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BBEP-440

THE WWR - 440: EASTERN EUROPE'S MOST IMPORTANT REACTOR

Dangers/Confidential Malfunction Reports/Catastrophe
Scenario

A Black Book: A Report by the Ecology Group, Hannover
on behalf of GREENPEACE, April 1987

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done by I.Albrecht/ U.Fink/ K.Hinrichsen/ H.Hirsch
Ecology Group, Hannover

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done by GREENPEACE

April 1987

EMBARGOED until 11.00 on 26th April 1987

GREENPEACE launches nuclear hazards study in Eastern Europe

To mark the first anniversary of the Chernobyl nuclear reactor accident, the international environmental organisation GREENPEACE will, at [REDACTED] press conferences in Vienna [REDACTED] today release a scientific report on the hazards of nuclear power in Eastern Europe.

The report, commissioned from Dr Helmut Hirsch, an independent Austrian nuclear expert is based in part on information obtained from some confidential International Atomic Energy Agency documents. It makes available for the first time detailed information on the safety problems of the Soviet designed +VVER-440+ nuclear reactor which is located at ten sites in seven countries throughout Eastern Europe and Finland.

Summaries of this report have been translated and are available in Russian, Polish, German, Czech and Hungarian. One thousand copies in each of these languages have been distributed in the appropriate Eastern European countries.

The design of the VVER-440 reactor is fundamentally different from that of the reactor that exploded at Chernobyl. Whilst the Chernobyl reactor is no more dangerous than other types of nuclear reactors throughout the world, the VVER-440 has been identified by the Greenpeace report as suffering from exceptional safety hazards.

The particular problems concerned include inadequate containment structures, rudimentary emergency coolant systems, fault-prone pressure reduction systems, leakage of primary coolant and signs of wear in valves and in the electrical system. The report makes public for the first time information that, in February 1983, the VVER-440 at Kozloduy in Bulgaria experienced a series of malfunctions that could have developed into a very serious accident.

The probability of a serious accident occurring before the end of the century at the Czechoslovak VVER-440 nuclear reactor plant at Dukovany is assessed to be between one in five and one in one hundred and seventy. In the event of a major, but not worst case, accident occurring at Dukovany, prevailing winds would carry fallout to Vienna in six hours. This could result in at least 100,000 extra cases of thyroid cancer and 5,000 cases of bone cancer in Austria alone.

Greenpeace is also releasing studies commissioned from independent scientists in Spain and the United Kingdom. In Madrid, a technical report will be launched that shows in detail how Spain could phase out nuclear power in five years.

In London, a report revealing previously unpublicised safety defects in British gas cooled nuclear reactors will be made public. Demonstrations and other undisclosed Greenpeace activities will accompany the release of all these studies.

For more informations please contact:

THE WWER - 440 : EASTERN EUROPE'S MOST IMPORTANT REACTOR

Dangers/Confidential Malfunction Reports/Catastrophe Scenario

A Black Book : A Report by the Ecology Group, Hannover

SUMMARY :

1. The WWER-440 is world-wide one of the most numerous types of reactor. Almost one in ten of all power reactors operating or under construction is of this design. It is at present the only type of reactor providing electricity in Bulgaria, the German Democratic Republic, Poland, Rumania, Czechoslovakia and Hungary (apart from one WWER-70), and is the only Russian-designed reactor to have been exported to non-COMECON countries (two blocks have been exported to Finland). They are often situated near borders, and also in the proximity of large cities (e.g., Berlin, Brno, Vienna, Copenhagen).

2. An international committee of experts commissioned by GREENPEACE in 1986 to investigate the potential dangers of all commercially operating power reactors in the world at present came to the conclusion that all modern types of reactors, both in the East and West, are approximately equally (un)safe. Major accidents with catastrophic consequences - as in Tschernobyl, and worse - are possible in all reactors. The committee of experts was not able to identify any one type of reactor which could be rated as considerably safer than the average. It was however able to point out a number of different types of reactors which were clearly worse than the average: among these was the WWER-440.

