1.7 What is Renewable Energy?

Renewable energy is energy that comes from resources which are continually replen such as sunlight, wind, rain, tides, waves and geothermal heat. About 16% of global final en consumption comes from renewable resources, with 10% of all energy from traditional bio mainly used for heating, and 3.4% from hydroelectricity. New renewable (small hydro, mo biomass, wind, solar, geothermal, and biofuels) accounted for another 3% and are growing rapidly. The share of renewable in electricity generation is around 19%, with 16% of elect coming from hydroelectricity and 3% from new renewable.

Renewable energy sources, that derive their energy from the sun, either directly or rectly, such as Hydro and wind, are expected to be capable of supplying humanity energ almost another 1 billion years, at which point the predicted increase in heat from the s expected to make the surface of the Earth too hot for liquid water to exist.

Renewable energy is derived from natural processes that are replenished constantly. various forms, it derives directly from the sun, or from heat generated deep within the Included in the definition is electricity and heat generated from solar, wind, ocean, hydrop biomass, geothermal resources, and biofuels and hydrogen derived from renewable resou Renewable energy resources and significant opportunities for energy efficiency exist over geographical areas, in contrast to other energy sources, which are concentrated in a limited nu of countries. Rapid deployment of renewable energy and energy efficiency, and technolo diversification of energy sources, would result in significant energy security and economic efits.

Renewable energy replaces conventional fuels in four distinct areas: electricity genera hot water/space heating, motor fuels, and rural (off-grid) energy services:

- **Power generation:** Renewable energy provides 19% of electricity generation world Renewable power generators are spread across many countries, and wind power already provides a significant share of electricity in some areas: for example, 14% i U.S. state of Iowa, 40% in the northern German state of Schleswig-Holstein, and 49 Denmark. Some countries get most of their power from renewable, including Iceland (1 Norway (98%), Brazil (86%), Austria (62%), New Zealand (65%), and Sweden (54
- **Heating:** Solar hot water makes an important contribution to renewable heat in countries, most notably in China, which now has 70% of the global total (180 GWth). of these systems are installed on multi-family apartment buildings and meet a portion hot water needs of an estimated 50-60 million households in China. Worldwide, tota stalled solar water heating systems meet a portion of the water heating needs of ov million households. The use of biomass for heating continues to grow as well. In Sw national use of biomass energy has surpassed that of oil. Direct geothermal for heati also growing rapidly.
- **Transport fuels:** Renewable biofuels have contributed to a significant decline in oil sumption in the United States since 2006.[17] The 93 billion liters of biofuels prod

worldwide in 2009 displaced the equivalent of an estimated 68 billion liters of gasoline, equal to about 5% of world gasoline production.

At the national level, at least 30 nations around the world already have renewable energy contributing more than 20% of energy supply. National renewable energy markets are projected to continue to grow strongly in the coming decade and beyond, and some 120 countries have various policy targets for longer-term shares of renewable energy, including a 20% target of all electricity generated for the European Union by 2020. Some countries have much higher long-term policy targets of up to 100% renewable. Outside Europe, a diverse group of 20 or more other countries target renewable energy shares in the 2020-2030 time frame that range from 10% to 50%.

1.8 Mainstream Renewable Technologies

1.8.1 Solar Power:

Solar energy is the most readily available and free source of energy since prehistoric times. It is estimated that solar energy equivalent to over 15,000 times the world's annual commercial energy consumption reaches the earth every year.

India receives solar energy in the region of 5 to 7 kWh/m^2 for 300 to 330 days in a year. This energy is sufficient to set up 20 MW solar power plants per square kilo meter land area. Solar energy can be utilized through two different routes, as solar thermal route and solar electric (solar photovoltaic) routes. Solar thermal route uses the sun's heat to produce hot water or air, cook food, drying materials etc. Solar photovoltaic uses sun's heat to produce electricity for lighting home and building, running motors, pumps, electric appliances, and lighting.

1.8.2 Wind Energy:

Wind energy is basically harnessing of wind power to produce electricity. The kinetic energy of the wind is converted to electrical energy. When solar radiation enters the earth's atmosphere, different regions of the atmosphere are heated to different degrees because of earth curvature. This heating is higher at the equator and lowest at the poles. Since air tends to flow from warmer to cooler regions, this causes what we call winds, and it is these airflows that are harnessed in windmills and wind turbines to produce power.

