Solar Photovoltaic System Answer to Energy Crisis

by Md Nazrul Islam

SINCE the early 1970's it has been recognised that energy is a factor central to the well-being of both the developed and developing world. The dramatic rises in the price of oil over the past decade or so, as well as the finite nature of the supplies of the main fossil fuels on which we rely, namely oil, gas and coal, have been a growing concern. It appears that we will exhaust these valuable resources produced by nature, in a few scores of years in the case of oil and in a few hundred years in the case of coal. Our country has a limited reserve of commercial energy. Per-capita energy consumption is one of the lowest in the world, which is about one tenth of Asian average and one thirtieth of world average. For socio-economic development of the country, supply of commercial energy has to be increased substantially. It is therefore an imperative to search for more efficient ways of using existing energy sources and developing new ones including nuclear-fusion, solar, wave, tidal and wind energy etc.

The search for an alternative source of energy in sun and the recent development on it is not at all a philosophical quest. The need arose in the industrialised countries as an alternative source of energy. To be more accurate, the sun is not only a source of energy but a requisite for life. Not only the industrialised and developed countries but many developing countries like Bangladesh have specially advantageous positions to develop and benefit from the technologies utilizing solar sources. Climatic factors and geographical location of our country can play a key role for using solar photovoltaic technology in solving its energy crisis. This will, in turn, have a positive impact to the development of the country.

Renewable and decentralised energy system appears especially suitable for Bangladesh not only because of abundant renewable resources but also because of high cost of grid extension to remote and widely scattered low-load demand areas. The centralised grid system is favoured in the case of multipurpose uses of electricity and need for round-the-clock service while decentralised generation is favoured in the case of single-end uses and the need for electricity at certain times or seasons. In economic terms renewable energy sources like photovoltaic systems are cost-competitive in comparison with centralised grid extension for rural areas. The ambitious rural electrification programme in Bangladesh is already under strain because of the inadequate supply of power from the national grid. Introducing the renewable energy sources like photovoltaic and others can greatly ease this problem arising from short supply; otherwise, rural distribution network could be fed from the national grid mostly at off-peak periods thus depriving the rural consumers from the full benefits.

In a country like Bangladesh power is required at remote places not covered by traditional electricity grid. For instance, it would be abnormally expensive (and at times almost physically impossible) to extend the electricity through grid to the scattered coastal belt and the hilly regions. The concept of stand-alone PV solar systems will be a right approach towards rural electrification in Bangladesh.

The electrification based on power plants and main grid distribution is not a solution for rural areas, since the high operational cost and the relatively low power demand would make it too expensive. Similarly, infrastructural programmes like telecommunications or railways, often require power facilities in far-flung areas for which diesel generators are neither adequate nor practical. In such situations, solar power systems may provide the ideal solution. The modularity of these systems and the availability of sunlight, allow their use in remote areas, obviating the need for expensive cabling and power grids. Solar power systems can be designed as small as budget permits and can be installed within a very short time frame. Developing country like Bangladesh can provide power to rural households and remote industrial sites without depending on large investment required for central power projects with long gestation periods.

A significant portion of Bangladesh is low-lying land. Devastating floods occur in the country submerging two-thirds of the land, to cause loss of life and properties. Besides, the mass use of trees as a cooking fuel is a great cause of deforestation having an adverse effect on the environment. Installation of decentralised PV system could contribute to prevention of floods. Other programmes like rural health care, primary and mass education, relief and rehabilitation can also be benefited through this decentralised power system.

Solar photovoltaic system have already gained worldwide acceptance. A global survey of photovoltaic energy projects and products provides a glimpse into the widespread applicability of this technology. This system is being used in water pumping, agriculture food storage, grain grinding, medical refrigerations, rural clinics, community centres, schools, environmental monitors, microwave transmitters, aviation aids, traffic control, telecommunication, desalination, cathodic protection, forestry, transportation, street light and a wide-range of domestic, industrial and for consumer products and other purposes.

