic energy, or energy in motion. Some of this energy can be harnessed to generate electricity to power homes, transport and industries.

The term marine energy encompasses both wave power i.e. power from surface waves, and tidal power i.e. obtained from the kinetic energy of large bodies of moving water. Off sore wind power is not a form of marine energy, as wind power is derived from the wind, even if the wind turbines are placed over water.

The oceans have a tremendous amount of energy and are close to many if not most concentrated populations. Ocean energy has the potential of providing a substantial amount of new renewable energy around the world.

The oceans represent a vast and largely untapped source of energy in the form of surface waves, fluid flow, salinity gradients, and thermal differences.

Marine and Hydrokinetic (MHK) or marine energy development in U.S. and international waters includes projects using the following devices:

- Wave power converters in open coastal areas with significant waves;
- Tidal turbines placed in coastal and estuarine areas;
- In-stream turbines in fast-moving rivers;
- Ocean current turbines in areas of strong marine currents;
- Ocean thermal energy converters in deep tropical waters.

- ## Solar energy

Solar energy is radiant light and heat from the sun that is harnessed using a range of technologies such as solar power to generate electricity, solar thermal energy including solar water heater, and solar agricultures.

It is an essential source of renewable energy, and its technologies are broadly characterized as either passive power or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photo voltaic systems, concentrated solar power, and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulated air.

The large magnitude of solar energy available makes it a highly appealing source of electricity. Solar energy has been cheaper than fossil fuels since 2021.

In 2011, the International Energy Agency said that "the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an indigenous, inexhaustible, and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating global warming .... These advantages are global.”

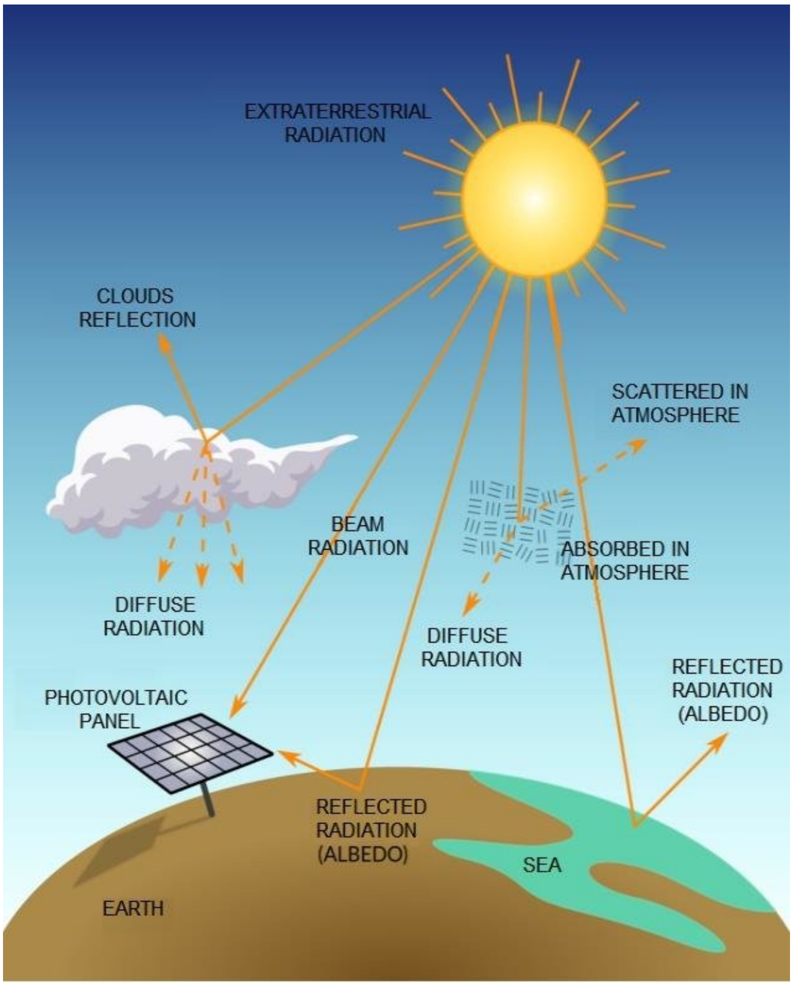
Solar radiation is absorbed by the Earth's land surface, oceans – which cover about 71% of the globe – and atmosphere. Warm air containing evaporated water from the oceans rises, causing atmospheric circulation or convection. When the air reaches a high altitude, where the temperature is low, water vapor condenses into clouds, which rain onto the Earth's surface, completing the water cycle. The latent heat of water condensation amplifies convection, producing atmospheric phenomena such as wind, cyclones and anti cyclones Sunlight absorbed by the oceans and land masses keeps the surface at an average temperature of 14 °C. By photosynthesis, green plants convert solar energy into chemically stored energy, which produces food, wood and the biomass from which fossil fuels are derived.

