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RENEWABLE ENERGY RESOURCES IN PAKISTAN-STATUS, POTENTIAL AND INFORMATION SYSTEMS

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ABSTRACT: This paper provides some details regarding the haracteristic properti s ; potential and assessment of renewable energy compar g with other forms of energy sources and the status of r newable energy sources in Pakistan. The last part o the paper is about the agencies providing technic information regarding renewable energy in Pakist ; and the suggestions and recommendations for the de lopment of these resources in the country. The discu ion presented has dual objectives: Firstly to ov -view the present status of renewable energy sources and secondly to explore and present some suggestio for its development in the country.

INTRODUCTION: The first part of the paper deals with the presentation of characteristic properties of Renewable Energy Sources and the techniques for resource assessment using the important technology of remote sensing. Some examples and application of small projects, set-up at different sites in Pakistan, are also referred to.

1- Resources Assessment. One of the factor in determining of renewable energy technologies for exploitation of energy in a country or region is to assess the available renewable resources. This depends on the data collection for wind, water-flow, forest resources and the most abundant, solar energy. Here, mostly, convention terrestrial observations have been used to perform such resource assessment, however such data lacks accuracy because, in most developing countries, such observations have been intermittent and have not been carried out adequately over distributed geographic areas. The only alternative for a better and accurate means of data collection is remote sensing or by using satellites. The satellites launched by NASA during the eighties and during the recent times provide the resource assessment by highly sophisticated measurement techniques, never been available before this, include the Coastal Zone Colour Scanner (CZCS) and the advanced very high resolution

radio-meters. This satellite data is transformed into useful products such as photos, maps etc. The analysts are then able to extract information about crops, vegetation,minerals water resources, terrain and intensity of solar radiation falling on that particular region.

Using these pieces of informations the planners then executes the resources exploitation programme most effectively and economically. It was very complicated to make use of the traditional scattered statistical information and it is a welcome departure in this regard. The energy policy analysts are now convinced that as for as solar energy is concerned, it should be widely used in Pakistan for water pumping, space heating and for generation of electricity; for domestic as well as, for small to medium size commercial projects.

The main reason for this option results from a comparison of the solar energy available at the earth's surface with the demand of energy. For example, the average winter solar power, incident on an area of 1000 sq.ft. would be 14 KW against a consumption of only 7.5 KW. Hence a 30% efficient collector would be able to provide 80% of the heating requirement of the house.

This comparison of supply and demand extends to electricity where there is the possibility that photo-voltaic cells, may one day be widely used to convert sun-light directly into electricity. These solid state devices, if economically prepared on large scale, will then change the energy scenario presently facing a crisis of shortage. In other words, in all parts of the country, each house-hold unit will be able to generate the energy for itself; in addition to the energy available by the power generating agencies in the country. In this way there will be bulk of surplus energy which will be available for the industrial requirements of the country.

A typical house today consumes electrical energy at the rate of 1 KW which could be supplied by a 10% efficient photo-voltaic array covering about 500 sq.ft. (south facing roof). Presently the main obstacle for immediate adaption of solar energy for domestic use is the high capital cost of cells, Secondly a storage system is required for the period when the sun does not shine. The sun having radius $R=6.96\times10^{5}$Km and Weight $M=2.01\times10^{30}$.0 Kg. is an inexhaustible source of energy. The intensity of solar radiations reaching the earth atmosphere has been determined very accurately by means of space crafts. This energy is known as Solar Constant 'GS'.

It is calculated as 'Gs' = 1355 W/M^2 = 4878 KJ/M^2h. The quantity given by the above equation represents the incident Solar radiation flux on a normal plane. As the earth moves around the sun is a slightly elliptical orbit, and distance between earth and sub varies from 98 3% to 101.75% of the mean distance, so the values of Gs also varies from 1315 W/M^2 to 1405 W/M^2, the average is taken as 1355 E/M^2. This values is determined by the formula $G's = (\frac{h}{R})\sigma T^4$

where $r = 6.96 \times 10^8 M$

Radius of Solar disc $R = 1.501 \times 10^{11} M$

mean distance earth-sun.

and $\sigma = 5.66\ 97 \times 10^{-8}\ W/M^2\ K^4$

(Stephen-Boltzmann constant)

Solar energy in its electromagnetic form is a "raw material" which should be processed to convert into useful form of energy such as heat, electricity etc.