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It has been estimated that the energy contained in just two and a half hours of sunlight falling on the earth could meet the entire global energy need for a full year.

For a solar PV system, the main component is solar module which consumes maximum cost of the system. Standard photovoltaic modules consists of series interconnected crystalline silicon solar cells. A solar cell is nothing other than a diode in which the incident photons are absorbed and create electron hole-pairs.

Solar cells are reliable because they are solid-state devices with no moving parts. It may last indefinitely. This is not true for any other technology all of which have moving parts which eventually need replacement. The only maintenance required for photovoltaic is removing the dust through wiping or hosing down the array once a week. Solar energy, absorbed by the solar modules on sunny days can be stored through the application of storage batteries for use in the continuous rainy or cloudy days when the level of temperature would not be high enough to produce energy through this mechanism. The modularity of the system provides flexibility of plant sites (which, in turn, permits reduced transmission and distribution line losses and costs) and also permits small incremental addition and reduction of service lead times. The system can use both direct and diffuse solar radiation and the large portions of the world in need of rural electrification receive high levels of sunlight.

Sunlight is composed of energy particles called photons, with variable energy but constant speed. Solar radiation also has a wave-like character. The basis for photovoltaic energy conversion is the absorption of photons by a semiconductor. Due to prevailing rural or agro-industrial nature of this country, solar electricity is a very attractive approach as it makes possible stand-alone systems which are fuel-free and highly reliable. Moreover, Bangladesh is situated in the sun-belt of the world. About 80% people of this country live in villages where decentralised electricity generation is necessary. Such decentralised power can possibly be generated enormously from solar photovoltaic system. The cost of photovoltic system is dropping day by day. Even now, the costs of a photovoltaic system at remote sites may be more economical than diesel for output up to 5 to 10 KW. The recent innovation on solar technology has caused a drastic fall in its price.

The present energy crisis is not due to energy shortage. Rather, the crisis is due to the non-utilization of renewable energy technologies. It is now the time to turn to renewable sources of energy technology including photovoltaic system.

(The writer is an electrical engineer, programme and planning, Rural Electrification Board)

Getting Rid of Toxic Waste

MANY industries with waste-disposal problems are likely to benefit from a safer and cheaper Australian technique for destroying toxic waste.

The CSIRO-developed plasma converter, PlasCon, destroys hazardous industrial waste in a plasma are at temperatures of up to 12,000 degrees.

Dr Rama Ramakrishnan, head of the PlasCon research group at the CSIRO's Division of Manufacturing Technology is Melbourne, has had a stream of phone calls from people in Europe and US who are interested in the converter.

Dr Ramakrishnan says the PlasCon technique is safer than alternative methods of disposal for several reasons.

First, it does not burn toxins but completely decomposes their molecules, separating their constituent atoms.

Second, the unit is small and designed to be located on the spot as part of an in-line process. This eliminates the risks associated with transporting toxic waste to other disposal facilities, including incinerators.

An incinerator takes some seconds to destroy toxic waste; in the searing temperatures of the plasma arc it is virtually instantaneous. With a continuous in-line process, only a few millilitres of waste are handled at one time, so in an emergency the process can be shut down quickly and safely.

Dr Ramakrishnan says PlasCon is also safer because the extremely high temperatures in the plasma are reduce the effect of temperature variations. "In an incinerator at 1200 degrees, the temperature dependence is very critical. At 12,000 degrees, a 500-degree change doesn't matter so much."

A wide range of industries faces the problem of disposing of hazardous waste — from solvents in the paint industry, dioxins in paper-making and chlorinated organics in the chemical industry.

Disposal is expensive, particularly as the most toxic forms of waste cannot be incinerated in Australia and have to be shipped overseas for destruction.