3. The WWER-440 was developed in the Soviet Union: the first forerunner prototype, the WWER-210 (pressurized water reactor with 210 MW electrical output), was put

into operation in 1964 in Nowo-Woronesh. Two further prototypes led to the first standardized Soviet type of reactor, the WWER-440 (first block: Nowo-Woronesh 3, put into operation in 1971). Almost all plants up to the present have been constructed by the Soviet atomic industry. One exception to this are the Czech power reactors from Bohunice-3 onwards, which were built under licence by the CSSR firm of Skoda. Developments have led to the larger type, the WWER-1000.

4. The WWER-440 is a pressurized water reactor (light water cooled and moderated, with two coolant circulations). Its reactor core contains approx. 40 t reactor fuel, comparable to the pressurized water reactors in the West (slightly enriched uranium), and similar to these this is contained in one single reactor vessel. It is equipped with two turbo-generators with 220 MW electrical output each. Two reactors are always constructed within one building (double-block plant). It is planned to incorporate power reactors equipped with WWER-440 reactors in the long-distance heating system; this is encouraged by the fact that they are often situated in the proximity of conurbations.

5. As in all pressurized water reactors - those in the West as well - the integrity of the reactor vessel is of prime importance: its breakdown (rupture) cannot be controlled and leads to a catastrophic accident. The weld seams of a number of WWER-440 reactor vessels are in particular danger of brittle fracturing as a result of impurities. In addition to this, 10 older plants have no protection against corrosion inside the reactor vessel. A further weak point for 17 plants are the main coolant pumps.

6. All WWER-440's have a particularly inadequate safety containment. Their compression resistance is very

slight. The danger of a premature malfunction through a building up of excess pressure in the reactor building following a break in one of the coolant pipelines and the escape of steam from the primary coolant circulation system is particularly high. The earlier the safety containment fails, then the greater the release of radiation and thus there is less time for the disaster control services to take the necessary measures.

7. In nearly half of all WWER-440's (the first generation) only the most rudimentary emergency coolant systems and systems to reduce pressure within the safety containment are present. It is thus possible for catastrophic accidents to develop from relatively small leaks and other such faults.

8. The second generation of WWER-440's also exhibits an increased risk of core meltdown accidents with early containment malfunction. Emergency coolant and pressure reducing systems have been further developed and are a great deal more complex than those of first generation reactors. The pressure reducing system is however prone to faults (vibrations in the condensation chamber). The large degree of interconnection between the emergency coolant and pressure reducing systems remains a disadvantage in respect of safety technology. A rupture in one of the main coolant pipelines ("ZF-Break") should be able to be controlled by the second generation safety systems. On the basis of the interaction between different systems, which are to some extent dependent on one another to function, a small fault can here lead to the situation getting out of control.

9. Both WWER-440's in Loviisa (Finland) have been subsequently fitted with western (US) safety technology. They have been equipped with an ice-condensor-containment system, which of all the American pressurized water

reactor containment systems exhibits the least compression resistance and is also otherwise to be rated as very negative.

10. Almost nothing has been reported in publications concerning actual faults in the WWER-440. Confidential malfunction reports from the Incident Reporting System of the IAEA however record numerous safety problems which have occurred in practice: leaks in the primary coolant circulation system and steam generators, faults and signs of wear in valves and gaskets, problems in the electrical system.

11. The most dangerous of all the malfunctions which are published here for the first time took place on February 21, 1983 in Kozloduy in Bulgaria: following an electrical defect, two valves of the pressure maintainer in the primary coolant circulation system were opened. The pressure in the primary circulation system dropped rapidly, the reactor was switched off. The valves could not be closed. After more coolant had been lost the emergency coolant system was activated. A third valve could be closed; the situation was under control again. Since cold emergency cooling water was fed into the reactor vessel, this meant an acute danger of brittle fracturing of one of the weld seams - the block in question in Kozloduy is most probably one of the plants whose weld seams are in particular danger.

12. The probability of a serious accident in a WWER-440 (or any other type of reactor) cannot be calculated with any degree of reliability. The uncertainties and gaps in our knowledge are too great. We can however guess at a range for our rough orientation, within which the probability lies. For example, the probability of a serious accident in the CSSR plant at Dukovany for the period 1987 to 2000 lies somewhere between 0,6% and 20%. It is

thus clear that this is in no way a negligible "residual risk".