The total solar energy absorbed by Earth's atmosphere, oceans and land masses is approximately 3,850,000 exa joules (EJ) per year. In 2002, this was more energy in one hour than the world used in one year. Photosynthesis captures approximately 3,000 EJ per year in biomass.

Solar technologies are characterized as either passive or active depending on the way they capture, convert and distribute sunlight and enable solar energy to be harnessed at different levels around the world, mostly depending on the distance from the equator. Although solar energy refers primarily to the use of solar radiation for practical ends, all renewable energies, other than geothermal power and tidal power, derive their energy either directly or indirectly from the Sun.

Active solar techniques use photovoltaic, concentrated solar power, solar thermal collectors, pumps, and fans to convert sunlight into useful outputs. Passive solar techniques include selecting materials with favorable thermal properties, designing spaces that naturally circulate air, and referencing the position of a building to the Sun. Active solar technologies increase the supply of energy and are considered supply side technologies, while passive solar technologies reduce the need for alternate resources and are generally considered demand-side technologies.

In 2000, the United Nations Development Programme, UN Department of Economic and Social Affairs, and World Energy Council published an estimate of the potential solar energy that could be used by humans each year that took into account factors such as insulation, cloud cover, and the land that is usable by humans. The estimate found that solar energy has a global potential of 1,600 to 49,800 joules (4.4×10^{14} to 1.4×10^{16} kWh) per year.



❖ *Solar photovoltaic power generation*

For this project we 3rd B.Sc students all are went to ONGC Solar Photovoltaic Power Generation plant at NAGARAM.All the information and process we all are obseverd their and we mention here about the power generation project brifely. And also mentioning about the system to produce electricity from solar radiation.All the belowed discription was clearly observed by the students only with the help of Department of Physics and Bhargav sir.

• Solar photovoltaic cells

Photo voltaic (**PV**) is the conversion of light into electricity using semi conducting materials that exhibit the photo voltaic effect, a phenomenon studied in physics, photo chemistry, and electro chemistry. The photovoltaic effect is commercially utilized for electricity generation and as photo sensors. The power system is controlled using power electronics.

A photo voltaic system employs solar modules, each comprising a number of solar cells, which generate electrical power. PV installations may be ground-mounted, rooftop-mounted, wall-mounted or floating. The mount may be fixed or use a solar tracker to follow the sun across the sky.

Some hope that photovoltaic technology will produce enough affordable sustainable energy to help mitigate global warming caused by CO_2. Solar PV has specific advantages as an energy source: once installed, its operation generates no pollution and no green house gas emissions, it shows simple scalability in respect of power needs and silicon has large availability in the Earth's crust, although other materials required in PV system manufacture such as silver will eventually constrain further growth in the technology. Other major constraints identified are competition for land use and lack of labor in making funding applications. The use of PV as a main source requires energy storage systems or global distribution by high voltage direct current power lines causing additional costs, and also has a number of other specific disadvantages such as unstable power generation and the requirement for power companies to compensate for too much solar power in the supply mix by having more reliable conventional power supplies in order to regulate demand peaks and potential undersupply. Production and installation does cause pollution and green house gas emissions and there are no viable systems for recycling the panels once they are at the end of their lifespan after 10 to 30 years.

