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Renewable Energy Analysis

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***Abstract*: Renewable energy resources, such as wind, solar and hydropower, offer clean alternatives to fossil fuels. They produce little or no pollution or greenhouse gases, and they will never run out. Generating electricity from renewable sources is more expensive than conventional approaches, but reduces pollution externalities. Analyzing the tradeoff is much more Challenging than often presumed, because the value of electricity is extremely dependent on the time and location at which it is produced, which is not very controllable with some renewables, such as wind and solar. Likewise, the pollution benefits from renewable generation depend on what type of generation it displaces, which also depends on time and location. Without incorporating these factors, cost-benefit analyses of alternatives are likely to be misleading. However, other common arguments for subsidizing renewable Power – green jobs, energy security and driving down fossil energy prices – are unlikely to substantially alter the analysis. The role of intellectual property spillovers is a strong argument for subsidizing energy science research, but less persuasive as an enhancement to the value of installing current renewable energy technologies.**

***Keywords:* Renewable energy resources (RES), concentrated solar power (CSP), Micro hydro systems (MHS), and photovoltaic (PV), biomass to liquids (BTLs).**

I. INTRODUCTION

Though renewable sources other than hydro-electricity have grown very quickly in the last decade, they were starting from a miniscule base, and they remain a very small share of total generation today due primarily to their high direct cost. The leveled cost of electricity for a given generation plant is the constant (in real terms) price for power that would equate the net present value of revenue from the plant's output with the net present value of the cost of production.2 Leveled cost estimates depend on numerous engineering factors that vary with the technology being reviewed, but these are not usually the main drivers of variation in estimates for a given plant. Current technological specifications for a plant are comparatively easy to establish with reasonable precision; for the most part, researchers agree on what inputs are going in and what outputs result. Economic variables are usually behind large discrepancies among leveled cost estimates [1]. These include assumptions about inflation rates, real interest rates, how much the generator is used, and future input costs, including fuel costs. Engineering factors also interact with these economic considerations; for example, the optimal usage of a plant will depend on the marginal cost of production, the speed with which its output can be adjusted, and the market price (plus other compensation, such as marginal subsidies) that the generator receives.

Because generation plants are heterogeneous in location, architecture, and other factors, even plants with similar technology will not have the same leveled cost of electricity. The variation tends to be relatively small for coal and gas plants because the fuel is fairly standardized and the plant operation is less affected by location. Even these plants' costs, however are affected by idiosyncratic site characteristics (including property values), local labor costs, environmental constraints, access to fuel transportation, and access to electricity transmission lines, as well as variation in technical efficiency of operation. Production from solar and wind generation is largely driven by local climate conditions, which greatly increases the variance across projects in leveled cost.

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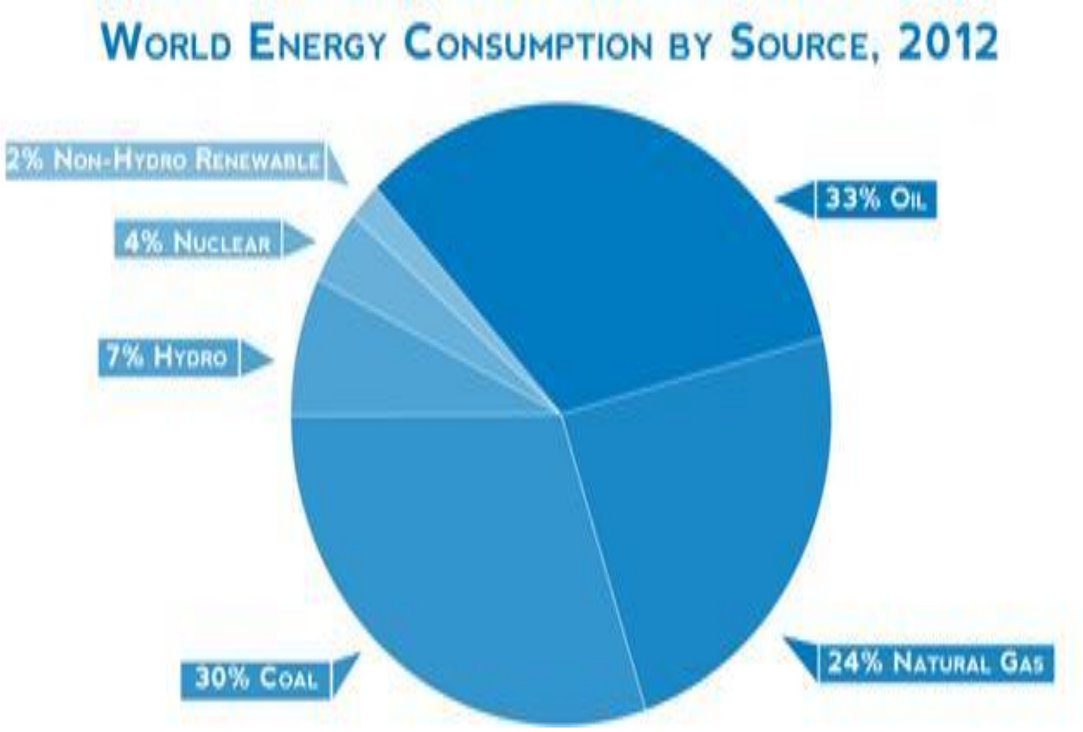