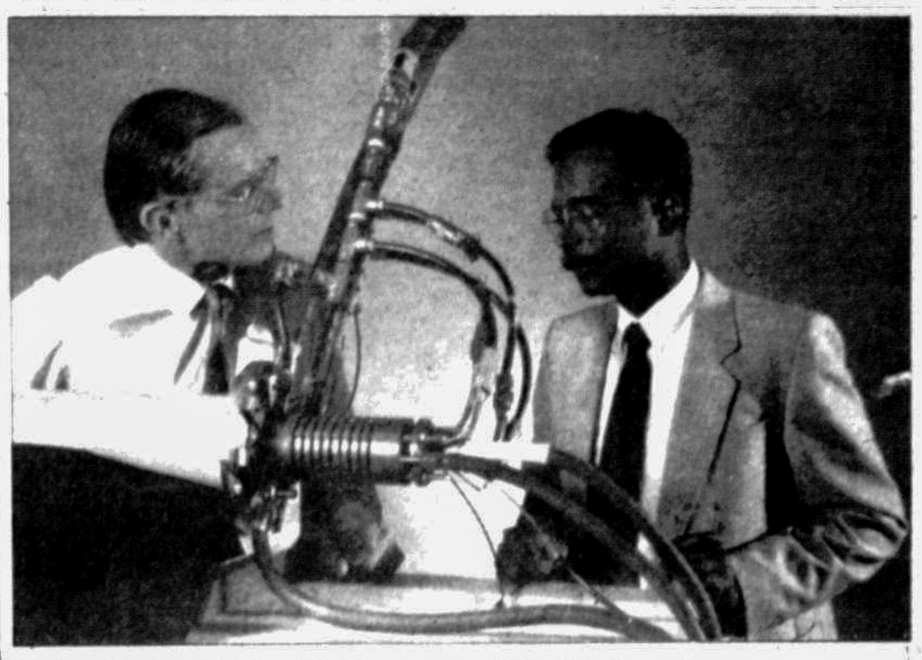
"There are lots of industries out there who want some help," Dr Ramakrishnan says. "They want better ways, cheaper ways of doing it." He says companies pay at least $5 or $6 a litre for the removal of toxic waste at present. He estimates that disposal in the PlasCon will cost between $1 and $1.50.

A pilot industrial-scale PlasCon is about to be installed in the production line of a leading chemical manufacturer. It is expected to be operating within a year, and Dr Ramakrishnan believes it will be the launching pad for exports of the converter.

"It is an excellent opportunity for us to prove to the world that we can win the race to install on-site waste-elimination systems in our factories."

Costing less than $1 million to construct and test, PlasCon offers industry an economical solution to a costly nightmare.

— Australian Science



Dr Ramakrishnan (right) and Dr Rowan Deam with the Plas Con system.

Protection of Man Against Ionizing Radiation

CLOSELY related to the goals of ensuring a healthy environment for mankind is the protection of man against ionizing radiation, an area in which the Agency carries out research contract programme activities.

Radon (Rn-222) is a natural radionuclide which occurs in the decay chain of uranium 238. Its immediate parent is radium (Ra-226), which is present in the earth's crust in varying degrees of concentration.

Radium concentration in building materials, particularly those derived from recycled industrial waste material such as fly-ash from coal-fired power plants can be significant and therefore may be one of the main sources of radon in buildings.

Another main source of radon in buildings is the soil surrounding the structure from which radon can migrate into the indoor air.

Radon in the outdoor atmosphere comes principally from the soil. The degree of radioactive equilibrium between radon and its decay products in the atmosphere at ground level depends to a large extent on the meteorological conditions.

The concentrations of radon in outdoor air vary with place, time, height above ground, and meteorological conditions. As the source of radon is the soil and radon has a rather short physical half-life of 3.8 days, the radon concentration is decreasing constantly with height.

Radon emanation from the areas with increased Ra-226 concentration such as granite or phosphate rocks can be significant. Houses and buildings in such areas may accumulate radon in concentrations which may result in significant radiation exposure.

