EXPLORING ALTERNATIVE ENERGY TO MEET ENERGY CRISIS OF BANGLADESH

Commander M Mahbubur Rahman, (L). psc, BN

Department of Electrical, Electronic and Communication Engineering, Military Institute of Science and Technology, Dhaka-1216, Bangladesh, mahbub549 @ yahoo.com

ABSTRACT

The explosive growth of worldwide energy demand has made it painfully clear that our traditional sources of electricity can no longer be expanded without creating a major environmental tragedy. Coal burning during the industrial revolution created localized disasters but the massive scale today is creating disaster on a global scale. Fuel costs are growing exponentially as the limits of our planet's resources is reached. Oil and natural gas supplies are running short but coal supplies were thought to be plentiful and cheap. The problem is that every ton of coal burned produces 3.7 tons of CO2! The idea of transporting and hiding forever that much CO2 was ludicrous from the start. To make matters worse, coal prices have quadrupled since 2003. Even if we ignore CO2, coal is an environmental nightmare. Mercury emissions make it dangerous to eat many fish today and may be responsible for our epidemic of autism. It will bring an end to the denial of coal's unsolvable problems. Already new laws are being considered to ban coal outright. But what is the alternative? Solar power works mainly during midday and wind power can stop almost completely from late night through morning. Weather conditions can completely disable both wind and solar. Geothermal power uses no fuel, produces no pollution and works reliably and steadily all day and every day. To choose the best alternatives for power solution, resource, capability, economic condition, geographic location, politics demand, growth rate, environmental factors etc are very vital. These factor are the prime consideration for power modeling.

Keywords - *Photophysical energy, Fossil fuels, Pyrolysis, Minihydro, Windmill, Photovoltaics, OTEC, Geothermal energy etc*.

INTRODUCTION:

1. Modern lifestyles demand a steady, reliable supply of energy: it lies at the heart of our mobility, our prosperity and our daily comfort. But we should not take this energy security for granted. Energy sources can be divided into three broad categories. The first
derives from chemical or photophysical energy
that relies on oxidizing some reduced substance, usually a hydrocarbon, or absorbing sunlight to generate either heat or electricity. The energy involved is that of a chemical bond or fractions of an electron volt (eV).

The second involves nuclear reactions that release energy either by splitting heavy nuclei or by fusing light nuclei. The energy involved in nuclear reactions is in the region of 106 electron volts (MeV) per nuclear reaction.

The third is thermomechanical in the form of wind, water, or geological sources of steam or hot water. The energy involved is in the milli-electron-volt (meV) region from, for example, water falling several tens of metres each energy source has some undesirable characteristics. Any process using fossil fuels produces carbon dioxide, and perhaps also other contaminants, such as nitrogen oxides, sulphur oxides and ash. Nuclear plants produce radioactive fission products. Hydroelectric plants require dams and large lakes. Solar energy and wind energy require large areas and are limited geographically. Geothermal sources are limited to very few locations. Schemes using small temperature gradients in the earth or oceans have low thermal efficiencies, and hence require very large heat-exchanger areas. At present most of the world’s energy supply comes from fossil and nuclear sources. And although mankind is increasingly having to face the issues of resource limitation and environmental pollution, these sources will continue to be important in providing energy worldwide for the next few generations.

ALTERNATIVE ENERGY CONSIDERATIONS

2. Power crisis in the world has compelled mankind to think for alternative energy. But all the alternative sources have not yet been exploited. From many ongoing researches, it reveals that if all the alternative energy sources are exploited, the energy crisis of the world would be reduced to a great

extent. Many alternative energy technologies today are well developed and they are reliable and cost competitive with the conventional fuel generators. There are many alternative sources of energy such as biomass, wind, solar, minihydro and tidal power. The most important advantage offered by alternative energy sources is their potential to provide sustainable electricity in areas not served by the conventional power grid. Most of the alternative energy technologies produce DC power, and hence power electronics and control equipment are required to convert the DC power into AC power.