13. An accident (one of many) could start as in Kozloduy in 1983 with a vessel valve opening and remaining open. The input of cold high-pressure emergency coolant leads to a great stress on the materials ("thermoshock") and to the rupture of a main coolant pipeline. The slightest carelessness during an inspection of the safety system (e.g. the water level in one of the tanks for the pressure reducing sprinkler system being too low) and this could lead to the breakdown of the pressure reducing system, and later the emergency coolant circulation system. (The accident scenario here is for one of the second generation plants.)

14. In this case the safety containment system fails within the first minute. It already shows an extensive leak, as during the next hour the core melts. During core meltdown radioactive materials are released into the atmosphere in large quantities. A further release of radioactivity occurs when the molten mass breaks through the reactor vessel and begins to react with the concrete of the building itself. The release of radioactive materials would be comparable to that experienced in the Tschernobyl accident, in the case of certain radionuclides (e.g. iodine-131) the amounts would be even higher, although the WWER-440 is a great deal smaller than the RBMK-1000.

15. In spite of the large amount of radioactivity released the case in question is by far not the worst. The amplifying effect of an explosion during the accident has not been taken into account; furthermore we have assumed that the other blocks in the same location are not affected by the accident, and that no radioactivity is released from the storage reservoirs for spent reac-

tor fuel which are situated within the reactor building.

16. The radiological consequences of this sort of accident were calculated as an example for the location Dukovany (CSSR). In accordance with actual atmospheric conditions which have been registered for the area, it was assumed that the radioactive cloud would move towards Vienna. The weather conditions chosen were not particularly unfavourable (e.g.: no rain which would greatly increase the radiation exposure over Vienna and lower Austria). Other atmospheric conditions are possible whereby the consequences would be a great deal worse. With a calculated wind speed of 14 km/h, the radioactive cloud would reach Vienna in approx. 6 hours.

17. The radioactive materials in the cloud would be inhaled by people in the areas affected. This type of radiation exposure is important above all for iodine-131, which collects in the thyroid gland. In the accident scenario presented here nearly 12,000 people in Vienna would contract cancer of the thyroid from radiation exposure by inhalation alone. A superproportional number of children would be affected because of their particular sensitivity. An infant's thyroid would be exposed to anything up to 1,9 Sv (190 rem).

18. Radioactive materials from the cloud also settle on the ground. Humans would then be exposed to radiation for a number of years, whereby caesium-134 and -137 play an important role here. The radiation level is significantly higher than the natural radiation exposure. In the years following the accident this ground radiation would lead to 4,500 deaths by cancer in Austria.

19. Finally, radioactive materials would also contaminate vegetable products, and would thus enter the food cycle. This would be predominantly through the ground

and the roots, at the beginning through the leaves as well. Radiation exposure via the consumption of food can be considerably reduced by setting limitations and withdrawing highly radioactive products from the market. If all radioactive foods were consumed (either because no limitations were set, or because the radioactive food which was above the limit was mixed with food below the limit and then eaten) we could expect more than 100,000 cases of thyroid cancer in the whole of Austria (with nearly 3% of these fatal), more than 5,000 cases of bone cancer (approx. 50% fatal) as well as other types of cancer. The number of fatal cases of cancer would be around 12,000. If the limits of the FAO (Food and Agriculture Organization of the United Nations) are adhered to and no radioactive foods are "diluted", the total number of fatal cases of cancer could be reduced to 1,400. A further 100 cases of thyroid cancer and more than 1,400 cases of bone cancer would be registered. At the same time, a large amount of food must be thrown away (kept in ultimate waste disposal areas) in the first three years following the accident: in the first year all foodstuffs produced in 1/10 of the area of Austria (i.e. approx. 180,000 t milk, 60,000 t meat and large amounts of vegetable products); and even in the third year approx. 6,000 t meat.

20. Obviously, not only Austria is affected by the accident. The radioactive cloud would take a course over agricultural and urban areas in the whole of Europe. The final consequences of the accident would amount to at least ten times those in Austria; with unfavourable atmospheric conditions (widespread rain) even more. The cloud would eventually reach other continents in a largely diluted form.