Fig. 1. World energy consumption of sources

II. MAINSTREAM RENEWABLE TECHNOLOGIES

A] Wind Power: -Airflows can be used to run wind turbines. Modern utility-scale wind turbines range from around 600 kW to 5 MW of rated power, although turbines with rated output of 1.5–3 MW have become the most common for commercial use; the power available from the wind is a function of the cube of the wind speed, so as wind speed increases, power output increases dramatically up to the maximum output for the particular turbine. Areas where winds are stronger and more constant, such as offshore and high altitude sites are preferred locations for wind farms. Typical capacity factors are 20-40%, with values at the upper end of the range in particularly favorable sites Globally, the long-term technical potential of wind energy is believed to be five times total current global energy production, or 40 times current electricity demand, assuming all practical barriers needed were overcome. This would require wind turbines to be installed over large areas, particularly in areas of higher wind resources, such as offshore [2]. As offshore wind speeds average ~90% greater than that of land, so offshore resources can contribute substantially more energy than land stationed turbines following are some methods of wind turbine.

Three different wind turbine generating systems are currently widely applied. The first is the directly grid coupled squirrel cage induction generator, used in constant speed wind turbines. The wind turbine rotor is coupled to the generator through a gearbox. In most turbines using this system, the power extracted from the wind is limited using the stall effect. This means that the rotor is designed in such a way that its aerodynamic efficiency decreases in high wind speeds, thus preventing extraction of too much mechanical power from the wind. When the stall effect is used, no active control systems are necessary. Pitch controlled constant speed wind turbines have, however, also been built. The second system is the doubly fed (wound rotor) induction generator, which allows variable speed operation. The rotor winding is fed using a back-to-back voltage source converter. Like in the first system, the wind turbine rotor is coupled to the generator through a gearbox. In high wind speeds, the power extracted from the wind is limited by pitching the rotor blades. The third system is a direct drive synchronous generator, also allowing variable speed operation. The synchronous generator can have a wound rotor or be excited using permanent magnets. It is grid coupled through a back-to-back voltage source converter or a diode rectifier and voltage source converter. The synchronous generator is a low speed multi pole generator; therefore, no gearbox is needed. Like in the second system, the power extracted from the wind is limited by pitching the rotor blades in high wind speeds [1]. The three wind turbine generating systems are depicted in Fig. 1.