Remoteness Factor K: Remoteness of the site of use implies that the cost of transportation of fuel, spares and other material is higher as is the cost of manpower and so the break-even cost of solar energy is also higher. Hence the higher the value of K the more economical becomes the solar device. The ratio of this cost to the cost of Kwhr at the cheapest point (such as Karachi, Multan) gives the remoteness factor for that place.

Solar Photo Voltaic Batteries.

The key element of the solid state electric system is the photo voltaic convertors, These are also called photo voltaic "Cells". Generally the most common element used in such cells is silicon (Si), available in quartzite sand. Compound solar calls using are copper sulfide (CuS), Gallium Arsenide (Ga. As) and cadmium sulfide (Cds) are also known. These compounds have significant performance in photo voltaic conversion. Silicon, a non-metal obtained from sand (most abundant next to O_2 in the earth's crust), gives the basic component to the semi-conductor device industry.

Fig: Shows: Solar Cell/Battries for direct conversion into electricity.

These cells have high rate of efficiency and are outstandingly stable over a wide range of temperature.

Its dis-advantage is the deep penetration of the longer wave-length photon which requires the silicon layers to be of high crystal perfection and at least 50 microns thick to obtain good "cell" performance. Another dis-advantage is silicon's relatively high chemical reactivity at high temp which needs attention at the manufacturing process stage. Cd-sulphide compound occurs in nature, as well as, it can be prepared by the action of H_2S on solutions of Cd-salts. Currently it is being used, in combination with a very thin layer of copper sulfide, as a solar cell. A number of heat engines (power dish type) placed at the focal points of dishes, are capable to generate as much as 300,000 units per year or of a capacity of 25 K-Watt from a small area of 1000 Sq. Yds. When a Bryton engine is coupled with the system it can produce more than 500 mega watt of electric power. Now it is high time when solar-power plants should be made available specially for the commercial applications conversion of photons to electricity. The major advantage of this combination is the potential for extremely low-cost of these thin film devices. The only dis-advantage is its low-efficiency (about half of si-cells). However silicon cells seem to be ahead by the present production rate. Both silicon and gallium arsenide solar cells,

efficiencies of 16 to 18% have been obtained. Efforts are being made to introduce new compounds to increase the efficiency.

Cost of System. The major problem is high cost, because they are sold only in small quantities and it requires large investment in process technology development till the market has not been fully developed. Hence it will require Government support to make a break through. In a relatively free economic system a new commodity source will not be able to replace the existing one unless it can compete with it in price .

As the "Fuel" for solar energy utilization is free and the maintenance cost is very low the price determining factor for solar electric energy is the capital cost of the system.

Some commercial solar plant (based on small-dish type) are now producing more than 500 mega watt electric in an area of one acre only.

WIND AND WAVE POWER

A very interesting example for low cost space heating is a house with solar collectors providing sufficient heat energy. Solar energy collected by the roof-top collector provides almost all the space heating requirement for a house. It is certain that in future the cost of the photo voltaic cell/batteries

will be reduced. If electricity costs twice as much as it does today, a small investment of approximately Rs. 400/sq. ft. or Rs. 20/Watt should be borne by the house owners for long term electric supply for the unit. At present the cost of solar cells is about Rs. 220/Watt which will be considerably reduced by the technological innovation and by modern production techniques.

At suitable places e.g. in Southern areas of Pakistan the wide belt along the coastal starting from Makran-Karachi coast, and the entire cities of Karachi Hyderabad alongother small towns and villages (where there is acute shortage of electrical energy) the wind and wave power is available for exploitation into useful form of energy.