21. In addition to the cases of cancer, the radiation would also bring about genetic damages. Our knowledge in

this area is so scanty that a numerical guess at the number of cases would appear impossible. But we can safely say that the genetic risk is approx. as great as the risk of cancer. Furthermore, we can expect damages to the fetus in the womb - e.g. a reduction of the intellectual abilities - as well as an increase in a number of other illnesses as a result of the general weakening of immunity by radiation.

22. The extremely short early warning period makes countermeasures such as evacuation impossible. Even if the Austrian authorities were informed immediately and effectively, the only advantage would be that measurements could be taken and measures to reduce radiation by consumption of contaminated foods could be planned and put into operation earlier. In spite of the agreement concerning immediate notification in the event of a nuclear accident, which was ratified in a special meeting of the IAEA in September 1986 in Vienna, and which came into force on October 27, 1986, we should not assume that this will lead to a rapid and efficient exchange of information.

23. It is uncertain whether, for example, the CSSR authorities know which authorities to inform in Austria: whether arrangements have been made to immediately transfer all important data; and whether it can be guaranteed that no language problems will arise during the exchange of information. Furthermore, there are no international guidelines as to what constitutes an "accident" and what can be regarded as a permissible "fault". The permissible fault limit for a whole-body dose is e.g. in Czechoslovakia 0,25 Sv (25 rem) per fault. The Austrian legislation in respect of radiation protection on the other hand makes no provisions for any special fault limits for the population, in all cases the maximum value of 0,0017 Sv (170 mrem) per year is

applicable. Thus, what is seen in one country as a medium sized accident, is seen in another as an acceptable fault, and as such no notification of this is necessary.

24. The reactor type WWER-440 has up to the present not been subjected to a critical analysis. This report hopes to make a start in filling this gap, which, in view of the lack of safety measures in the WWER-440, must be seen as particularly serious. But this does not mean that it is only this type of reactor which causes concern. This is not the case. Only someone who can convince another person that he or she takes the dangers of atomic reactors in his or her own country seriously, can credibly point out the dangers of atomic reactors in other countries.

Hannover, April 1987

THE ROAD TO A NUCLEAR FREE FUTURE

GREENPEACE, April 1987

The Problems of Nuclear Power

As the accident at the Chernobyl nuclear power station one year ago so tragically showed, nuclear power is a problem for all those of us who live within its reach.

Scientific studies conducted in many countries now conclude that anything up to five hundred thousand people may die in Europe over the next seventy years as a result of the radioactive pollution from the Chernobyl disaster. The cost of the accident to the Soviet Union alone has been officially assessed to be 2.800 million dollars. This money has been needed to pay for the attempts to decontaminate miles of countryside, for the evacuation of towns, for the construction of twelve thousand new homes to house the refugees, for the loss of agricultural produce. It is widely regarded that this figure represents a low estimate of the total cost. It does not include the ongoing health care of the victims. The total cost to all the countries of Europe who were effected will be far higher.

After Chernobyl, and the accident at Three Mile Island in the United States, it is clear that a future with nuclear power can only promise further disasters of this kind. With over one hundred and seventy nuclear power reactors spread throughout Europe, it has been calculated, using scientific risk assessment models, that major nuclear accidents be expected to occur in Europe once every seven years.

No technology can ever be one hundred per cent reliable. People will always make mistakes. However, it is not only because of the risks of regular nuclear catastrophes that Greenpeace is opposed to nuclear power. There are many other reasons to demand, as we do, a "Nuclear Free Future" for all countries, East and West:

* Cost

When all the costs are considered, from the mining and processing of uranium, through the expenses of constructing and operating nuclear reactors, to the costs of the unsolved problems of the disposal of nuclear wastes and the decommissioning of nuclear plant, it is clear that nuclear power is more expensive than other methods presently used for the generation of electricity.

The only country in the World where nuclear power is expected to be competitive with other ways for generating electricity without Government subsidy is the United States. In the US, because of the excessive costs of nuclear power, no new nuclear power reactor has been ordered since 1978, and over 100 orders for new stations have been cancelled.

