



**RV College of
Engineering®**

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Unit V: Part - B

2023-24 (Odd): 1st Semester

BE in CV, CY, EC, EI, IM

ME113AT: Fundamentals of Mechanical Engineering

(Category: Engineering Science)

(Theory)

ESC: 'C' Section

Unit – V

MECHATRONICS AND ENERGY SOURCES

Faculty In-Charge:

Dr. V L Jagannatha Guptha

Assistant Professor

Department of Mechanical Engineering

Mobile: 9243447122

Email ID: jagannathagvl@rvce.edu.in

- Introduction
- Evaluation of Mechatronic system, Measurement
- Control System, Basic Elements of Control System
- Applications:
 - Water Level Controller
 - Washing Machine
 - Engine management system (EMS)
 - Anti-Lock Braking System (ABS)

Energy Sources>>

- Introduction
- Applications of Energy sources like
 - Fossil Fuels
 - Nuclear Fuels
 - Hydel
 - Solar
 - Wind and
 - Bio-Fuels
- Environmental Issues like
 - Global warming and
 - Ozone depletion

Unit-V	6 Hrs
Mechatronics: Introduction: Evolution of Mechatronic system, measurement; control system, basic elements of control system, Applications-water level controller, washing machine, Engine management system (EMS), Anti-lock Braking System (ABS). Energy Sources: Introduction and applications of Energy sources like Fossil fuels, Nuclear fuels, Hydel, Solar, wind, and bio-fuels, Environmental issues like Global warming and Ozone depletion.	

Energy Sources>>**➤ Introduction and Applications of Energy sources like**

- Fossil Fuels
- Nuclear Fuels
- Hydel

Unit-V	6 Hrs
Mechatronics: Introduction: Evolution of Mechatronic system, measurement; control system, basic elements of control system, Applications-water level controller, washing machine, Engine management system (EMS), Anti-lock Braking System (ABS). Energy Sources: Introduction and applications of Energy sources like Fossil fuels, Nuclear fuels, Hydel, Solar, wind, and bio-fuels, Environmental issues like Global warming and Ozone depletion.	

Introduction and Applications :

- **Energy** is defined *as* the capacity to do work and *power* is *the* rate at which the *energy* is consumed.
- **Energy resources** are material objects that contain energy in usable quantities.
- Used *as* a quantitative measure of the motion of matter in its various mutually transformable forms, energy is classified into light, chemical, electrical, nuclear, etc.

Energy Sources>>

Energy resources are classified into:

- Renewable and
- Non-renewable or Expendable resources

Renewable energy:

- Its resources are continuously restored by nature.
- It is so named because they recur, are seemingly inexhaustible, and are freely available.

Examples:

Geothermal, solar, wind, hydro power and oceans

Disadvantages:

- Intermittence
- lack of dependability, and
- low energy densities

Non-renewable energy sources :

- Their existence is extremely limited because the process of their **formulation** (renewal) needs a very long time (millions of years).
- The process of formulation takes a long time compared to its exploitation, thus this energy can expire.

Classification:

Non-renewable sources are classified into:

- **Fossil** fuels and
- **Nuclear** fuels

Fossil fuels:

These constitute **oil, natural gas and coal** which over millions of years are formed and stored within the earth, originate from micro organisms, plants and animals.

The formulation process of fossil energy **sources requires**

High pressure and High temperature as they exist within the earth.

Energy Sources>>

Comparison between renewable and non-renewable energy Sources:

Renewable energy Sources	Non-renewable energy Sources
The energy can be renewed within a short time	The energy cannot regenerated on a human time scale
The energy sources can not be exhausted and are freely available	The energy sources are exhaustible
It is clean energy or 'green power' and does not produce harmful pollution to environment	Hazardous to environment
Low energy density and lack of dependability	High energy density and highly reliable
High initial investment & low maintenance cost	Initial & maintenance costs are high
Examples: Solar, wind, tidal, hydel & geothermal energy	Examples: Coal, petroleum, natural gas and uranium ₇

- Another way of classifying the energy sources is:
 - Conventional and
 - Non-conventional energy sources

Examples:

Conventional fuels:

Fossil fuels, hydro and nuclear energies

Non-conventional fuels:

Direct solar energy, tidal, geothermal, wind energy, and ocean thermal energy

Comparison between Conventional and Non-conventional energy Sources:

Conventional Energy Sources	Non-conventional Energy Sources
They are widely used and	They are rarely used and
They are hazardous to environment	They are environmentally clean sources of energy
Most of the energy sources are exhaustible	Inexhaustible energy sources
High extraction cost and are reliable	Freely available and not reliable
Examples: Hydel, nuclear, fossil fuels	Examples: Solar, wind, tidal, & geothermal energy

Classification of Conventional Energy Sources:

- Fossil fuels (Coal, Petroleum)
- Hydro energy
- Nuclear energy

Fossil fuels:

- These fuels are formed by natural processes such as anaerobic decomposition (*microorganisms break down biodegradable material in the absence of oxygen*) of buried dead organisms.
- The age of the organisms and their resulting fossil fuels is typically millions of years and sometimes exceeds 650 million years.
- The fossil fuels, which contain high percentages of carbon, include:

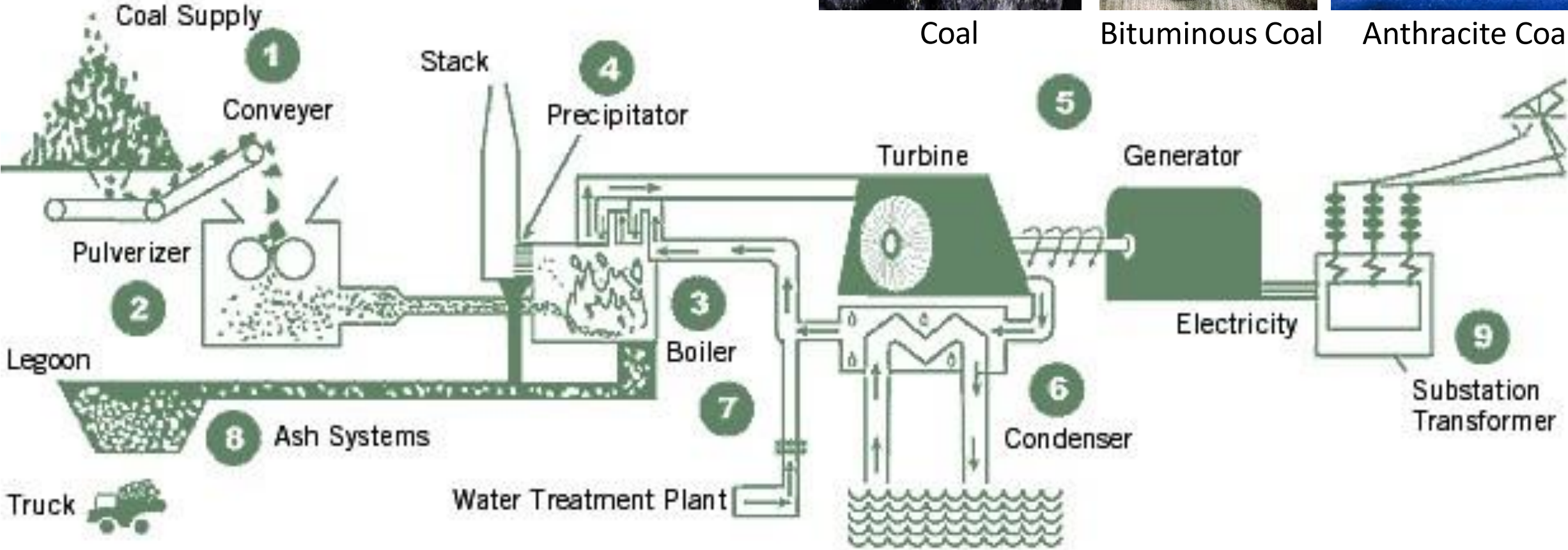
Coal, Petroleum, and Natural gas

Energy Sources>>

Fossil fuels:

Coal Fired Thermal Power Plant:

Components of a coal-fired thermal plant



Coal

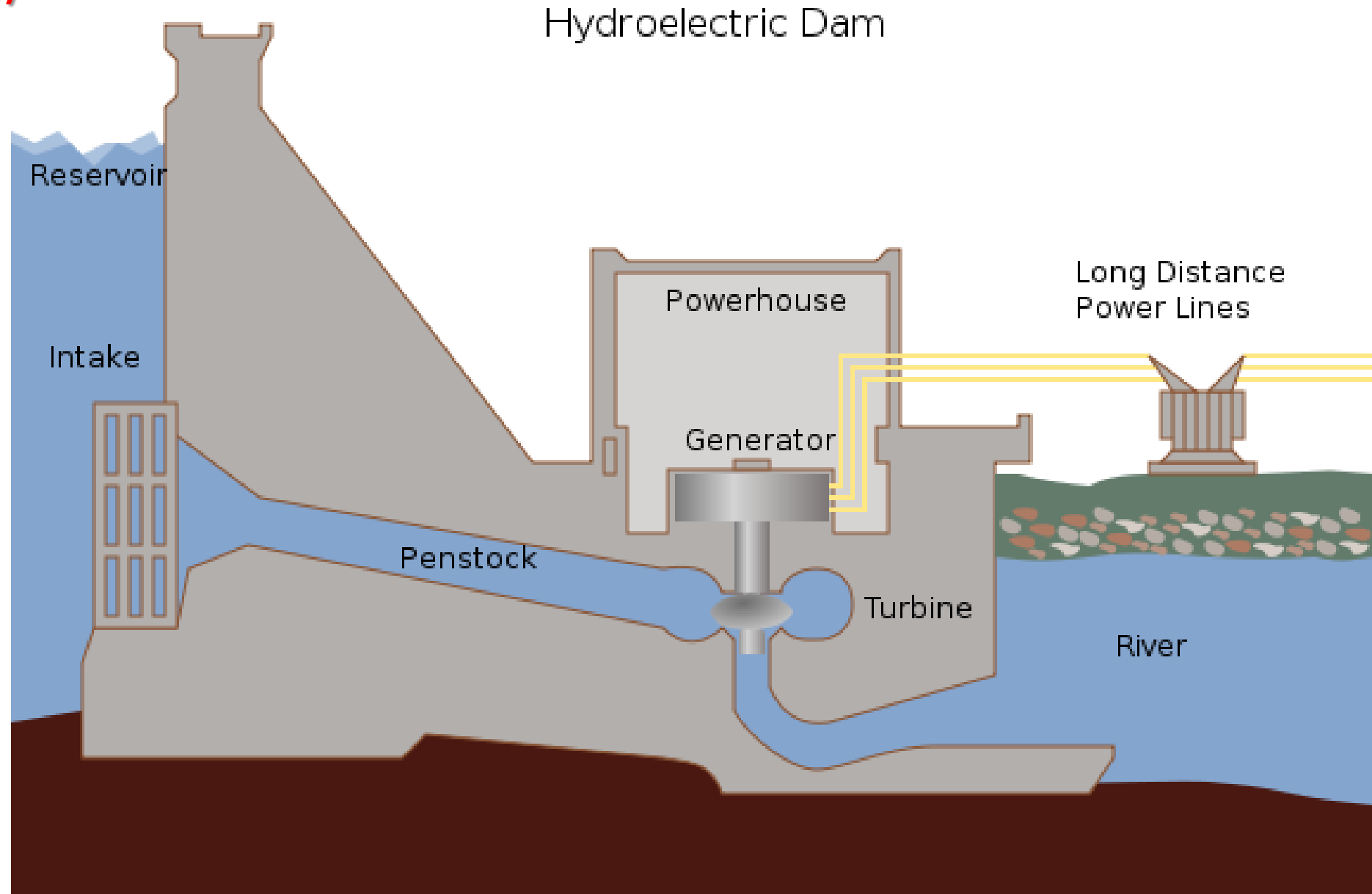


Bituminous Coal

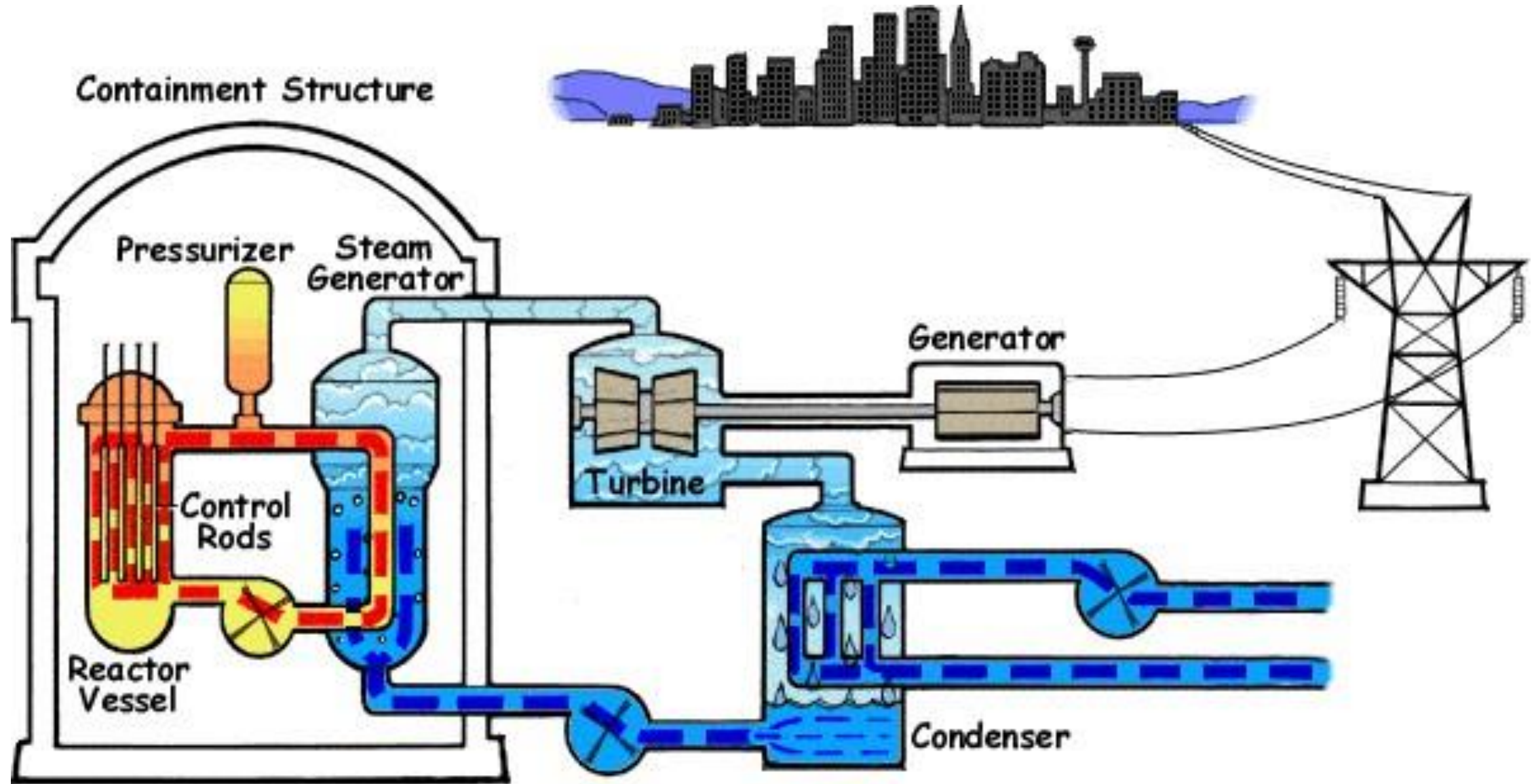


Anthracite Coal

Hydro Energy:



Nuclear Energy:



Fundamentals of Mechanical Engineering
MECHATRONICS AND ENERGY SOURCES

Assignment – Unit 5a - 01

<<for Practice>>

- 1) Explain with neat sketch
- 2) Brief about

Note:

- i) Use new A4 size sheets, provide 1" left and top margin for each sheet.
- ii) Write Roll No., Name (at right top), Topic and Assignment No. (at top Middle) in the 1st sheet.
- iii) Use red pen to write the questions and blue or black pen for answer
- iv) Draw neat sketches using instruments (avoid free hand sketching)

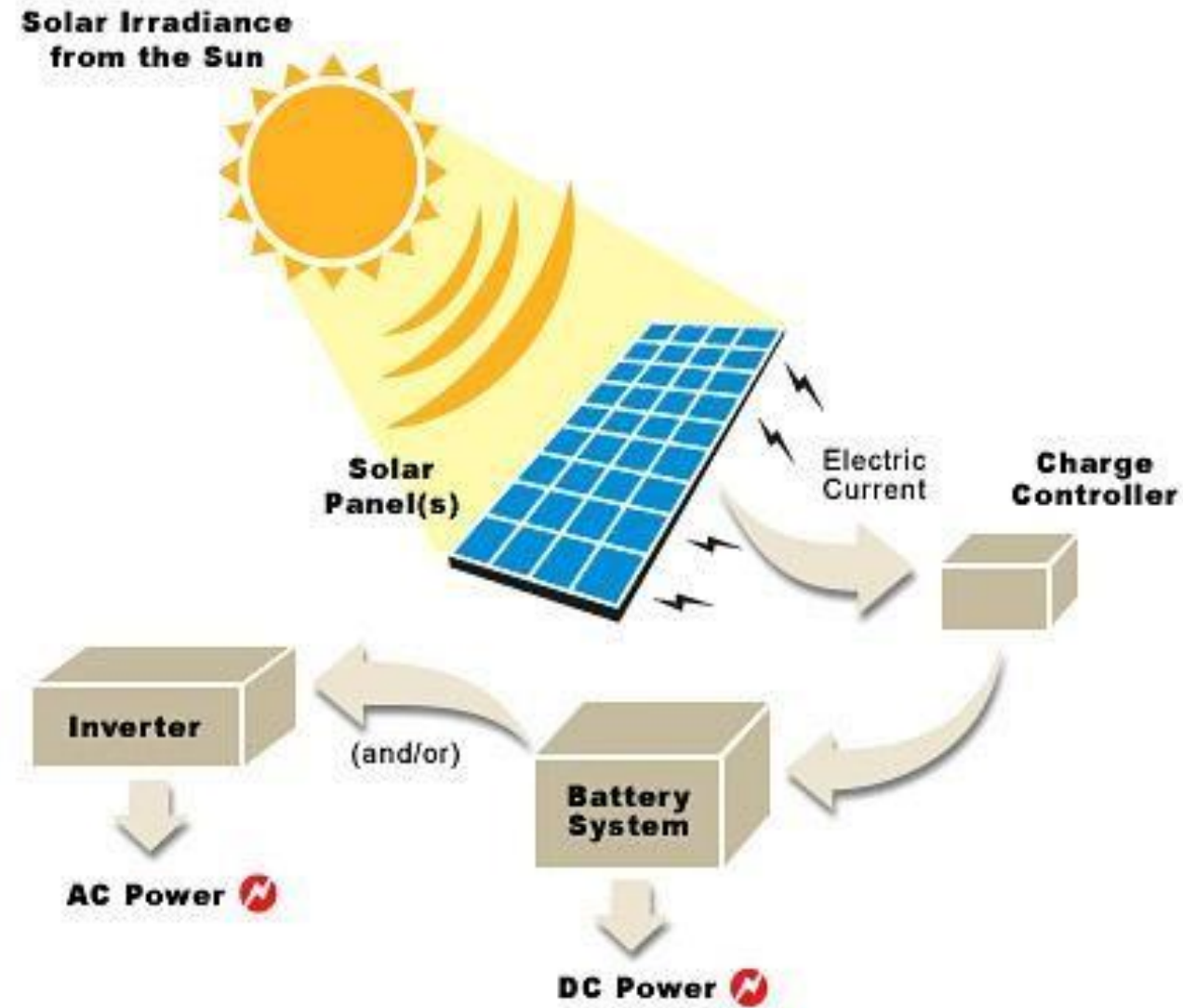
The following are the **non-conventional energy sources considered:**

- Solar Energy
- Tidal Energy
- Geothermal Energy
- Wind Energy
- Ocean thermal Energy

Non-conventional Energy Sources>>

Solar Energy:

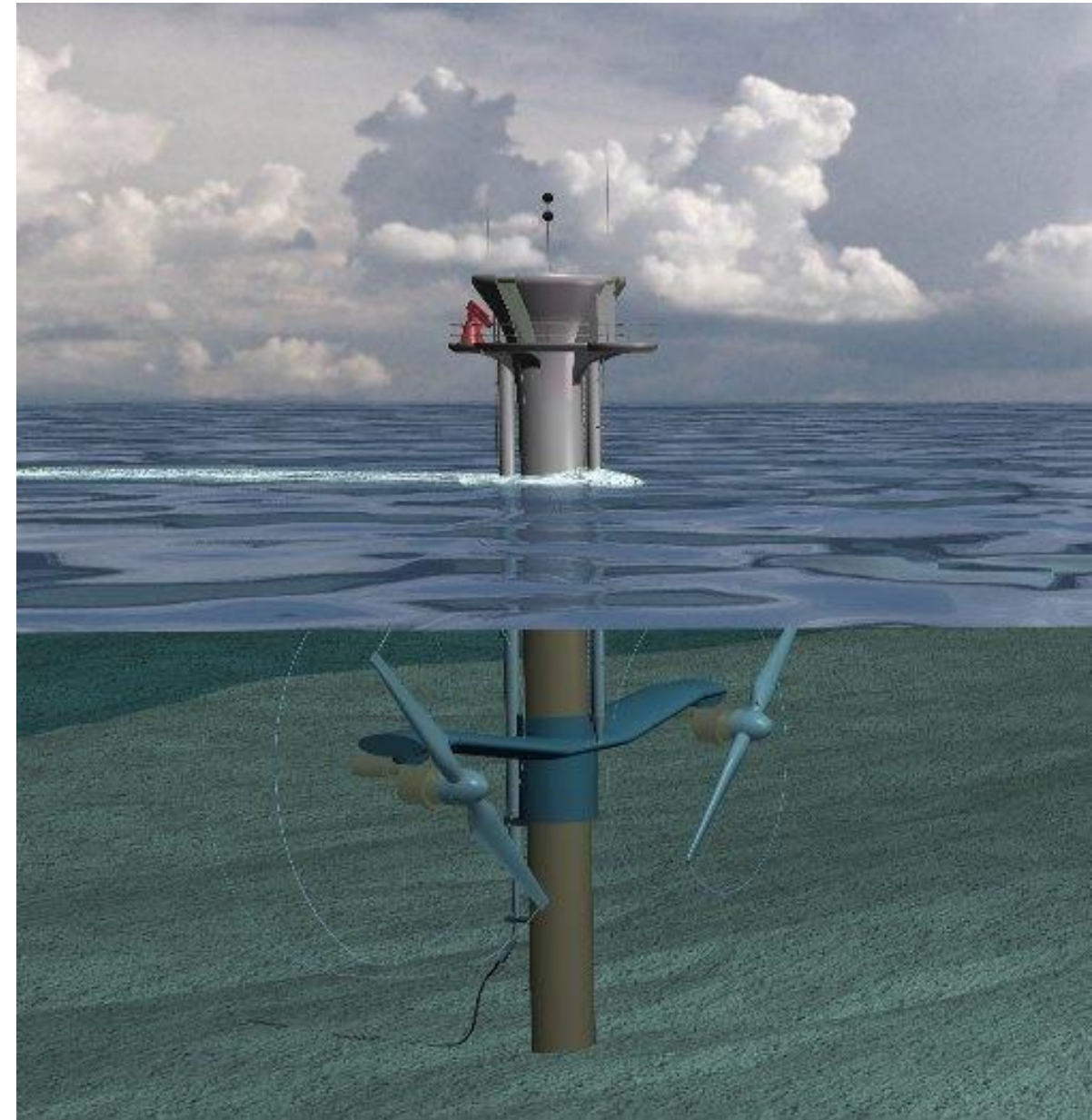
- The sun is a free source of energy all year round.
- Its radiation reaches the solar panels on rooftops which converts energy into electricity to operate the household devices.
- When the sun delivers energy to the earth by means of electromagnetic radiation, this Photovoltaic (PV) effect is the process by which several PV cells made from silicon convert sunlight into electricity.
- A simple solar energy system is made up from solar panels, an inverter to convert DC to AC power, charge controller and charging battery.
- The main elements of the solar energy system can be identified as the battery which can save the energy for use when the sun disappears and the converter can convert from DC power to AC and the charge controller is to protect the battery from overcharging and getting damaged.
- Solar energy can be utilized to produce thermal energy or mechanical form of energy which eventually can be used to produce electricity; convenient for transmission and distribution.



