THE GROWING ENERGY CRISIS

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The inhabitants of Delhi will remember the summer of 1973 for the fickleness of the city's power supply. Yet it served as an uncomfortable reminder to the citizens of the capital, of the acute power famine that is now plaguing the whole of the country. Apart from the inconvenience caused to the public, the industrial and agricultural sectors of our economy are hard hit, since for them power is an essential requirement. Industry as a whole may lose up to ₹ 30 crore a month. Dr K.L. Rao has estimated that the loss to the country from power cuts is of the order of ₹1000 crore. And on and on runs this disheartening story.

There are many valid reasons for this power shortage. The rain gods have been unkind. Maintenance of power plants has been very poor so that even existing facilities have not been fully utilised. Power planning has not been of the highest order. There have been frequent labour troubles. Transmission loses in our power lines have been the highest in the world. There is a shortage of fuel.

All the above reasons, save the last, can, at least in theory, be controlled to some extent. By fuels one is referring to what are known as fossil-fuels like coal, oil and natural gas. These have been formed over millions of years beneath the earth's surface, and provide the energy to run our industries, electricity to light our homes and power our gadgets, and speed many of our locomotives. So far mankind has been freely plundering nature's invaluable gift of energy. These fuels are non-renewable since the time period over which man consumes this resource is an insignificant fraction of the time it takes nature to produce them. It is only in the last decade or so that we have been seeing the limits to this plenteous supply. This, together with the realisation that in the future our energy needs can only keep increasing, is at the heart of what has come to be called "the growing energy crisis".

Energy is vital to our very existence on earth. The ability to master the use of energy for his own needs has been the key to man's survival and development. In modern times it plays a crucial role in providing man food, comfort and raising the quality of his life.

Today, the world demand for energy is growing at an annual rate of six per cent. It doubled in 13 years up to 1971 and is expected to double again by 1982. This gives some idea of how the world energy consumption is growing. The trend for the last third of the twentieth century, and beyond, is

striking. It is the fossil fuels that have so far shouldered the brunt of this mammoth demand. And these, we can see, are now running out.

It Affects All Mankind

The first point to realise is that this is very much a global problem, since energy is basic to any progress. For developing countries like India, all our huge and ambitious developmental plans hinge around this vital resource. Apart from our industrial build up, we need it to further our Green Revolution and provide food for all our people. We need it for the expansion and modernisation of our armed forces, to protect our borders from restless neighbours. But the energy crisis hits harder at the industrially advanced nations because they consume much more energy. The U.S., for example, uses one-third of the world's energy production though they have but six per cent of the world's population. In fact the developed countries together swallow up 80 per cent of the total energy produced.

To make matters worse, there was a time not very long ago when fuel was available far in excess of the world's requirements. The U.S., the Soviet Union, West Asia and other countries had enough fuel for themselves and more. So that industries geared themselves to be fossil-fuel based. Now with a gradual depletion of fuel resources, they are beginning to feel the pinch.

In order to understand the problem we have to see what the balance sheet looks like. We can calculate pretty accurately how much fuel is used at present for all the world's industry, agriculture, life and leisure. We could also make a projection of our future needs. But there is a controversy which may in the long run turn out to be largely irrelevant, about the fossil-fuel left at the world's disposal. The debate is over the 'proven' and 'unproven' reserves. The figures on proven fossil-fuel reserves represent a basic minimum estimate of potential world resources. This means it only refers to the amount of fuel which on the basis of geological and engineering information is assumed to be recoverable from known reservoirs and under current economic and technological circumstances. On the other hand unproven reserves may take into account probable and possible reserves.

For instance, coal resources determined by mapping and exploration have been estimated at 8,610 billion metric tonnes. In addition, resources in unmapped and unexplored areas are of the order of 6,570 billion metric tonnes. This "guesstimate" will vary with the methods used for such predictions. But for coal one has also to slap on a fraction for recoverability – 50% by present mining experience – which is the quantity judged to be recoverable under given technological conditions. Hence recoverable known reserves would work out to 4,305 billion metric tonnes. Where does this leave us?

If energy use was to grow at the expected annual rate of five to six per cent, then cumulative energy requirements by the end of the century might amount to 400 billion metric tonnes of coal equivalents. Not only could the estimated 4.3 trillion tonnes of recoverable coal resources meet this entire growth of energy demand, but in the year 2000, at then prevailing rates of total energy consumption, enough coal would be left in the ground to meet the entire bill for a century and a half beyond.