Fossil fuels or mineral fuels are fossil source fuels, that is, hydrocarbons found within the top layer of the Earth's crust. There are three major forms of fossil fuels: coal, oil and natural gas. All three were formed many hundreds of millions of years ago before the time of the dinosaurs - hence the name fossil fuels.

They range from volatile materials with low carbon:hydrogen ratios like methane, to liquid petroleum to nonvolatile materials composed of almost pure carbon, like anthracite coal. Fossil fuels currently supply most of the world's energy needs, and however unacceptable their long-term consequences, the supplies are likely to remain adequate for the next few generations. Scientists and policy makers must make use of this period of grace to assess alternative sources of energy and determine what is scientifically possible, environmentally acceptable and technically promising.

SAVING FOSSIL FUELS

3. Fossil fuels take millions of years to make. We are using up the fuels that were made more than 300 million years ago before the time of the dinosaurs. So, it's best to not waste fossil fuels. They are not renewable; they can't really be made again. We can save fossil fuels by conserving energy. Once we've burned them all, there isn't any more, and our consumption of fossil fuels has nearly doubled every 20 years since 1900.

SEA POWER

4. The Earth is covered mainly by water. The seas as we call them have currents and tides that circulate round the world. This vast amount of moving water produces immense

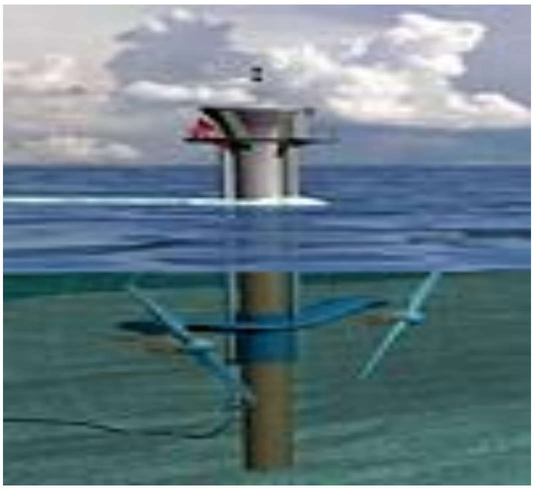

Fig 1: Sea Generator set

amount of energy. Countries like Britain that are surrounded by powerful seas and oceans are ideally placed to convert the energy of tides, sea currents and waves to produce electrical energy. Tidal power utilization is also considered to be a very reliable source of energy due to its predictability. Compared to other sources of energy such as wind or solar energy, tidal changes are easier to predict. They're also sure to occur consistently. Unlike solar or wind energy, tidal power does not depend on the season or the weather type. Instead, tidal energy relies purely on the orbital kinetic energy that the sun exerts as the earth orbits around it. The same goes with the moon and earth orbital system. As the moon orbits around the earth, a gravitational force is experienced by both bodies.

The incoming and outgoing tides of the sea can be harnessed to produce electrical power. Tides are often very powerful and the sea can move very quickly when the tide is coming into land. When the tide approaches toward land the amount of water rushing forwards can be measured in terms of millions of gallons. This is an immense force of moving water.

TIDAL ENERGY

5. The gravitational energy produces tidal that range from 25 to 30 ft in many places in the world. Potential energy in water increases as height is increased. More energy is stored by an object as it goes