Non-conventional Energy Sources>>

Tidal Energy:

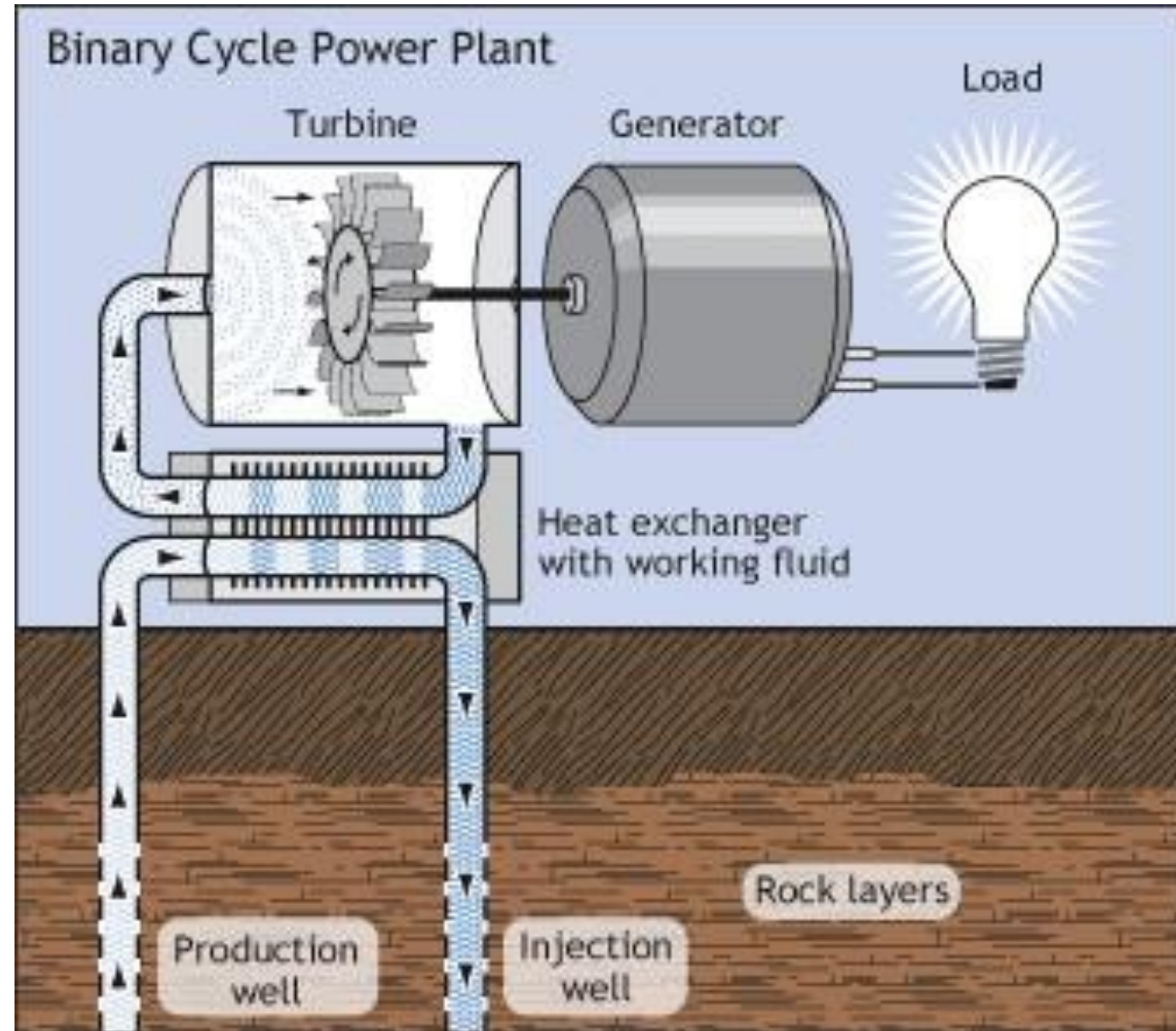
- The phenomenon of rise and fall in the ocean waters, called tides, is due to the attractive forces between the celestial bodies; Sun, Earth and the Moon.
- When the ocean water rises to a maximum extent, it is called spring tide and when they fall off to the lowest possible extent, it is called neap tide.
- With progress in technology, the usage of electric and electronic devices is exponentially increasing and there is a need to produce extra power other than the existing, in order to meet the future demands.
- Tidal energy can be considered as one of the best existing source of renewable energies.
- Unlike the wind, solar, thermal energy etc., tidal energy is something that has a long term perspective and it can be forecasted more accurately.
- Tidal energy is clean and not depleting. Because of these features it is unique and suitable to use it as a power generating source in the future. There are various types of tidal power plants across the world with varying tidal elevation.



Non-conventional Energy Sources>>

Geothermal Energy:

- Geothermal resources consist of thermal energy from the Earth's interior stored in both rock and trapped steam or liquid water.
- Its widespread deployment could play a significant role in mitigating climate change by reducing greenhouse gas (GHG) emissions as an alternative for capacity addition and / or replacement of existing base load fossil fuel-fired power and heating plants.
- Geothermal resources can be classified as convective (hydrothermal) systems, conductive systems and deep aquifers.
- Hydrothermal systems include liquid- and vapour-dominated types.
- Conductive systems include hot rock and magma over a wide range of temperatures.
- Deep aquifers contain circulating fluids in porous media or fracture zones at depths typically greater than 3 km, but lack a localized magmatic heat source.
- They are further subdivided into systems at hydrostatic pressure and systems at pressure higher than hydrostatic (geo-pressured).