Being a noble gas, inhaled radon does not undergo any chemical reaction with the body tissues and is almost completely exhaled. A small amount of inhaled radon may be dissolved into the body fluid and thereby transported from the lung to other parts of the body.

Radiation exposure from inhaled radon alone is small and mainly due to its decay during transit time within the respiratory tract. Radiation exposure attributed to radon is due mainly to the inhalation of radon daughter products in air and daughter products resulting from the radioactive decay of inhaled radon gas.

Radon daughters attach themselves to the walls and to airborne particles. Those attached to airborne particles are inhaled together with unattached radon daughters. Fine particles enter into the alveolar region of the lung, where they may enter into either the bloodstream or interstitial spaces of the lung.

In recent years, substantial attention has been paid to natural radon, particularly to the problems of exposure to radon and its daughters in buildings and houses.

In cold climates, where energy saving measures have led to the tighter sealing of windows and doors, the radon problem is significant.

A recent survey carried out by the United States Environmental Protection Agency indicated that an estimated 5,000 US lung cancers among non-smokers each year are probably due entirely to indoor radon exposure and that some 15,000 lung cancer deaths among smokers are attributable to this exposure.

This compares to some 19,200 deaths due to AIDS in the United States in 1989. However, while AIDS can only be transmitted by bodily fluids, radon is inhaled by everyone to a largely varying degree, e.g. some residents receive up to 100 times the average dose — higher than miners in modern uranium mines! These figures mean that indoor radon's human toll is likely ten-fold that of the problem of outdoor pollution.

Radon is by far the largest source of natural radiation exposure — on average contributing at least two-thirds of any individual's background radiation dose and over 50% of the total radiation dose from all sources of ionizing radiation to which man is exposed.

The need for research on radon in the national environment and in buildings and houses is well justified.

Further studies are needed to understand the problem in order to devise ways and means to minimize the exposure to radon and its daughter products.

Thus, in 1990, the Agency initiated a CRP on radon in the human environment, partially funded by the Government of the United States of America, to develop better designs, select improved building materials, and devise methods to minimize radon concentration in indoor air.

More than 100 proposals for participation in this CRP were submitted by institutes in 54 Member States.

In addition, the results of 25 research projects funded by the Commission of the European Communities will be included in this CRP. Therefore, the CRP was split into two programmes, one concentrating on instrumentation, modelling, dosimetry, and surveys and the other on risk assessment.

A recently completed CRP, carried out jointly by the Agency's Divisions of Life Sciences and Nuclear Safety, examined the use of chromosomal aberration analysis in radiation protection.

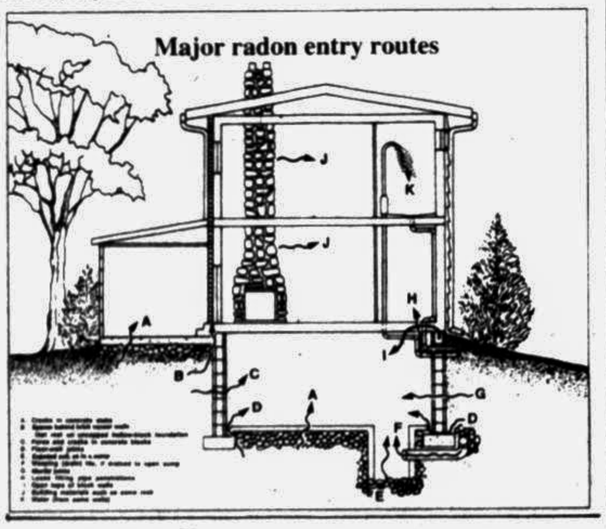
Its goals are to develop biological methods of absorbed radiation dose assessment in individuals affected by accidental over exposure.

Radiation cytogenitic researchers — those scientists carrying out comparative studies of the mechanism and behaviour of chromosomes — from nine developing Member States have worked with specialists from six advanced countries and have benefited from expertise shared during the CRP.