WIND POWER: The energy associated with wind can be concentrated by a number of devices to yield energy. At a suitable place such as transmission towers, streched through out the country, about 100 ft above the ground, the velocity is measured at 20-25 miles/hours. This velocity is capable to generate 45 watt/sq.ft. This high quality mechanical energy is capable enough to rotate a wind mills and convert into electricity (1/3 of the instant energy on the area by the propeller). Hence this system gives 60% efficiency in terms of energy

conversion. The interesting characteristic of wind is that the power developed, increases as the cube of the wind velocity so that the power available at 25 mph is about double than that available at 20 mph which means that the energy power developed by the wind mills is greater than the power produced from a wind of average speed. This is the reason that in a number of countries an entire profile of wind mills have been set up long ago which provided huge amout of mechanical energy. This system gave remarkable energy for the development for these countries. We as tourists take them as symbol and as fancy or novelty, such as the wind mills of Holland, Denmark etc. Many countries are taking a keen interest in the development of wind power over the last few decades, particularly for power production in remote areas, which cannot be supplied from the main electrical networks at reasonable costs. For this purpose, they have undertaken wind surveys in different countries e.g. France, Germany, Britian, Ireland, Spain, Denmark, Somaliland, Egypt, India, South Australia, U.S A., Canada, Canary Isles, Tobago, Uruguay and USSR. A wind speed of 5 to 10 miles per hour is also considered to be suitable.

The wind produced energy, it it is electricity, can be fed into the local or sub-network directly, without any storage of energy being needed, and resulting in fuel saving.

In Denmark, a 200 KW wind-driven generator has been running successfully, connected to the a.c. network for several years. Two machines one of 25 KW and the other 100 KW, are operating in the Isle of Mann. These have shown considerable promise of solving the problem, by economic wind-power generation. In Germany and in France, wind-driven machines of 100 KW, 130 KW and 640 KW have been installed which are very successful.

WAVE POWER. At our coastal belt due to high wind velocity of Arabian Sea in the direction of almost SSE to WWS, the sea develops waves about 5' high. These waves carry an average power of 5000 Watt/linear ft. The wave power is high quality mechanical power. Now it is our duty to use wind and wave energy to harness the potential of these waves by suitable methods.

SCOPE OF HYDRO-POWER IN PAKISTAN.

By the historical decision about distribution of water between provinces a complicated national issue pending for a long time has been concluded. It

is not clear that each provice will move forward to exploit/use the opportunities of the hydro-power by development of small dams and a sound planning will be rade. Recently NWFP, Sind, Baluchistan andPunjab Governments have announced that a number of small dams/projects are being taken up to utilise the hydro-power to generate electricity for the rapid development of rural areas of these provinces. The Kalabagh Dam when completed, will also provide a huge amount of hydro-electric power for the country.

Status of Technical Information regarding Renewable Energy in Pakistan.

Some years ago the Ministry of Science and Technology was created to look after the science and technology affairs and its development. This Ministry is responsible for looking after the activities of science and technology in the country. This Ministry is providing information on a number of scientific issues including renewable energy.

There are other agencies which are contributing towards the R&D for renewable energy as well as providing information in this field by publishing their news, journals and magzines. Some of the important organisations are:

1- Pakistan Council for Scientific&Industrial Research.

2- National Institute of Silicon Technology.

3- Pakistan Academy of Sciences, Islamabad

4- Pakistan Science Foundation.

5- Pakistan Scientific Technology Information Centre.

6- Pakistan Council of Appropriate Technology, Islamabad.

7- National Institute of Electronics.

8- National Centre for Technology Transfer.

9- Institute of Oceanography, Karachi.

In addition to the above organisations the scientific society of Pakistan is planning an important role by means of publications as well as by arranging seminars and annual science conferences at different Universities of the country.

Having all these institutions it is regretful to observe that there is no integration and there is a need of a collective source which can be consulted with authenticity and accuracy to provide all the required information/news in respect of renewable energy for all those who are doing research and developments in this field.

1- It is suggested that Ministry of Science and Technology should take this responsibility to collect all the information from national and international agencies to provide it in the form of a monthly publication available to every one interested in this field.

2- Different types of data/maps such as readiation should be available for different months in the country, coal and hydro-power available at different sites. Wind power and its intensity in different areas of the country, Wave power and its intensity along with coastal areas etc.

3- It is also ted that in each province a science meusium/science centre may be established where all the demonstrations/informations are made public. The general public, students and the scholars working in this field will be benefitted by these centres.

4- A central data base may be establish where all the information are recorded stored and updated to use for different applications.

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