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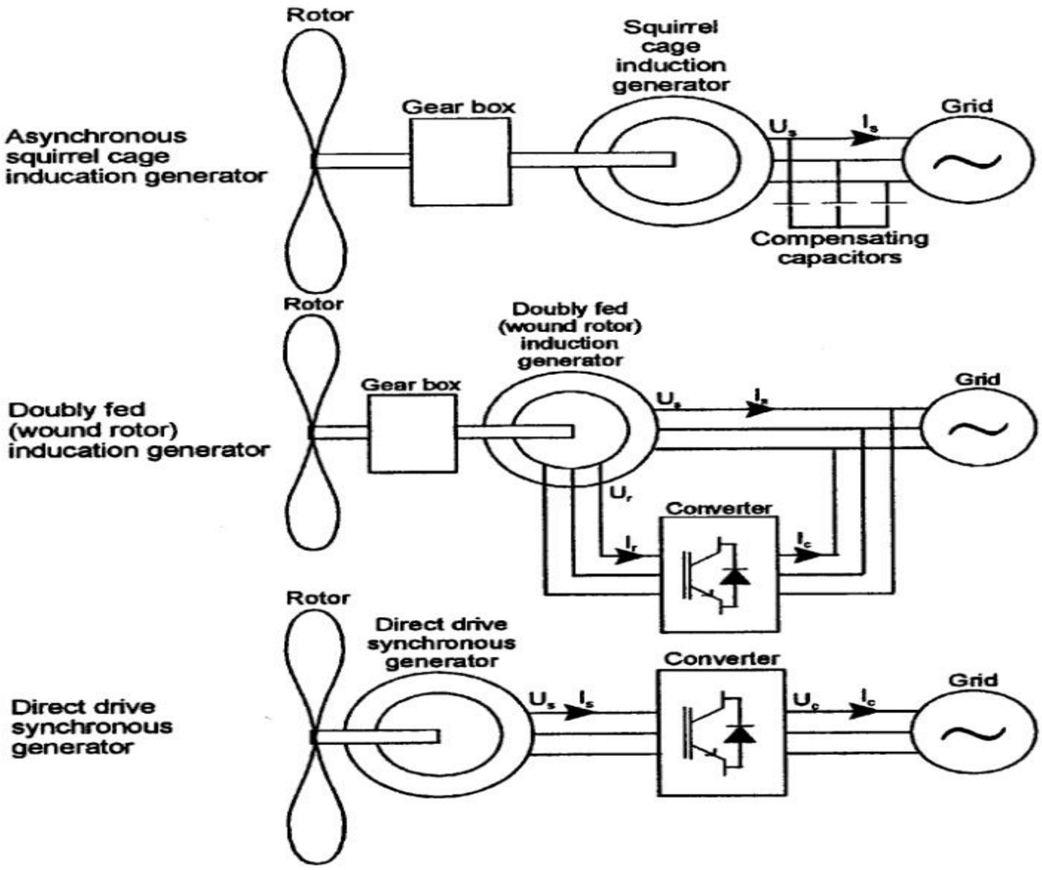

Fig. 2. Frequently occurring wind turbine generating systems

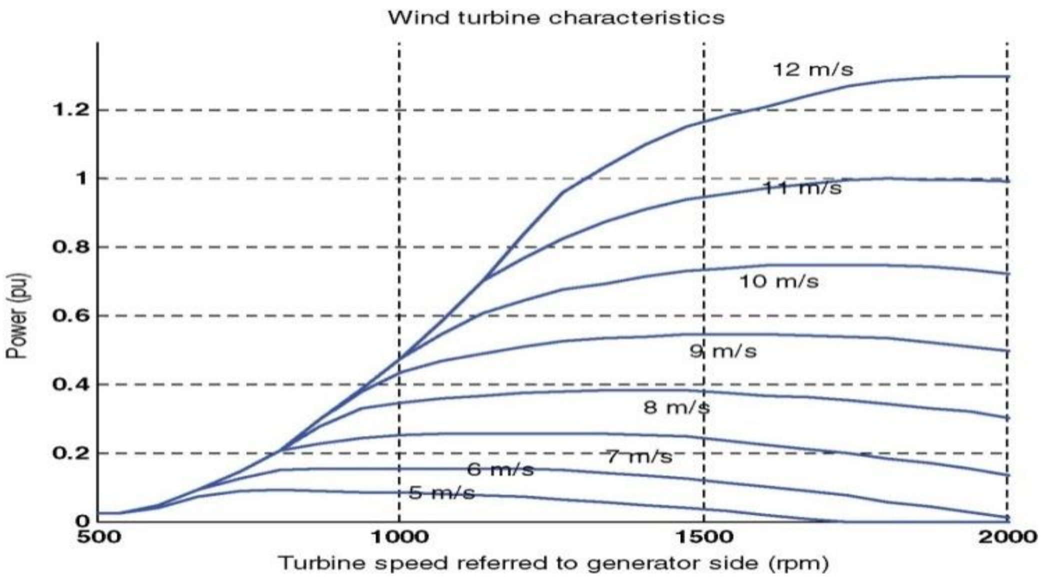

Fig.2. Power-speed characteristic of turbine

B] Small Hydro Power: -Energy in water can be harnessed and used. Since water is about 800 times denser than air, even as low flowing stream of water, or moderate sea swell, can yield considerable amounts of energy. There are many forms of water energy [3]:

- Hydroelectric energy is a term usually reserved for large-scale hydroelectric dams.

- Micro hydro systems (MHS) are hydroelectric power installations that typically produce up to 100 kW of power. They are often used in water rich areas as a remote-area power supply(RAPS).

- Run-of-the-river hydroelectricity systems derive kinetic energy from rivers and oceans without the creation of a large reservoir.

Fig. 3.Small hydroelectric plant - 1.2 MW, Ammassalik, Greenland

Fig. 4.Small hydroelectric plant layout

Hydropower is produced in 150 countries, with the Asia-Pacific region generating 32 percent of global hydropower in 2013. China is the largest hydroelectricity producer.

C] Solar Power: -Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors 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 circulate air.

Solar power is the conversion of sunlight into electricity, either directly using photovoltaic (PV), or indirectly using concentrated solar power (CSP). Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Commercial concentrated solar power plants were first developed in the 1980s. Photovoltaic convert light into electric current using the effect [4]. Photovoltaic are an important and relatively inexpensive source of electrical energy where grid power is inconvenient, unreasonably expensive to connect, or simply

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unavailable. However, as the cost of solar electricity is falling, solar power is also increasingly being used even in grid-connected situations as a way to feed low-carbon energy into the grid.

Solar power in India:-

India is densely populated and has high solar insolation, an ideal combination for using solar power in India.. In the solar energy sector, some large projects have been proposed, and a 35,000 km2 (14,000 sq. mi) area of the Tharp has been set aside for solar power projects, sufficient to generate 700 to 2,100 GW. Also India's Ministry of New and Renewable Energy has released the JNNSM Phase 2 Draft Policy,[1] by which the Government aims to install 10 GW of Solar Power and of this 10 GW target, 4 GW would fall under the central scheme and the remaining 6 GW under various State specific schemes. In July 2009, India unveiled a US$19 billion plan to produce 20 GW of solar power by 2020.[2] Under the plan, the use of solar-powered equipment and applications would be made compulsory in all government buildings, as well as hospitals and hotels.[3]On 18 November 2009, it was reported that India was ready to launch its National Solar Mission under the National Action Plan on Climate Change, with plans to generate 1,000 MW of power by 2013.[5] From August 2011 to July 2012, India went from 2.5 MW of grid connected photovoltaic to over 1,000 MW.

According to a 2011 report by BRIDGE TO INDIA and GTM Research, India is facing a perfect storm of factors that will drive solar photovoltaic (PV) adoption at a "furious pace over the next five years and beyond". The falling prices of PV panels, mostly from China but also from the U.S., have coincided with the growing cost of grid power in India. Government support and ample solar resources have also helped to increase solar adoption, but perhaps the biggest factor has been need. India, "as a growing economy with a surging middle class, is now facing a severe electricity deficit that often runs between 10% and 13% of daily need".[5] India is planning to install the World's largest Solar Power Plant with 4,000 MW Capacity near Sāmbhar Lake in Rajasthan.[5]