Wind Energy:

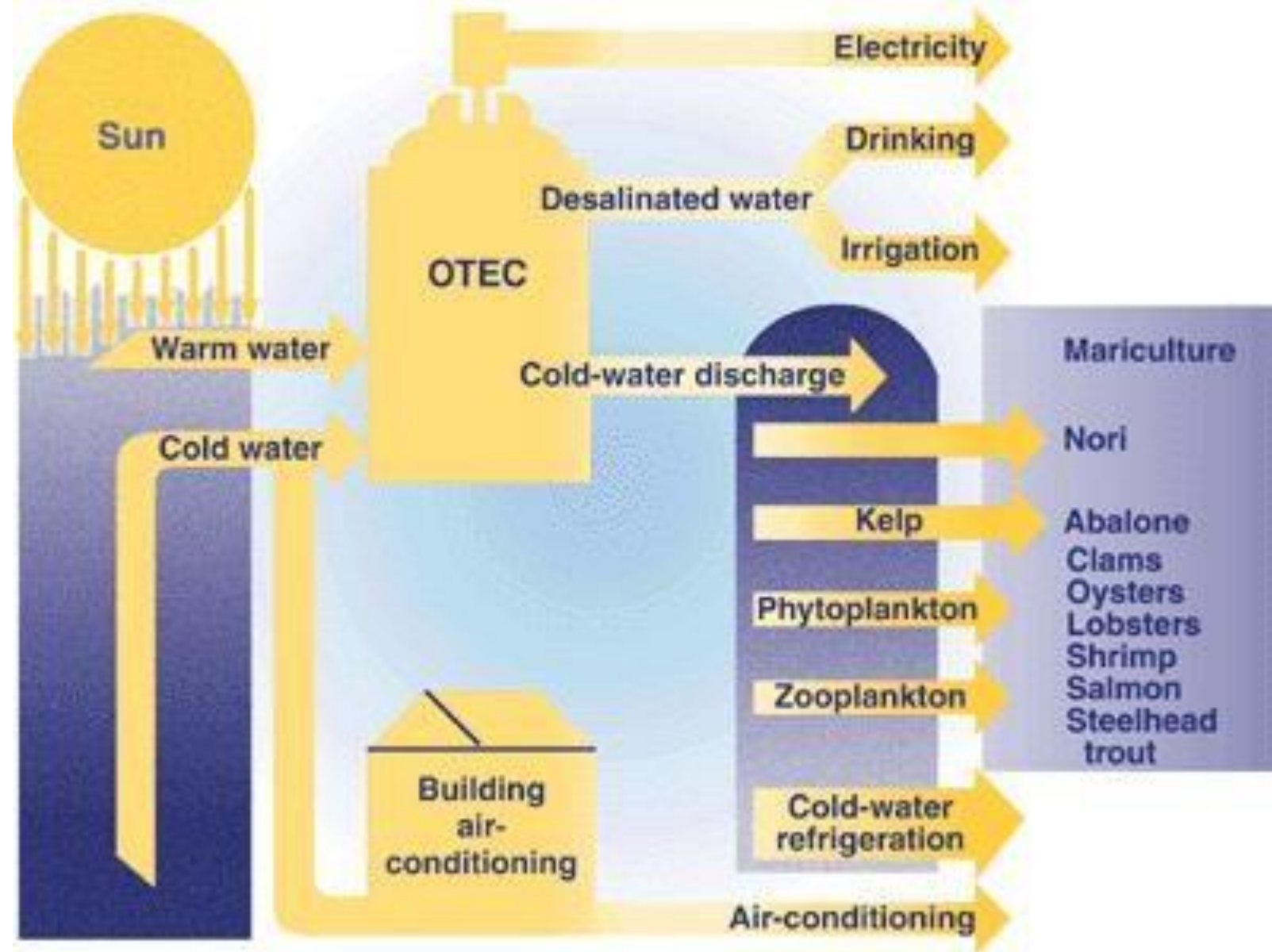
- Wind power or wind energy is the use of wind to provide the mechanical power through wind turbines to operate electric generators.
- Wind power is a sustainable and renewable energy. Wind possesses energy by virtue of its motion.
- Any device capable of slowing down the mass of moving air, like a sail or propeller, can extract part of the energy and convert it into useful work.
- The spinning blades, attached to a hub and a low-speed shaft, turn along with the blades. The rotating low-speed shaft is connected to a gearbox that connects to a high-speed shaft on the opposite side of the gearbox. This high-speed shaft connects to an electrical generator that converts the mechanical energy from the rotation of the blades into electrical energy.
- The key characteristics of a good wind power site are high average wind speed, sufficient separation from noise-sensitive neighbours, good grid connection, good site access, No special environmental or landscape designations.
- The integration of wind into grid has certain challenges like, Variability, Uncertainty, Location-specificity, Nonsynchronous generation, Low capacity factor.