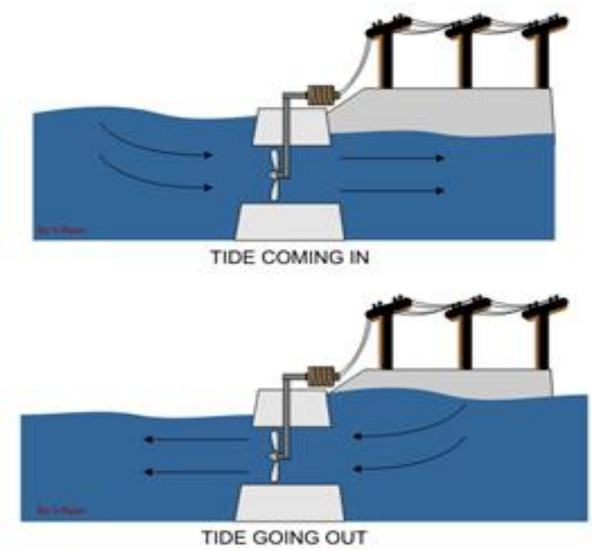

Fig 2: Utilizing tidal energy

higher and higher. This potential energy could then be released and then converted into electricity through the use of proper devices and modern technology. Tidal energy would be most effective and economical to produce, therefore, if water levels between tides are significant. Water could be trapped or held within specially made structures during high tide. A water containment reservoir called a tidal lagoon is constructed. The lagoon is filled with water as the tide goes up the reservoir.

As the tide shifts from high to low, there exists a difference in pressure between the water in the higher containment structure and that in the open water source. This will form a head pressure (also known as hydrostatic pressure) on the containment structure. The difference in water levels between the open water source and of the contained water will result to potential energy which could be utilized when the contained water is released. This tidal electricity generation works as the tide comes in and again when it goes out. The turbines are driven by the power of the sea in both direction.

When the natural body of water (water outside the containment) reaches a very low level due to the low tide, the water within the reservoir is released using specially made outlets that are usually equipped with turbines. The force of the rushing water would spin the turbines which would in turn power generators that would produce electricity. There are three tidal electric systems have been constructed in the world. A 20-MW_e system at Kislaya Guba in Russia, a 20-MW_e system at Nova Scotia in Canada and a 240-MW_e tidal systyem in France. A diagram of 10-MW_e reversible hydraulic turbine tidal system is shown in the following figure:

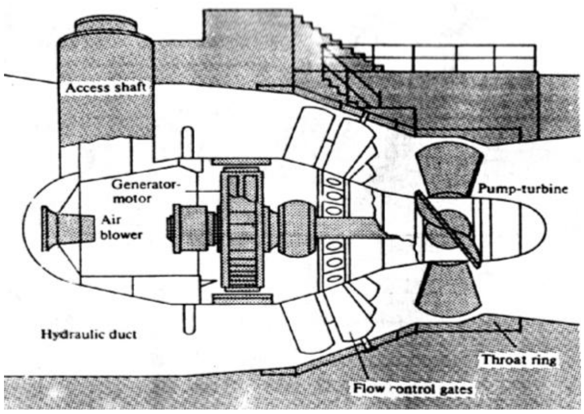

Fig 3: Reversible Hydo -Turbine Power Plant

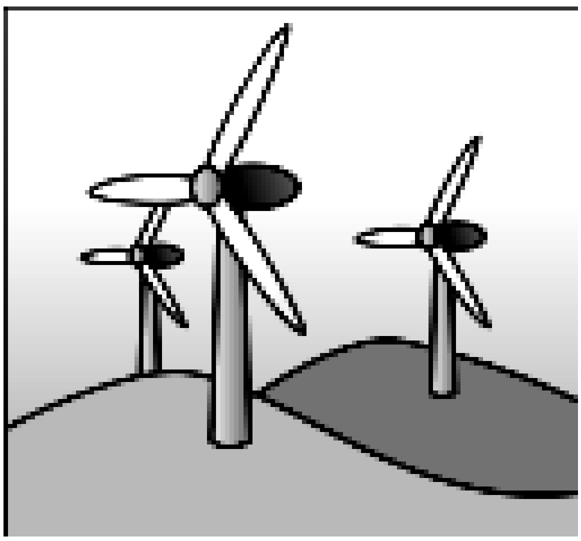

Fig 4: Wind Turbine

BIO OIL

6. BioOil is an alternative fuel made using Dynamotive’s pyrolysis process of biomass. It is a dark brown, free flowing liquid fuel with a smoky odour reminiscent of the plant from which it was derived. BioOil is formed in a process called

pyrolysis wherein plant material (biomass), such as sawdust or bagasse from sugar cane, is exposed to 400-500 degrees Celsius in an oxygen free environment. BioOil contains up to 25% water. The water component in BioOil is not a separate phase and is important because it lowers the viscosity of the fuel. BioOil is not a hydrocarbon-water mix like Orimulsion. Another feature of BioOil is its propensity to change slowly over time. This is not to be considered an instability because it can take months.