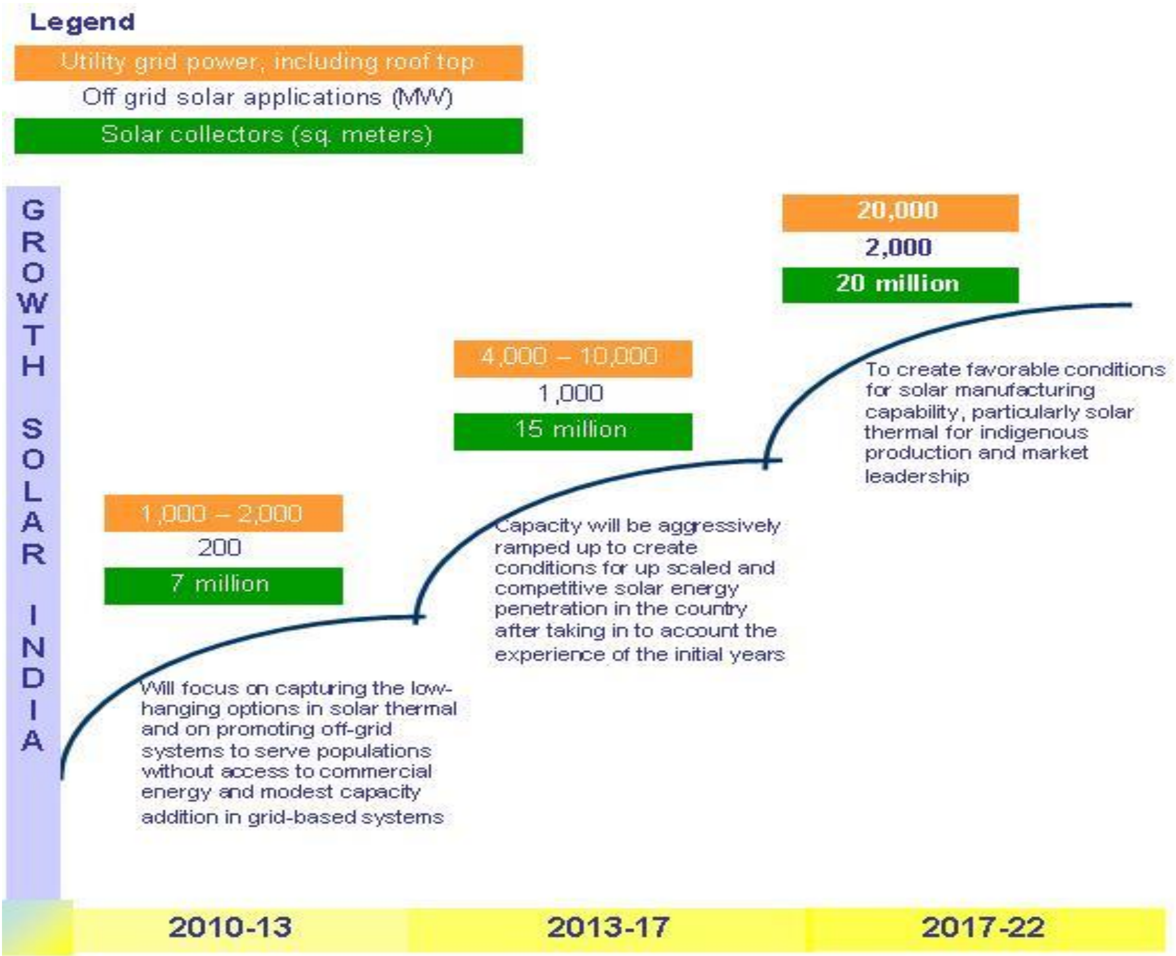

Fig. 5.National Solar Mission in India

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D] Biomass Power: -Biomass is biological material derived from living, or recently living organisms. It most often refers to plants or plant-derived materials which are specifically called lignocellulose biomass. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Conversion of biomass to biofuel can be achieved by different methods which are broadly classified into: thermal, chemical, and biochemical methods.

Wood remains the largest biomass energy source today; examples include forest residues (such as dead trees, branches and tree stumps), yard clippings, wood chips and even municipal solid waste. In the second sense, biomass includes plant or animal matter that can be converted into fibers or other industrial chemicals, including biofuels. Industrial biomass can be grown from numerous types of plants. Plant energy is produced by crops specifically grown for use as fuel that offer high biomass output per hectare with low input energy. Some examples of these plants are wheat, which typically yield 7.5–8 tons (tones?) of grain per hectare, and straw, which typically yield 3.5–5 tons (tones?) per hectare in the UK. The grain can be used for liquid transportation fuels while the straw can be burned to produce heat or electricity. Plant biomass can also be degraded from cellulose to glucose through a series of chemical treatments, and the resulting sugar can then be used as a first generation biofuel. Biomass can be converted to other usable forms of energy like methane gas or transportation fuels like ethanol and biodiesel. Rotting garbage, and agricultural and human waste, all release methane gas—also called "landfill gas" or "biogas." Crops, such as corn and sugar cane, can be fermented to produce the transportation fuel, ethanol. Biodiesel, another transportation fuel, can be produced from left-over food products like vegetable oils and animal fats. Also, biomass to liquids (BTLs) and cellulosic ethanol are still under research. There is a great deal of research involving algal, or algae-derived, biomass due to the fact that it's a non-food resource and can be produced at rates 5 to 10 times those of other types of land-based agriculture, such as corn and soy.