But then one must remember that such exercises do not look at the resource pinch that may occur much earlier, in localised regions. Moreover, they ignore the fact that at present coal accounts for well under 40 per cent share of energy use and seems destined to account for progressively lower percentages in the years ahead. But this is typical of the type of hypothetical excursions that the energy planners indulge in these days.

Incidentally, energy forecasting has become a science with its own highly sophisticated techniques. There are a large number of uncertain factors that may swing estimates either way, like unproven assumptions, lack of data, etc., apart from economic, social and political factors. But it is a necessary exercise in order to get some sort of a handle on a complex problem.

There is more controversy over estimates for oil and natural gas reserves. A significant body of opinion flatly states that we are going to run out of oil by that magical year 2000 A.D. There is another vociferous group which states that the above estimate is based on present limited technology and once we, for instance, learn to extract oil from shale, and find more yet undiscovered sources like those beneath the deep blue sea, our oil supply is going to last much longer.

Our Precious Environment

There are other considerations to complicate the energy crisis still further. We are becoming gradually more and more 'environment conscious'. This issue of *School Science* is one manifestation of this concern. It is dawning on us how we have been ravaging our natural environment through the many and diverse activities of modern civilisation. A large portion of this environmental degradation has to do with man's use of energy in some form or the other. Thus the exhaust from our cars, buses, trains, aeroplanes and so on is causing a lot of air pollution. Our industries belch out smoke and other harmful chemicals. The way we tap our energy sources is coming under severe fire. For instance, strip mining of coal which literally gouges the coal out of the ground, is being frowned upon since it leaves large tracts of scarred land that are not only an ugly sight but cause damage to the flora and fauna for miles around. Our thermal power plants throw up into the air fly-ash and other particulate matter. They cause thermal pollution because the large amounts of water required for cooling purposes get heated and are released into the streams and rivers causing harm to fish and other aquatic organisms. The nuclear power plants, apart from causing thermal pollution, have a radioactive waste disposal problem that is going to progressively increase in magnitude. Moreover, people are getting increasingly finicky about the quality of fossil-fuel that we use for energy purposes. High sulphur coal or oil is rejected or subjected to prior treatment so that it does not cause air pollution through excessive sulphur dioxide release.

The exploitation of an energy source involves seven operations, some of which are inter-related. They are: discovery of the resources, harvest, transportation, storage, conversion, use and disposal. What our enhanced concern for the quality of the environment is going to do is to increase the cost of these steps and hence make energy all the more expensive. Ironically enough, society's avowed goal of cleaning up the

environment is going to require more inputs of energy. Thus we are going to require power for our sewage treatment plants, our industrial effluent cleaning processes and other pollution abatement facilities and (to complete the vicious circle) for using more efficient and less damaging ways of tapping energy sources. It is not difficult to realise how all this is going to add to the energy crisis.

Political Implications

But lest one should run away with the idea that all this is purely a scientific or technological problem, it is well to remember that the long fingers of international politics and high finance creep into the situation to further mess up an already messy problem. The world's consumption of oil is increasing by eight per cent a year. U.S. consumption is now nearly 40 per cent of the total. On the supply side we see that the Arab countries and Iran together are floating on 70 per cent of the world's oil. This area is now doling out oil to satisfy 60 per cent of Europe's needs, almost the whole of Japan's and about 20 per cent of America's, apart from a large percentage of the needs of developing countries. The combined income of these oil producing countries (excluding Iran) which was $4.4 billion/year five years ago is now $10 billion/year and by 1980 could reach $40 billion/year.

What this means is that within a decade or so, these few countries, some of them politically unstable, will be sitting on a stupendous portion of the world's money, and will be able to threaten the international monetary system. The oil wealth will give the Arabs power undreamed of, that could be used for peaceful development or for political arm-twisting, violence and revenge.

This has given the developed nations an added incentive to go scurrying around looking for alternate energy sources as well as to develop new technologies to try and become self-sufficient in energy. These new technologies are in various stages of readiness and economic feasibility. It would be interesting to review some of them.

Energy of the Future

It is obvious that in the future man will have to turn increasingly to nuclear power. There are quite a few atomic power plants of various sizes working all over the world. Almost all of these are the conventional water cooled reactors, fuelled by U 235, that is becoming increasingly difficult to mine and process economically. One modification of the normal fission technology that appears closest to widespread application is the "breeder reactor".