BioOil is a fossil fuel substitute. It pumps well, ignites, and burns readily when atomized. Recently, Bio Development Company, Bangladesh has proposed to produce bio fuel from a locally available plant (named Jatropa) at cheaper cost. Certainly it is encouraging and needs patronizing from the Government for further research and development.

WINDMILL

7. Wind power can be an excellent complement to a solar power system. Here in Colorado, when the sun isn't shining, the wind is usually blowing. Wind power is especially helpful here in the winter to capture both the ferocious and gentle mountain winds during the times of least sunlight and highest power use. In most locations (including here) wind is not suitable as the ONLY source of power--it simply fills in the gaps left by solar power quite nicely. A windmill is a machine that is powered by the energy of the wind. It is designed to convert the energy of the wind into more useful forms using rotating blades or sails. The term also refers to the structure it is commonly built on.

A wind turbine is a rotating machine which enables the conversion of kinetic energy in wind into mechanical energy. If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is usually called a windmill.

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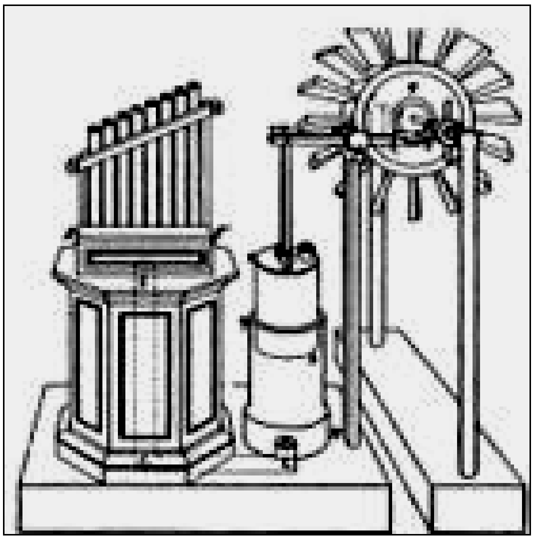
(a)



(b)

Fig 5: Wind power setup to produce electricity

If the mechanical energy is then converted to electricity, the machine is called a wind generator, wind turbine, wind power unit (WPU) or wind energy converter WEC).

SOLAR ENERGY

8. Solar energy is energy from the Sun in the form of radiated heat and light. It drives the climate and weather and supports life on Earth. Solar energy technologies make controlled use of this energy resource.

Solar power is a synonym of solar energy or refers specifically to the conversion of sunlight into electricity by photovoltaics, concentrating solar thermal devices or various experimental technologies. The solar cells that you see on calculators and satellites are photovoltaic cells or modules (modules are simply a group of cells electrically connected and packaged in one frame). Photovoltaics, as the word implies (photo = light, voltaic = electricity), convert sunlight directly into electricity. Once used almost exclusively in space, photovoltaics are used more and more in less exotic ways. They could even power your house. How do these devices work?