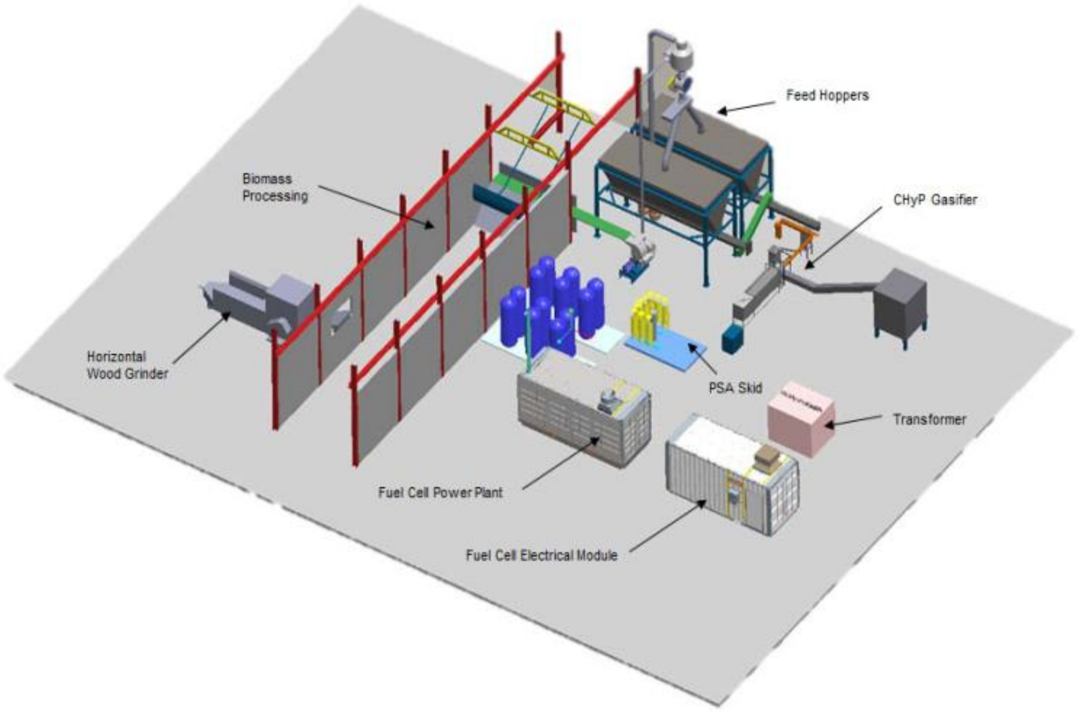

Fig. 6.Sample biomass-to-fuel-cell system layout

E] Geothermal Power: -Geothermal energy is from thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. Earth's geothermal energy originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%).The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface. The adjective geothermal originates from the Greek roots geo, meaning earth, and thermos, meaning heat. The heat that is used for geothermal energy can be from deep within the Earth, all the way down to Earth's core – 4,000 miles (6,400 km) down. At the core, temperatures may reach over 9,000 °F (5,000 °C). Heat conducts from the core to surrounding rock. Extremely high temperature and pressure cause some rock to melt, which is commonly known as magma. Magma convicts upward since it is lighter than the solid rock. This magma then heats rock and water in the crust, sometimes up to 700 °F (371 °C).