Non-conventional Energy Sources>>

Ocean Thermal Energy (OETC):

- Ocean covered a 70% of earth's surface which is a world's largest solar energy collector and has a potential to store energy.
- Now a day solar energy absorbed by sea is equivalent to 4000 times amount presently consumed by people.
- OTEC use a temperature difference (20°C) between the upper layer of ocean and bottom layer of the ocean.
- Ocean Thermal Energy Conversion (OTEC) is a renewable energy technology that uses the natural temperature difference in oceans to produce clean, reliable electricity, day and night, year-round. The heat from the warm ocean surface and cold from the deep ocean drives a Rankine Cycle, which produces electricity



ADVANTAGES OF OCEAN THERMAL ENERGY CONVERSION (OTEC):

1. Reduce fossil fuel: The dependence on fossil fuel is decreased with increased in the used of ocean thermal energy conversion. With the sky rocketing price of oil, many countries are pushing the company to adopt these clean sources of energy.
2. Unlimited sources of free energy especially in tropical water.
3. OTEC generated electricity with NO GREENHOUSE emission.
4. OTEC has a potential to generate a large amount of electricity.
5. Ocean thermal energy conversion can create cold fresh water which can be used for air condition or drinking water.
6. It does not emit pollutant in atmosphere.
7. IN OPEN CYCLE OF OTEC:- It has an ability to create desalination, fresh drinking water when the warm water is recondense.
8. OTEC is a great option for developing area that not only for domestic power but also need fresh water.
9. The cold water effluent produced through OTEC can also provide useful product that application in agriculture, ice production, hydrogen production, mericulture.
10. Power from OTEC is continuously and pollution free.
11. Drawing warm water and cold water and returning of sea water closed the thermocline could be accomplished with minimum environment impact.
12. OTEC system might help in enrichment of fishing ground due to nutrients from the unproductive depth water to warmer surface water.

DISADVANTAGES OF OCEAN THERMAL ENERGY CONVERSION (OTEC):

1. The installation of the OTEC device and maintenance of power plant is high.
2. OTEC can be only performed in tropical ocean, where is a temperature difference at least 20 °C between upper layer of ocean water and bottom layer of ocean about 1000 meter depth.
3. Efficient commercial exploitation is difficult.
4. Land based OTEC power plant pipe of 3 k.m long is required to transport a large volume of cold water from the depth of ocean about 1000 meter the cost of the pipe as about 75% of the cost of the current plant design.
5. In a land based plant, there is a problem of cold and warm sea water. The discharge has to be carried out in appropriate depth of the ocean to avoid the damage of aquatic environment. This required a addition maintenance.
6. OTEC plant needs to be installed as near to national grid.
7. OTEC plant need to safe location from storm.
8. There is small temperature difference between surface water and bottom water. So the efficiency is very low 3-4%.
9. Due to low efficiency of OTEC plant and coupled with high cost and maintenance cost make them uneconomical for small plant.
10. Construction of floating OTEC plant is difficult.
11. The company has not invested money on this project because it had been only tested.

Fundamentals of Mechanical Engineering
MECHATRONICS AND ENERGY SOURCES

Assignment – Unit 5a - 02

<<for Practice>>

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Course Outcomes (COs):

Course Outcomes: After completing the course, the students will be able to:-	
CO 1	Understand the knowledge of various properties of Engineering materials and their Joining processes
CO 2	Elucidate the principles and operation of vision system in product inspection.
CO 3	Illustrate the Energy sources, mechanical drives and electrical drives in industrial applications
CO 4	Understand about Mechatronics, Automation and Robotics in Industrial Applications

References:

Reference Books	
1.	Elements of Mechanical Engineering, K. R. Gopalakrishna, Subhas Publications, 18 th Edition. ISBN 5551234002884
2.	Material Science & Engineering- William D Callister, 2 / 10 th Edition, ISBN 978-1-119-45520-2.
3.	Welding Technology (PB), Khanna O P, Dhanpat Rai publication, 4 th Edition, ISBN 9383182555.
4.	Electric and Hybrid Vehicles, Design Fundamentals – Iqbal Husain, CRC Press, 2 nd Edition, 2010. ISBN – 13-978-1439811757.
5.	Modern Electric, Hybrid Electric & Fuel Cell Vehicles, Fundamentals, Theory and Design - Mehrdad Ehsani, CRC Press, 1 st Edition, 2005. ISBN – 13- 978-0849331541.
6.	Mechatronics – Electronic control systems in Mechanical and Electrical Engineering, William Bolton, Pearson, 6 th Edition, ISBN: 978-1-292-07668-3, 2015.

Assessment and Evaluation Pattern:

CONTINUOUS INTERNAL EVALUATION		
ASSESSMENT AND EVALUATION PATTERN		
Theory & quizzes questions are to be framed using Bloom's Taxonomy Levels - Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating		
WEIGHTAGE	CIE (50%)	SEE (50%)
A. QUIZZES: Each quiz is evaluated for 10 marks		
Quiz-I for 10 Marks	20	*****
Quiz-I for 10 Marks		
B. TESTS: Each test will be conducted for 50 Marks adding upto 100 marks. Final test marks will be reduced to 40		
Test – I for 50 Marks	40	*****
Test – II for 50 Marks		
C. EXPERIENTIAL LEARNING: Fabrication of prototype of energy generator – 10 marks Fabrication of Mechatronics/Electrical/Mechanical drive prototype components– 20 marks Prototype models of Robot – 10 marks	40	*****
TOTAL MARKS FOR THE COURSE (A+B+C)	100	100

Practice to Prepare

All The Best