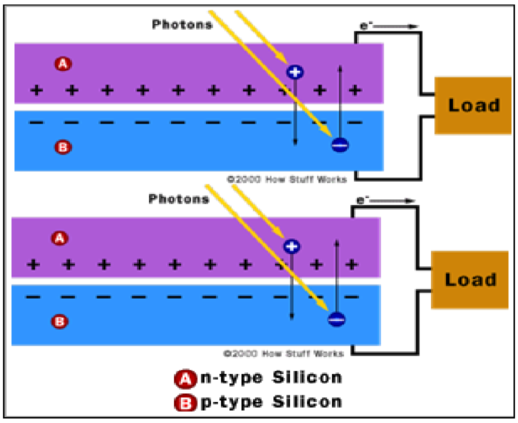


Fig 6: Photovoltaic Cells: Photons to Electrons

Photovoltaic (PV) cells are made of special materials called semiconductors such as silicon, which is currently the most commonly used. Basically, when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. This means that the energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely. PV cells also all have one or more electric fields that act to force electrons freed by light absorption to flow in a certain direction. This flow of electrons is a current, and by placing metal contacts on the top and bottom of the PV cell, we can draw that current off to use externally. For example, the current can power a calculator. This current, together with the cell's voltage (which is a result of its built-in electric field or fields), defines the power (or wattage) that the solar cell can produce. concentrating solar thermal devices or various experimental technologies.

That's the basic process, but there's really much more to it. Let's take a deeper look into one example of a PV cell: the single-crystal silicon cell.

OCEAN THERMAL ENERGY CONVERSION (OTEC)

9. The utilization of temperatures gradients in ocean by some sort of system called OTEC is now-a-days an advance technology used in developed countries to

meet the growing demand of electricity all over the world. In recent years, it is well discussed and studied for further development. The first operational OTEC was a 40 KW_e power plant built in Cuba in 1926. This system uses the worm surface waters of the ocean to boil a working fluid in a Rankin cycle power plant and then uses the cooler deep water to condense the vapor leaving turbine.

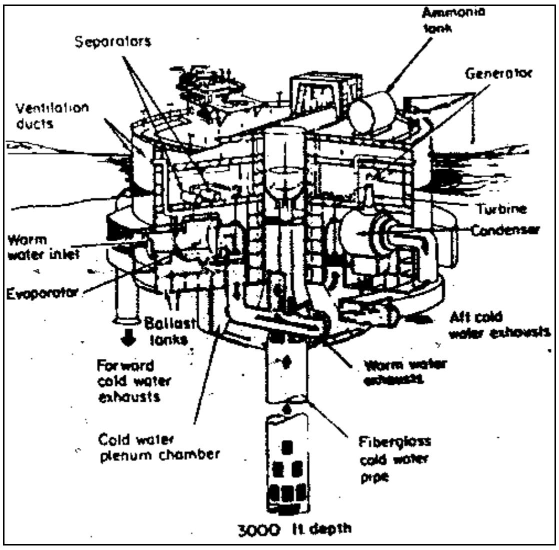


Fig 7: Diagram of OTEC plant

GEOTHERMAL ENERGY

10. The final major source of fuel energy available to the human race is geothermal energy. This is thermal energy trapped beneath and within the solid crust of the earth. This energy exists in the form of steam, hot water, and/or hot and molten rock. It is released naturally as geysers, hot springs, and volcanic eruptions. Geothermal energy comes from two sources. It includes the primordial thermal energy which was present when the earth was formed as well as the thermal energy produced from the decay of heavy radioisotopes.

There are tremendous reserves of thermal energy trapped beneath the earth's crust. However, to date, it has not been possible to drill through the earth's crust despite several attempts. In 1904, the first successful geothermal steam drilling was carried out at Larderello, Italy. The present electrical capacity of that plant is around 400-MW_e. There are a number of geothermal plants existing around the world including USA, Mexico, Iceland, New Zealand, Japan and Russia. All these are located on or near major geological faults. A schematic diagram of a typical geothermal power plant is shown below:

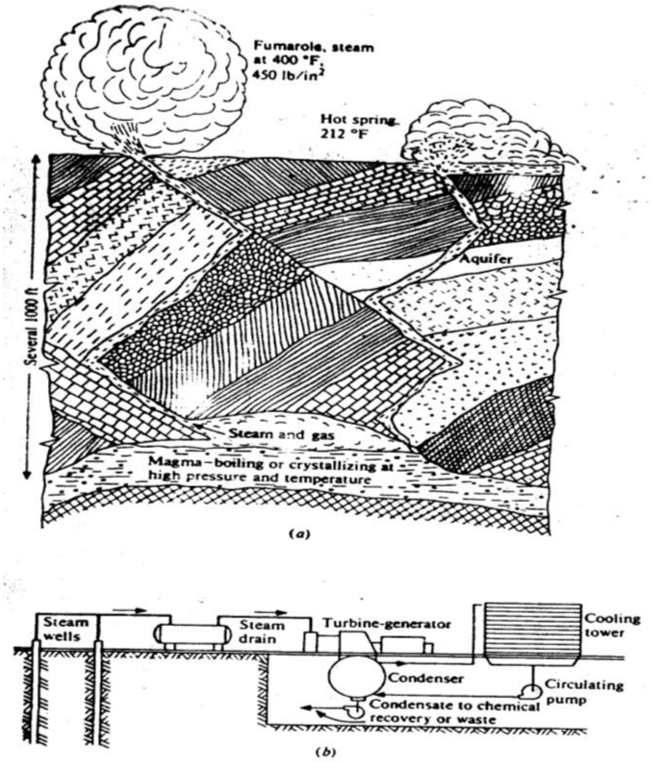


Fig 8: Schematic diagram of a geothermal power system:

(a) Schematic diagram of a typical geothermal deposit.

(b) Schematic diagram of a typical geothermal plant.

NUCLEAR ENERGY: ENERGY FROM ATOMS

11. Nuclear Energy is energy due to the splitting (fission) or merging together (fusion) of the nuclei of atom(s). The conversion of nuclear mass to energy is consistent with the mass-energy equivalence formula $\Delta E = \Delta m.c^2$, in which ΔE = energy release, Δm = mass defect, and c = the speed of light in a vacuum (a physical constant).

Nuclear energy is released by three exoenergetic (or exothermic) processes:

Nuclear energy can be used to make electricity. But first the energy must be released. It can be released from atoms in two ways: nuclear fusion and nuclear fission. In nuclear fusion, energy is released when atoms are combined or fused together to form a larger atom. This is how the sun produces energy. In nuclear fission, atoms are split apart to form smaller atoms, releasing energy. Nuclear power plants use nuclear fission to produce electricity.

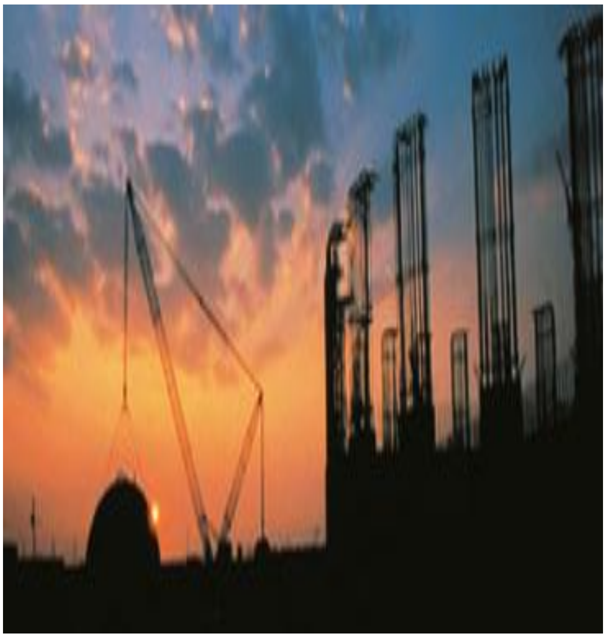
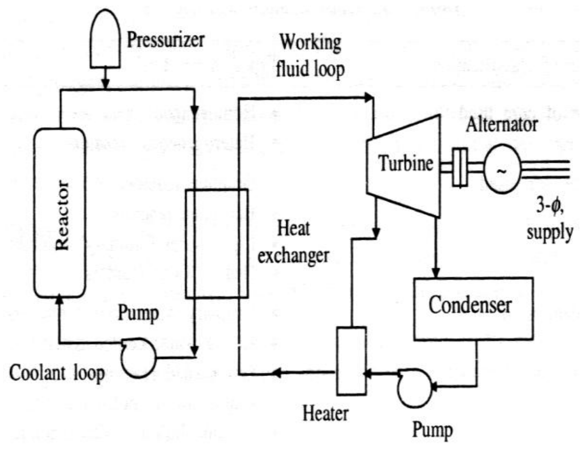