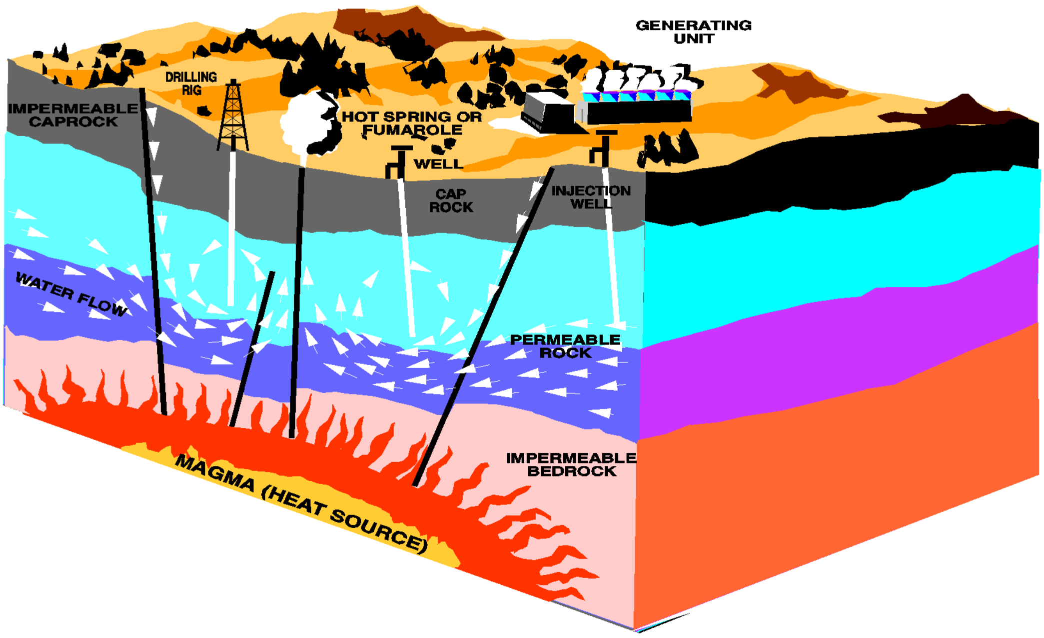

Fig. 8.Geothermal power technology

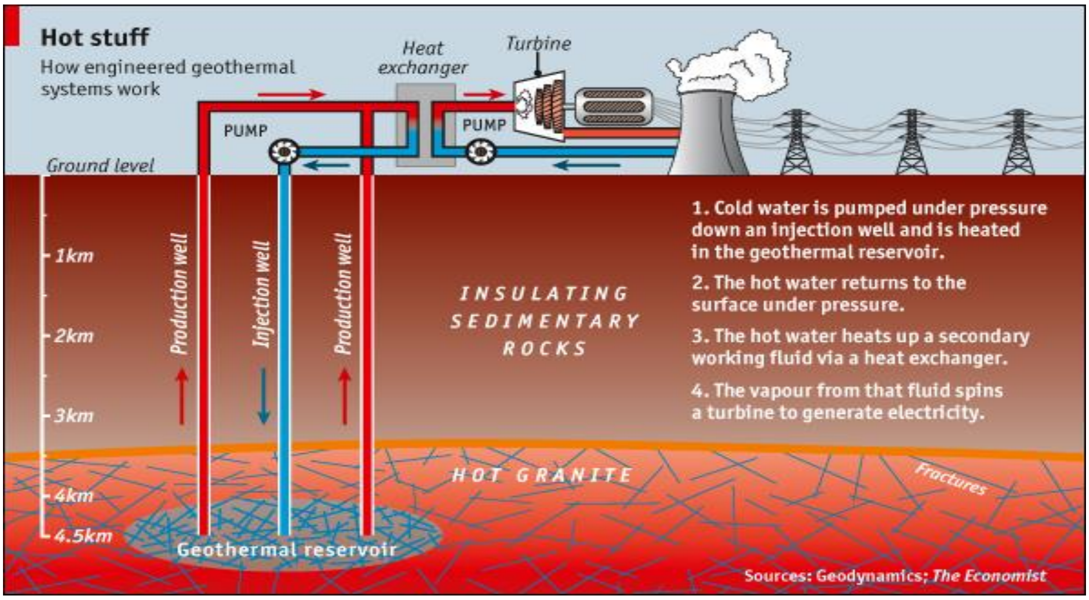

Fig. 9.Geodynamics Technology Layout

E] Tidal Power: -There is a net flux of potential and kinetic energy from the deep oceans, where tide-raising forces are significant, to the shallow shelf seas where direct