* Health

It is not only by occasional, but nevertheless regular, nuclear accidents that nuclear power threatens the health of the general public. Even the routine operation of nuclear power plants results in the release of small but measurable amounts of radioactivity into the environment. In those countries where detailed scientific studies have been carried out, it is now becoming clear that the incidence of radiation-induced illness amongst people living in the vicinity of nuclear plants is measurably higher than in other areas.

* Reliability

Nuclear power reactors are unreliable technology. Quite apart from major accidents, less severe unforeseen technical problems and relatively minor accidents are constantly arising. These often mean that reactors have to be shut down for investigation or repair. Most nuclear power stations are "off line" for a higher proportion of their working lives than was anticipated in their design expectations.

* Transport

The operation of nuclear power stations requires the constant transport of radioactive materials by sea, road, rail, and even by air. Chernobyl has clearly shown that even the relatively elaborate containment structure of a nuclear power reactor is not entirely secure. The movement of these hazardous materials spreads the net of nuclear risk even more extensively across Europe.

* Society

In all those countries where nuclear power is presently employed it has led to an increased need for security, to a growth in official secrecy, and to a failure to consult with ordinary people who will have to live with the technology. And, of course, without the nuclear reactors to produce the plutonium, nuclear weapons would not now be threatening the future of all societies, whether nuclear or not.

* Shutting Down Old Reactors

No large power reactor has yet been successfully decommissioned. As the experience with the decontamination of Three Mile Island in the US has shown, many of the technical difficulties of decommissioning are as yet unforeseen.

Once a nuclear reactor has ended its active life, after about thirty years if it is lucky, it will require large amounts of energy and a long period of time before it can be dismantled. In the first few years after the last fuel has been removed, the reactor is still so radioactive that it has to be cooled, initially using a significant proportion of the energy that it produced whilst it was in operation. Even after it has cooled down, the reactor itself will be so radioactive that it will not be practical to begin taking it apart for up to one hundred years. Throughout this whole period, the building must be protected and maintained at great expense. In the end, the most radioactive parts of the reactor become nuclear waste, with a whole new set of problems of its own.

The problems of disposal of nuclear wastes, (including spent nuclear fuels and certain components of old reactors) are not only unsolved, they are fundamentally insoluble. The most dangerous of the radioactive pollutants in nuclear waste will remain hazardous to life for a period up to, and in some cases exceeding ,a quarter of a million years. No building or other work of man can hope to last this far into the future undamaged. No matter how deep or how strong the nuclear dumps are, it is inevitable that radiation from nuclear waste will come back into contact with life. The only way of preventing this is to stop producing nuclear waste.

The moral question of expecting future generations to cope with the thousands of tonnes of highly radioactive wastes produced by our wasteful civilisation thousands of years after we are dead, is something that no society has ever had to consider in the past.

Nuclear power is simply a very expensive, dirty, dangerous and old fashioned way of boiling water.

A nuclear power reactor does exactly the same job as a coal boiler or a gas burner; it boils water to make steam, to drive turbines, to generate electricity. It was thirty years ago that the first nuclear reactors were used to produce electricity. Since then, no fundamental developments upon the original basic design principles have taken place. It is time that the nuclear nations looked beyond the 1950's technology of nuclear power.

As the world approaches the twenty first century, many other cheaper, cleaner, safer and more modern alternatives are now available. It is with these that our plans for a "Nuclear Free Future" should lie.

The Place for Fossil Fuels

Most of the electricity that is generated, even in the industrialised world, is produced by burning fossil fuels such as coal, oil or gas. Fossil fuels are limited in supply, and, burnt in the present manner, they can cause very serious pollution such as acid rain. However, these fuels do not present us with the problems with the same kind of problems with which we are faced from nuclear power.

The technology now exists by which the acid emissions from the combustion of coal and oil can be reduced to almost zero. Flue gas desulphurisation systems can be fitted to existing power stations to reduce the acid emissions, and new power stations can be designed to use fluidised bed combustion technology, which permits the more efficient clean and economical combustion of coal.