Fig 9: Typical Nuclear Power Plant

After years of stagnation, many countries have announced plans to build new nuclear power plants. More than 30 reactors are under construction. Demand is also growing in Asia. Facing energy shortages, China and India are building several reactors, and intend to increase their nuclear capacity several times over in the next 15 years. The power unleashed by nuclear fission has no equal on Earth, but the world's 439 nuclear reactors only produce around 6 percent of the world's energy and between 12 and 15 percent of its electricity. This small number has less to do with limited resources, technological problems, or geopolitical constraints, than the low cost of fuel alternatives like gas and widespread fears over the safety of nuclear power plants.

Many poor countries, on the other hand, simply have no access to nuclear power, because of the high costs of building a nuclear power plant, the complicated technology involved, or political restrains on nuclear material that can be used both for a power plant and nuclear weapons.

During nuclear fission, a small particle called a neutron hits the uranium atom and splits it, releasing a great amount of energy as heat and radiation. More neutrons are also released. These neutrons go on to bombard other uranium atoms, and the process repeats itself over and over again. This is called a chain reaction.



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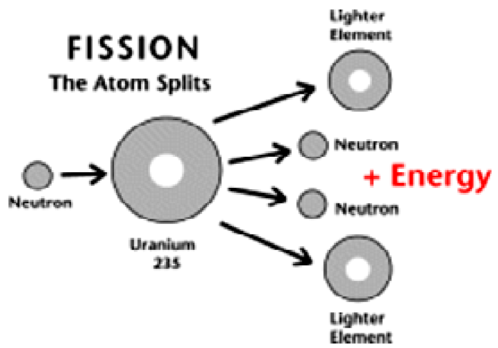

(b)

Fig 10 : (a) Schematic of a Nuclear Power Plant (Pressurized Water Reactor)
(b) Fission Process

ELECTRICITY FROM COAL

12. Electricity from coal is the electric power made from the energy stored in coal. Carbon, made from ancient plant material, gives coal most of its energy. This energy is released when coal is burned. Coal is a fuel that is found in the ground. It is made of the remains of plants that died millions of years ago. Soil piled up on top of the remains and that weight compacted it into a more dense material, called coal. The energy in the coal came from the sun and was stored in the plants. When the coal is burned, it gives up that energy as heat. The coal's heat energy can then be turned into electrical energy. This happens at a power plant.

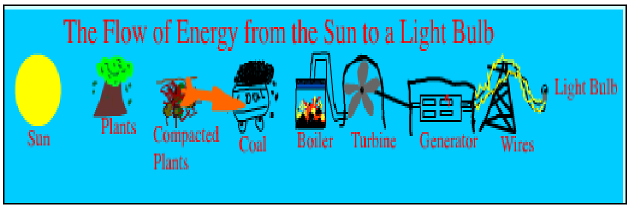

Fig 11: Energy Cycle for Coal to produce Electricity

RELEASING COAL'S ENERGY

13. The process of converting coal into electricity has multiple steps and is similar to the process used to convert oil and natural gas into electricity:

a. A machine called a pulverizer grinds the coal into a fine powder.
b. The coal powder mixes with hot air, which helps the coal burn more efficiently, and the mixture moves to the furnace.
c. The burning coal heats water in a boiler, creating steam.
d. Steam released from the boiler powers an engine called a turbine, transforming heat energy from burning coal into mechanical energy that spins the turbine engine.
e. The spinning turbine is used to power a generator, a machine that turns

mechanical energy into electric energy. This happens when magnets inside a copper coil in the generator spin.