Gravitational forcing is a small effect [8]. The energy propagates in the form of very long waves, influenced by the rotation of the Earth. The rate of dissipation of tidal energy in the Earth's shelf seas is on average about 2.5 TW (out of a total dissipation of 3.5 TW) [8].This is less than originally thought, as previous estimates failed to take into account dissipation due to internal waves in the deep ocean [9–11]. At the edge of a continental shelf, some of the incident tidal

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energy is reflected back into the deep ocean and the remainder is transmitted onto the shelf, where the energy is – with the exception of a handful of tidal barrage schemes [6]–dissipated in turbulence. When a continental shelf is close to resonance, the amplitude of the reflected wave at the shelf edge is reduced and the transmitted wave onto the shelf increased in amplitude; the extent to which an area of shelf can resonantly absorb energy is governed by its geometry and frictional damping [7]

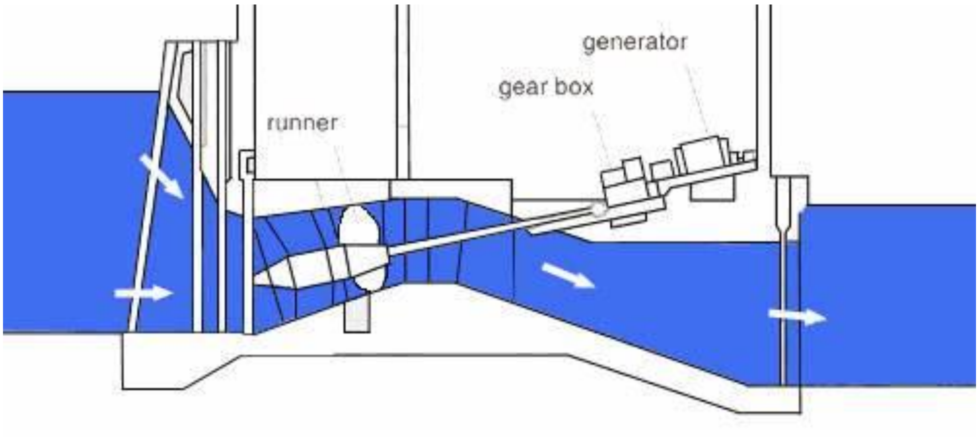

Fig. 10.Working of tidal turbine

Utilizing Electric Energy from Tidal Power Plants:-

A serious issue that must be addressed is how and where to use the electric power generated by extracting energy from the tides. Tides are cyclical by their nature, and the corresponding power output of a tidal power plant does not always coincide with the peak of human activity. In countries with a well-developed power industry, tidal power plants can be a part of the general power distribution system. However, power from a tidal plant would then have to be transmitted a long distance because locations of high tides are usually far away from industrial and urban centers.

Fig. 11.Positions of tidal generating plants

III. CONCLUSION

This research has established that key aspects of the use of various energy sources. As we can see there are number of different alternative energy sources that are more than capable to replace currently dominant fossil fuels, of course given enough money for their further development. The main advantage of these alternative energy sources is that they are ecologically acceptable energy sources that unlike fossil fuels do not release large quantities of CO_2 and other harmful greenhouse gases into the atmosphere, causing global warming and climate change.

This is really the advantage that should mean faster development of different alternative energy technologies because world will otherwise lose the battle against climate change. Even politics has become aware of this fact, and world looks ready to embrace new rules that should reduce current emission levels. In order to succeed in this world will need to stop relying on fossil fuels to satisfy its energy demand, and will have to focus on alternative energy sources, especially renewable energy sources, and make them more effective.

Science will have to play its part in this whole story, and make sure that these sources become competitive to currently dominant fossil fuels because many people still despite the environmental disaster that threatens us, are not ready to pay for energy more than they are currently paying. This is where science should drop in and offer solution through different technologies that should transform renewable energy sources into highly competitive energy sources.

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BIOGRAPHIES

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