Using these fuels, conservation measures and, in some cases, hydroelectric power as short term alternatives, detailed programmes have been put forward in many European countries, for the complete phasing out of nuclear power. Sweden has already embarked upon a programme for the phase out of her forty per cent nuclear capacity by, at the latest, the year 2010. In Britain, with 19 per cent of electricity nuclear generated, plans for a phase-out range from four years to fifteen years. Similar proposals have been advanced at a high political level in West Germany (31% nuclear), Italy (4% nuclear) and Spain (24% nuclear). Austria has already decided to scrap its only nuclear power station even before it begins operation. Denmark and Ireland have decided not to pursue nuclear technology.

If countries with nuclear power contributing up to forty per cent of their electricity can consider phasing it out completely then this strategy is even more feasible for an eastern block country. All of whom have nuclear proportion of total electricity below 32%.

However, no amount of treatment can avoid the simple fact that burning fossil fuels produces carbon dioxide gas. Whilst not poisonous, the production of carbon dioxide is gradually but inexorably leading to a global "Greenhouse Effect" which, if we continue to burn these fuels at the present rate, will cause radical worldwide climatic change beginning as early as the next century. For this reason, and because these materials are valuable resources with which we can do better things than simply burning them, we should be seriously planning to minimise our dependence on fossil fuels.

The transition away from nuclear power does not mean that we need to burn more coal or oil. In fact, as is explained below, alternative technologies are available that can eventually replace both nuclear power and fossil fuels.

Energy Saving and Efficiency

Electricity is responsible for under thirty per cent of the worlds energy use (only four per cent of the worlds energy is nuclear). One reason for this is that conversion into electricity is a very inefficient way to make use of the limited energy available to us. For this reason, the most immediately promising alternative to nuclear power is not another rival fuel, but more rational methods for using those fuels we have.

At a power station, whether it be coal, oil, gas or nuclear, only about one third of the energy contained in the fuel is converted into electricity. The remaining two thirds is usually disposed of as waste heat into the atmosphere or through water pipes into a river or the sea. Then, in transmitting the electricity to the place of use, whether that be factories or homes, a further 10% can be lost in the cables. With electricity, only one about 27% of the energy extracted from the fuel is actually delivered to the user.

Of course, electricity will always be required for certain purposes. However, in countries that have embarked upon nuclear power programmes, the investment is so great that it

compels them to neglect other alternatives and concentrate too much on electricity. The most efficient way to utilise our available resources is the direct use of fuels as near as possible to the place of consumption. Nuclear power stations are so huge in their output, that they demand a very centralised electricity supply system. This is the least efficient way of using the energy extracted from the fuel.

Investment in energy conservation measures such as thermal insulation or timing devices is more cost effective in terms of the amounts of energy made available for use than is investment in nuclear power (or any electrical power). The potential for energy saving technologies is only now being realised in certain countries. It has been estimated that the energy demand of a northern European country could be reduced by up to fifty per cent, simply by investing in a programme for the conservation of energy. This is equivalent to the output of several nuclear power stations.

Further measures such as using the waste heat from electricity power stations to heat houses and factories are also promising and under-utilised in Europe as a whole. Nuclear power stations are inappropriate for this purpose since they are so large and so sparsely distributed, and because the safety hazards require that they be situated as far from houses or industry as possible.

Renewable Energy Sources

The energy technology of the future lies with what is now known as "alternative technology". By harnessing the power available in the natural forces at work around us, we are guaranteed a truly inexhaustible and non-polluting source of energy. The fuel is free. In many countries, these technologies are already becoming available.

Despite the huge amounts of resources poured into research and development for nuclear power, it is still uneconomic and beset with problems. A fraction of the input of minds and investment that is currently squandered on nuclear power would quicken the development of alternative technologies.

* Wind

Some renewable energy sources, such as the power of waves and tides, are for the most part, not available in Eastern Europe. However, wind is something that nobody is short of. Already large wind turbines are under construction in Europe with outputs of up to three Megawatts. Groups of these, and even larger machines, will have outputs comparable to small fossil fuel power stations.

A network of such machines across the country, along with a system for the storing of the electrical energy produced, would provide a constant and reliable supply of electricity for purposes where no other energy source will do. The environmental impact of these machines would be no more than that of the huge towers of the national grid systems that are presently required to distribute the power from nuclear stations.