Transportation accident scenarios were evaluated to provide a sound technical basis for the package design and test requirements embodied in the transport regulations, or to establish a basis for change.

Member States transporting radioactive material were the intended beneficiaries of the CRP. It confirmed the validity of the accident basis for the requirements in the transport regulations.

— IAEA Research



Twin Master System Protects Pipes from Calcium Deposits

A twin master system designed, manufactured and marketed by a French company, RAUH, prevents scale from building up in bathroom plumbing, water-heaters and pipes, reports ACTIM. Over time, it will loosen scale that has already formed and that is then removed by the simple movement of water.

Scale is a deposit of calcium formed by the passage of water with a high concentration of calcium bicarbonate. Such deposits increase with the water temperature. They can obstruct pipes and calcify plumbing. They are quite harmful: they reduce the productivity of water heating devices and lead to deterioration of taps, faucets, valves, and gates. They also reduce a pipe's cross section, the ACTIM report said.

Water is treated with an electric field (magnetic or electromagnetic) to prevent scale from forming and without changing the chemical make up of the water. This promotes the creation of free nonadherent calcium crystals that simply flow away with water.

Unlike other systems, the Twin Master system makes use of electric fields and magnetic impulses. The synergy of these processes, each acting on its own, produces results that would be impossible using just on one of these principles. The Twin Master can be installed easily. It does not require any maintenance, and is quite energy-efficient, the report said.

Chinese Research Options for High-Tech Future

by Zhou Meiyue

WHEN Beijing University professor Chen Zhangliang succeeded in cul-tivating a virus-resistant tobacco plant called PK-873, it promised a big saving in foreign exchange for China.

China imports 90 per cent of the high quality tobacco required for scented cigarettes. Professor Chen's PK-873 plant looked well suited to replace the costly imports.

In 1990, the new tobacco was put to a field test with about three million seedlings planted in a 30-acre farm — the biggest test of its kind in the world. The test results added up a bonus — a 10 per cent increase in output.

Prof. Chen's research topic — antiviral genetic engineering — is one of 15 major subjects in Programme 863, a State-run scheme which acts as a cutting edge for China's high technology development. The State High-Tech Research and Development Plan contains seven domains: biotechnology, information, automation, energy, new materials, astronautics and laser.

The programme was code-named 863 because it came from a joint proposal raised by four senior Chinese scientists to the central government in March, 1986. They said it was imperative for China to develop high technology if it was to keep level with the latest results of Western research. In the same month, China's top leader, Deng Xiaoping, approved the proposal, calling for immediate discussion on the issue.

Soon after, more than 200 scientists met to draw up the state high-tech research plan, later to be named Programme 863.

The High-Tech Central Coordinating Panel in the State Council serves as Programme 863's policymaker and administrator. The programme "seeks to narrow the gap between China and the West in high-tech development within the last 15 years," says Prof Zhu Lilan, a member of the panel and Vice-Minister of the State Science and Technology Commission.

It also aims to "raise a new generation of high-tech researchers in China." The Programme, for example, provides the largest grant paid to any research project in the country.

Prof Zhu says that over the past six years, more than 15,000 scientists, mostly aged between 40 and 50 have taken part in the programme. This has led to more than 470 research results, of which 93 were considered significant.

More than 20 were tested in plant and field before being transferred to mass production.

A breakthrough in the field of biotechnology is the hybridisation of rice. A test in an experimental plot of 13,300 acres showed a 5.10 per cent increase in the yield over routine hybrid varieties, according to Prof Hou Yunde, chief scientist of the China National Expert Committee for Biotechnology Development in Programme 863.

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In some aspects, China has made breakthroughs. But its high-tech workers have so far done no more than 'adding a few leaves' to the academic tree planted by Western scholars

The work "ranks first in the world both in quantity and quality," says Prof Hou.

Chinese biologists have also perfected the technology of breeding "in vitro" calves, he says. This makes it possible to popularise the use of common cattle as surrogate mothers for well-bred dairy calves.