Fig 12: Typical Coal Power Plant

f. A condenser cools the steam moving through the turbine. As the steam is condensed, it turns back into water.
g. The water returns to the boiler, and the cycle begins again

POWER MODEL OF BANGLADESH

14. Keeping the present requirement of the country into purview, a power model for the year 2014 is proposed in the following figure: (In 2014, the total power requirement is taken to be 6000MW (approx).

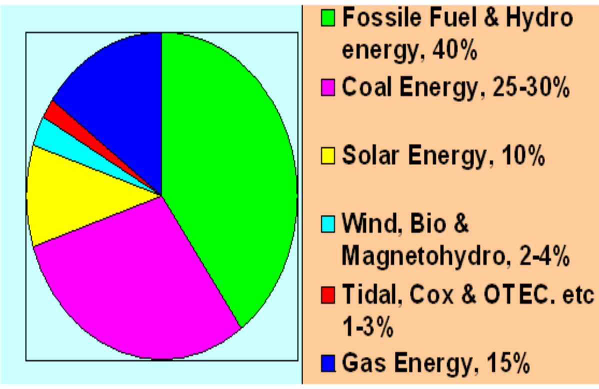

Fig 13: Power Model of Bangladesh in 2014 (proposed)

ANALYSIS OF THE POWER MODEL

15. The power model is analyzed in the following:

a. The price hike of fossil fuel has stopped all prospects of fossil fuel generators all over the world. So, existing generators may be continued for its maximum service but any future planning should avoid the consideration of such plant. Analysis shows that current installations including the ones in the pipeline to be established soon, may meet the demand of approximately 40% in the year 2014.

b. The Nuclear Plant is yet to be established; the proposed site is in Ruppur. If it is possible to install such plant the energy crisis could be minimised to a great extent. But fuel for the plant is a prime consideration. The present world's political scenario dictates that for such nuclear plant we are too ambitious.

d. The reserve coal of our coal mines are very sufficient to install 3-4 coal power stations in addition to the exixsting ones, if the it is possible to collect the coal in proper manner. A study shows that within next 5-6 years it is possible to share 25-30% load of the total demand on the year 2014.

c. Solar power in an intermediate solution of the power crisis. It can adequately serve the purpose of rural and remote areas. But this sector is to be patronized by the government to reduce the price of the solar panel. The manufacturing organizations may be given incentive and if required, to be subsidized by the government. The local people are to be encouraged to use solar. If so happens, it may take the load upto 10%.

d. Other alternative source is to be encouraged equally. Research may continue to establish windmill, production of Bio Fuel, Picohydo/Magnatohydro plants, even Geothermal plant wherever geographically suitable may be setup to reduce the load on national grid. With our current situation it is possible to produce 3-5% power from these plants.

e. The height of tide in the Karnaphully river (also in some other rivers of Coastal area) varies between 12-18 ft during high tide and low tide. This height of water may be trapped in some basin individually or collectively to produce electric power. There are some countries in the world like Cuba, Canada, Russia etc. which produce significant amount of power from same system. 1-2% load can be meet up by tidal/cox's power.

RECOMMENDATIONS

16. The recommendations from the above analysis are:

a. The power model shown above may be taken as a proposed solution of the existing power crisis.

b. All efforts are to be made to diversify the dependency of common mass to the national grid power, as such alternative source power (like solar power) is to be encouraged and subsidized if required.

c. As the prospect of fossil fuel plant is discouraging, also the alternative power source can not face the bulk/mass demand the also establishment of Nuclear Plant is not feasible in the present world's political scenario, coal power may be explored to the best of our capacity to meet the growing demand.

d. As Solar power is an intermediate solution of the power crisis, efforts may continue to supply solar panel in a cheap and easy way to the common mass.

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