* Sun

Even in a northern European winter, solar power can make a very significant contribution to human energy needs. It is not as a producer of electricity, or as a source of high grade heat, that solar energy is most promising - although in certain countries these contributions will be important. In northern Europe, it is as a source of basic "low grade heat" that solar energy promises to be most useful. Specially designed systems of water pipes on south facing rooves of buildings can collect sufficient energy from the sun, even on a cloudy winters day, to save significant amounts of energy in heating.

More important perhaps, is the potential for thoughtful architectural design. By creating buildings with features such as very large triple glazed south facing windows, or glass walls outside of existing south facing walls, the heat from the sun can be used to provide nearly all the heat required to heat a family home or office block, even in a country as far north as Sweden. Such techniques are now becoming well established building practice in some parts of the world.

In the near future, further development of existing photovoltaic technology will allow the widespread and relatively efficient direct conversion of sunlight into electricity on a large scale.

* Heat Pumps

Just as refrigerator works by extracting heat from a cold chamber and passing it into a warm kitchen, so a heat pump can transfer heat from a cold stream or pond, or even from cold earth, and pass it into a warm house. The heat brought into the building is far greater than the electrical energy necessary to drive the heat pump. This technology is already in widespread use in certain countries, but its potential contribution to our energy requirements is barely tapped.

* Other Technologies

Many other alternative energy technologies are already in existence. Some, such as "biogas" involve the utilisation of renewable or waste resources to produce useful energy. Installed on farms, biogas converters extract valuable methane gas fuel from animal manure. Others, such as biofuels or geothermal energy, involve the utilisation of finite resources in much the same way as fossil fuel combustion does at present.

Nevertheless, in the short term, these technologies can all play their part in relieving us of our dependence on the dangerous nuclear option. In the longer term they can be used together to provide us with an energy diversity and adaptability which will permit a fundamentally more healthy society.

Conclusion

Nuclear power is an old fashioned, expensive, dirty and dangerous way of boiling water. The energy technologies of the next century will utilise the "free fuels" of wind, sun, earth and water. Already, with a minute fraction of the investment enjoyed by nuclear power, these advanced technologies are beginning to make important contributions to our energy needs.

Despite over thirty years of development, nuclear power still only provides a small share of our electrical energy, remains more expensive than other technologies and has failed to solve some very fundamental problems. It promises us and our descendants a future of having to play guardian to thousands of tonnes of nuclear waste for thousands of years. The prospects of future Chernobyl disasters are as certain in a nuclear future as they are terrible. Both on safety and on economic grounds, it is essential that nuclear nations phase out nuclear energy immediately.

In the interim period between the phase out of nuclear power and the introduction of renewable energy technologies, the clean burning of fossil fuels can make a valuable contribution. However, by far the most important method of replacing the nuclear contribution in the short term is by implementing very basic energy saving and energy efficiency techniques.

For the sake of health, safety, economy and environment, Greenpeace therefore demands:

- 1: An immediate cessation of the construction and development of all nuclear power plants.
- 2: The phase-out of the present installed nuclear electricity generating capacity as rapidly as safety will allow.
- 3: An immediate cessation to the transport and trade in the radioactive materials associated with nuclear power.

- 4: The immediate implementation of a programme for the insulation of buildings and for the improvement of energy efficiency. Such a programme will save more money in saved energy than it will cost.
- 5: All existing fossil fuel power stations should be fitted with optimal "cleansing systems" such as flue gas desulphurisation equipment.
- 6: If, despite energy conservation and efficiency measures, it becomes necessary to replace obsolete fossil fuel stations with more fossil fuel capacity, new plants that are constructed should utilise clean modern technologies such as fluidised bed combustion.
- 7: In the longer term, but as rapidly as is possible, renewable energy resources should be harnessed to provide us with all our energy needs. Investment and research that is currently wasted on nuclear technology could be used instead to develop the already existing advanced technologies for the utilisation of the energy of sun, wind, water and earth. In the longer term, in an energy efficient society, these energy sources will become dominant.

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