In simple terms, this is a reactor that would use fissionable fuel to produce power, at the same time creating more nuclear fuel in the ratio of about one and half parts of fuel created for every part burned. During the normal chain reaction, surplus neutrons from the atoms of U 235 in the reactor core, bombard a surrounding blanket of U 238, a much more plentiful though non-fissionable form of uranium and converts it into plutonium. This fissionable by-product can be used as fuel in other breeders. But then there is still the problem of fission wastes being highly radioactive and extremely difficult to store or dispose of.

Probably the most exciting future possibility is harnessing of the energy source of stars—nuclear fusion. The principle behind it is that when light

atoms like deuterium are made to collide at very high temperatures, their nuclei combine to form heavier atoms. This process releases tremendous amounts of energy. Thus in a controlled thermonuclear power plant, which is a power plant built around a fusion reactor, the energy released from the fusion reaction would be recovered as heat and converted through steam into electricity. The raw material deuterium is plentifully available in sea-water. But there is still a long way to go before this process becomes feasible. Very optimistic scientists are shooting for the turn of the century.

The magneto-hydrodynamics generator (MHD) is a future power source for which Indian scientists have produced a design based on the one worked out by their Soviet counterparts. MHD promises to produce power from fossil fuels that will be five to 20 per cent cheaper than thermal power and also will be less polluting. It creates an electric current by passing a stream of hot ionised gas at high speed through a powerful magnetic field.

People all over the world are working to make use of solar energy. When one realises that the sun bathes the earth with about 100,000,000 kw of light energy each moment one begins to wonder why we cannot utilise some of this energy. The trouble is that this is a very diffused form of energy and has to be concentrated before it can be put to any practical use. So far solar energy has been used only for heating water and generating electricity for spacecraft—nothing on an industrial scale.

Then there are the eternal energy sources such as the tides and geysers. Geothermal power utilises the underground reservoirs of steam and hot water. For instance, the geysers in California drive turbo-generators that produce roughly 40 per cent of San Francisco's total electricity requirements.

And so on to the wayward wind. Our ancestors used this unseen force to do their work. There are still a number of windmills, standing as forlorn showpieces of a bygone era. But the earth's winds are considered too irregular to serve as a major power source.

An overview

It would be simplistic to think that technology by itself can produce a magical solution to man's problems. The energy crisis involves an unholy maze of inter-related political, economic, social and technological factors. The only thing definite, at least for the foreseeable future, is that we are going to require energy on an unprecedented scale. Those who fondly believe that man can all of a sudden achieve a decrease in total energy demand are being naïve. Even if the world's population control effort is successful we are going to have a significant increase in population over the next few decades. The basic energy demands of these increased numbers will be enormous.

True, energy conservation can go a long way towards relieving shortages. Already, recycling of materials in industry is achieving substantial savings. But, man will have to go further than that. We will have to have changes in our attitudes life styles.

Being a controversial question, the energy crisis invites a wide variety of opinions. There are those who believe that this is not much of a crisis after

all. Man will find substitute materials for the diminishing fossil-fuels and that well-tried law of economics will work wherein if a commodity becomes more expensive then it encourages producers to increase supplies at the same time pressuring consumers to cut down their demand for it. Whatever be the truth in this complex situation, a hot debate is on.

There is one unifying thread that runs through this diverse fabric. The energy crisis affects all mankind, so that the 'oneness' that ecologists have been trying to stress, and the concept of all men being co-passengers on Spaceship Earth are not merely philosophical or sentimental ideas. Mrs. Indira Gandhi meant quite the same thing when she said at Stockholm, "Life is one, and the world is one". Being caught up in this "web of life", where what happens in one part of the system affects other parts, we have to seek collective solutions to all our problems, not the least of which is the energy crisis.

But since we are only human, controversy will always rage, with sweeping pronouncements from people of all points of view. The situation is serious, of that there is little doubt. But when one hears profound statements being made beginning with the words: "If present trends continue, we are headed for doom...", then one must take them with large pinches of salt, since one of the chief lessons of history is that present trends are only for the present. Man is an ingenious animal. His ingenuity has carried him through many crises in his evolution. May be just a few decades from now, he will have made energy such a clean, freely available commodity that he will laugh when he thinks of the time people thought there was an impending energy crisis.

Suggestions for Further Reading

1. Energy and Power: A Scientific American Book. W.H. Freeman & Co.
2. Energy and Economy of Nations: W.G. Jensen.
3. New Scientist, 4th Jan. 1973.
4. New Scientist, 22th Feb. 1973.
5. New Scientist, 5th April 1973.
6. Span, September 1972.