Photovoltaic systems have long been used in specialized applications as stand-alone installations and grid connected PV systems have been in use since the 1990s. Photovoltaic modules were first mass-produced in 2000, when German environmentalists and the Euro solar organization received government funding for a ten thousand roof program.

Decreasing costs has allowed PV to grow as an energy source. This has been partially driven by massive Chinese government investment in developing solar production capacity since 2000, and achieving economies of scale. Much of the price of production is from the key component poly silicon, and most of the world supply is produced in China, especially in xinjiang. Beside the subsidies, the low prices of solar panels in the 2010s has been achieved through the low price of energy from coal and cheap labor costs in Xinjiang, as well as improvements in manufacturing technology and efficiency. Advances in technology and increased manufacturing scale have also increased the efficiency of photovoltaic installations.Net metering and financial incentives, such as preferential feed in tariffs for solar-generated electricity, have supported solar PV installations in many countries. Panel prices dropped by a factor of 4 between 2004 and 2011. Module prices dropped 90% of over the 2010s, but began increasing sharply in 2021.

- **Inverter**

A **solar inverter** or **PV inverter**, is a type of electrical **converter** which converts the variable direct current (DC) output of a photo voltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off grid electrical network. It is a critical balance of system (BOS)–component in a photo voltaic system, allowing the use of ordinary AC-powered equipment. Solar power inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking and anti-islanding protection.

- **Trasformer**

A **transformer** is a passive component that transfers electrical energy from one electrical circuit to another circuit, or multiple circuits. A varying current in any coil of the transformer produces a varying magnetic flux in the transformer's core, which induces a varying electro motive forces across any other coils wound around the same core. Electrical energy can be transferred between separate coils without a metallic (conductive) connection between the two circuits. Faraday discovered in 1831, describes the induced voltage effect in any coil due to a changing magnetic flux encircled by the coil.

Transformers are used to change AC voltage levels, such transformers being termed step-up or step-down type to increase or decrease voltage level, respectively. Transformers can also be used to provide galvanic isolation between circuits as well as to couple stages of signal-processing circuits. Since the invention of the first constant potential transformer in 1885, transformers have become essential for the transmission, distribution and utilization of alternating current electric power. A wide range of transformer designs is encountered in electronic and electric power applications. Transformers range in size from RF transformers less than a cubic centimeter in volume, to units weighing hundreds of tons used to interconnect the power grid.

- **Storage system**

At full rated power, battery storage power stations are generally designed to output for up to a few hours. Battery storage can be used for short-term peck power and ancillary services such as providing operating reserve and frequency control to minimize the chance of power outages. They are often installed at, or close to, other active or disused power stations and may share the same grid connection to reduce costs. Since battery storage plants require no deliveries of fuel, are compact compared to generating stations and have no chimneys or large cooling systems, they can be rapidly installed and placed if necessary within urban areas, close to customer load.

❖ Conclusion

- Solar power is pollution-free and causes no greenhouse gases to be emitted after installation
- Reduced dependence on foreign oil and fossil fuels
- Renewable clean power that is available every day of the year, even cloudy days produce some power
- Return on investment unlike paying for utility bills
- Virtually no maintenance as solar panels last over 30 years
- Creates jobs by employing solar panel manufacturers, solar installers, etc. and in turn helps the economy
- Excess power can be sold back to the power company if the grid inner tied
- Ability to live grid free if all power generated provides enough for the home/building
- Can be installed virtually anywhere; in a field to on a building
- Use batteries to store extra power for use at night
- Solar can be used to heat water, power homes and buildings, even power cars
- Safer than traditional electric current
- Efficiency is always improving so the same size solar that is available today will become more efficient tomorrow
- Aesthetics are improving making the solar more versatile compared to older models; i.e. printing, flexible, solar shingles, etc.
- Federal grants, tax incentives and rebate programs are available to help with initial costs.
- No trenching is needed since the solar can be close to or at the place of installation.