Wind power is not a new development as this power, in the form of traditional windmills -for grinding corn, pumping water, sailing ships - have been used for centuries. Now wind power is harnessed to generate electricity in a larger scale with better technology.

1.8.3 Hydro Energy:

The potential energy of falling water, captured and converted to mechanical energy by waterwheels, powered the start of the industrial revolution. Wherever sufficient head, or change in elevation, could be found, rivers and streams were dammed and mills were built. Water under pressure flows through a turbine causing it to spin. The Turbine is connected to a generator. which produces electricity. Energy in water can be harnessed and used. Since water is about 800 times denser than air, even a slow flowing stream of water, or moderate sea swell, can yield considerable

- Hydroelectric energy is a term usually reserved for large-scale hydroelectric dam largest of which is the Three Gorges Dam in China and a smaller example is the Ako Dam in Ghana.
- Micro hydro systems are hydroelectric power installations that typically produce up kW of power. They are often used in water rich areas as a remote-area power (RAPS).
- Run-of-the-river hydroelectricity systems derive kinetic energy from rivers and oceans the creation of a large reservoir.

1.8.4 Biomass Energy:

Biomass is a term for all organic material that stems from plants (including algae, tre crops). Biomass is produced by green plants converting sunlight into plant material th photosynthesis and includes all land- and water-based vegetation, as well as all organic w The biomass resource can be considered as organic matter, in which the energy of sunli stored in chemical bonds. When the bonds between adjacent carbon, hydrogen and oxygen ecules are broken by digestion, combustion, or decomposition, these substances release stored, chemical energy. Biomass has always been a major source of energy for mankind presently estimated to contribute of the order 10- 14% of the world's energy supply.

Biomass is the plant material derived from the reaction between CO^2 in the air, wate sunlight, via photosynthesis, to produce carbohydrates that form the building blocks of bio Typically photosynthesis converts less than 1% of the available sunlight to stored, che energy. The solar energy driving photosynthesis is stored in the chemical bonds of the stru components of biomass. If biomass is processed efficiently, either chemically or biological extracting the energy stored in the chemical bonds and the subsequent 'energy' product com with oxygen, the carbon is oxidized to produce CO^2 and water. The process is cyclical, as th is then available to produce new biomass.

1.8.5 Geothermal Energy:

Geothermal energy is an enormous, underused heat and power resource that is clean little or no greenhouse gases), reliable (average system availability of 95%), and home (making us less dependent on foreign oil). Geothermal resources range from shallow ground water and rock several miles below the Earth's surface, and even farther down to the extre hot molten rock called magma. Mile-or-more-deep wells can be drilled into underground voirs to tap steam and very hot water that can be brought to the surface for use in a varie applications.

Heat energy continuously flows to the Earth's surface from its interior, where central peratures of about 6000°C exist. The predominant source of the Earth's heat is the gradual of long-lived radioactive isotopes (40K, 232Th, 235U and 238U). The outward transfer o occurs by means of conductive heat flow and convective flows of molten mantle beneat Earth's crust. This results in a mean heat flux at the Earth's surface of 80kW/km^2 approxim This heat flux, however, is not distributed uniformly over the Earth's surface; rather, it is co

rated along active tectonic plate boundaries where volcanic activity transports high temperature molten material to the near surface.

Although volcanoes erupt small portions of this molten rock that feeds them, the vast majority of it remains at depths of 5 to 20 km, where it is in the form of liquid or solidifying magma bodies that release heat to surrounding rock. Under the right conditions, water can penetrate into these hot rock zones, resulting in the formation of high temperature geothermal systems containing hot water, water and steam, or steam, at depths of 500 m to >3,000 m.

.8.6 Ocean Thermal Energy:

Ocean can produce two types of energy: *thermal energy* from the sun's heat, and *mechanical nergy* from the tides and waves. The fact that the marine renewable sector is less well developed han other energy industries presents companies with both opportunities and challenges. The lack of an established industry structure can make entry into the market uncertain for newcomers. However, this lack of structure also means that companies are potentially more able to create and ake opportunities than is possible in other parts of the energy industry that are developed and more mature.

A wide range of companies are involved in the marine renewable sector. The figure below hows the key segments of the sector - services that are needed for the successful completion of project range from insurance and finance, resource assessments, environmental surveys, design, anufacture, offshore construction, operation and decommissioning.