Scientists use the external fertilisation process of uniting the sperm from well-bred bull with the ovum of a milch cow, and then placing zygote in the womb of an ordinary cow.

"In our country, we have more than enough oxen to carry the calves, thus making it possible to produce milk cows in large numbers," says Prof Hou.

High-technology has helped produce special pharmaceuticals, suggesting a new way to bolster human health, says Prof Zhu.

A recombinant hepatitis B virus vaccine has been developed by Prof Hou and colleagues using a Chinese hamster ovarian cell. The new vaccine is "cheaper but more effective," compared with the former plasma-derived vaccine, says Prof Hou.

At the moment, China has 120 million hepatitis B virus carriers, more than half of the world total. "Five years ago, china still had to import the vaccine from America," says Prof Zhu. "Now we can process it in batches and we even have surplus to export."

Now Prof Hou and his colleagues are in long-term cooperation with the Pharmacia LKB Co. of Sweden in the separation and purification of genetic engineering products, including the Recombinant Hepatitis B vaccine.

In the modernisation of industries, studies of the Computer Integrated Manufacturing System (CIMS) have shown initial success, Prof Zhu says.

CIMS is expected to increases out put, improve product quality, and make full use of factory assets, says Prof Wu Cheng, director of the State CIMS Engineering Research Centre of China (CIMS-ERC). The technique is to integrate — with the aid of computer and software — product design, manufacturing methods and management. It will streamline formerly isolated proeesses in a factory.

About one-third or China's large and medium-sized state-owned enterprises are unable to keep up with market competition and are threatened with bankruptcy. CIMS hopes to help them survive by sharpening their competitive edge.

A CIMS, research centre is being constructed at Tsinghua University. It will function as a central laboratory to study CIMS integration techniques, and to exchange advanced techniques with other countries, as well as a training centre. Construction will be completed by the end of this year. The CIMS research centre is one of eight research centres involved in Programme 863.

Over the past six years, 250 scientists from six universities and five research institutes have gathered at CIMS-ERC. They have completed feasibility analyses, primary and detailed designs and a number of other studies.

Programme 863 researchers have also lifted China's research level on automation by manufacturing intelligent robots adapted to special environments and equipped for special functions, says Prof Zhu.

On the whole, according to Chinese experts, there is "no very large gap" separating China from developed nations in theoretical studies and, in some aspects, China has made breakthroughs.

Nevertheless, Chinese scholars have to show more initiative. Prof Wu says China's high-tech workers have so far done no more than "adding a few leaves" to the academic tree already planted by Western scholars. That is why Prof Zhu Lilan stresses constantly that scientists should try hard to "blaze new trails."

Another headache is the transfer of research results to industry. Many factories are "poorly-equipped" with under-qualified personnel, says Prof Wu. "To improve the situation, a lot more time and money are needed, and we have to make the transition step by step based on the requirements of factories."

Even today, China's best CIMS pilot plant remains 10 to 15 years behind and ordinary Western plant, says Prof Wu.

The brain drain, which confronts many parts of the country, is also a problem. "The long duration of research, and the low pay make some young scientists impatient with research. They would rather work abroad, and are well qualified to do so," says Prof Li Bohu, a member of the State High-Tech Expert Committee.

Some cities are trying to attract scientists with special funds and awards. In March, the government of Zhuhai, a special economic zone bordering Macao, rewarded 27 scientists with cash bonuses of 300,000 to one million yuan (US $ 55,000 to US $ 190,000) each, automobiles and special housing to acknowledge their outstanding contributions. Within a month the city received well over 100 inquiries for scientific cooperation and more than 600 job applications from local scientists and those abroad.

Prof Zhu stresses that the last decade of this century is most critical to China. "The key techniques are to be tackled and the strategic targets are to be hit, not to mention the fact that more and more countries and regions, developed or developing, are throwing themselves into the high-tech contest."

— Depthnews Asia