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* Fission energy is safe only if a number of critical devices work as they should, if a number of people in key positions follow all their instructions, if there is no sabotage, no hijacking of the transports, if no reactor fuel processing plant or repository anywhere in the world is situated in a region of riots or guerrilla activity, and no revolution or war—even a 'conventional one'—takes place in these regions. The enormous quantities of extremely dangerous material must not get into the hands of ignorant people or desperadoes. No acts of God can be permitted.
Hans Alfren, Nobel Laureate

* The risks and consequences of accidents in nuclear power stations have been closely examined in many studies in recent years and these conclude that the risks of a serious accident are extremely small and considerably lower than the level of risk normally considered as acceptable.
Government Green Paper on Energy.

NUCLEAR IRELAND? looks at these opposing views—and many others—in the context of the nuclear power station now being considered for Carnsore Point in County Wexford.

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Dr. Matthew Hussey is a medical physicist who teaches at Kevin Steet College of Technology. He has spoken extensively on the nuclear issue and is a recognized expert on radiation and its effects.

Carole Craig is a journalist who has covered the nuclear controversy in Washington D.C.

NUCLEAR IRELAND?

Matthew Hussey · Carole Craig

NUCLEAR IRELAND?

Matthew Hussey and Carole Craig

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All statements in italics are from the government's Green Paper on energy *Energy-Ireland, Discussion Document on some Current Energy Problems and Options.* Numbers in parentheses are page numbers.

INTRODUCTION

With the announcement of the government's plan to build a nuclear power station at Carnsore Point in County Wexford, Ireland has been launched full tilt into the centre of the nuclear controversy.

According to the government's Green Paper on Energy, Ireland is an "energy deficient" country, importing 80% of the energy it uses. Seventy five per cent of this is oil, a fuel subject to unpredictable price rises and political embargos.

To remedy the situation, the present government recommends the development of an energy programme based on the use of other energy sources, electricity generated by nuclear power coming at the top of the list.

The nuclear option is now being debated world wide. Britain, Spain, France, Germany, the Netherlands, Sweden—where a national election was fought on the issue—Japan and the USA all have nuclear power stations and growing anti-nuclear movements.

Without nuclear power, say its defenders, we shall all end starving, freezing and fighting in the dark. With it, say the opponents, pointing to the alternatives, we will endanger ourselves and the environment for longer than the recorded history of humankind.

In Ireland, as in all countries involved in the nuclear controversy, the debate is not just about one form of energy rather than another, but about the future of Irish society.

Nuclear power represents a path of energy development—and therefore economic development—which requires large capital investment, centralization, and careful government regulation.

The alternatives—conservation and the use of renewable resources (biomass, sun, waves, wind)—would employ people rather than vast amounts of capital, tend toward decentralization (such as solar heating of homes), and require little government intervention.

The question, then, of whether or not Ireland is to 'go nuclear' is not just a technological one, but has a moral and economic base, about which it is the right of every citizen to decide.

This book is designed to give an account of both the technological and social issues as they apply to Ireland in the nuclear power debate.

DR. BORIS by Martyn Turner

RÉAMHRÁ

Ní Mór Na Ceisteanna go Léir a Bhaineann le Fuinneamh Núicléach a phlé.

Tá beartaithe ag Bórd Soláthar an Leictreachais stáisiún ginte leictreachais núicléach a thógáil ag Rinn an Chairn i gContae Loch Garman. Féachann sé go bhfuil an t-Aire Tionscail, Tráchtála agus Fuinnimh, an t-Uasal Ó Máille, díreach chun cead a thúirt don mBórd dul ar aghaidh leis an obair. Ach níl daoine uile na tíre ar aon aigne i dtaobh na ceiste, nó mar ba chóir a rá, i dtaobh na gceisteanna a bhaineann le fuinneamh núicléach.

Dar leis an t-Aire, tá an stáisiún núicléach seo ag teastáil ón dtír chun go mbeimíd i ndon dul chun cinn a dhéanamh i gcúrsaí eachnamaíochta agus sóisíalta. I láthair na h-uaire, 80% dár mbreosla iomlán, ola is ea é as tíortha thar lear. Is ró mhór ár spleáchas ar ola, go mór mhór toisc nach mairfidh na foinsí ola ach go de an mbliain 2010 nó mar sin.

Dá bhrí sin, deireann an t-Aire agus an Bórd, go bhfuil sé do dhíth orainn éagsúlacht breosla a bheith againn. Gléas ginte leictreachais núicléach an tslí is fearr agus is sláintiúla dar leo chun an cuspóir sin a bhaint amach. Ní mór an chontuirt a bhaineann len a leithéid de ghléas, dar leis an t-Aire, mar féach conas sna Stáit Anotaihte atá a dó nó a trí nó fiú a ceathair de stáisiúin núicléacha in aice le cathracha éagsúla, agus iad ag obair gan tubaist le blianta anuas.

Deireann fir labhartha an Bhóird nach bhfuil rogha againn, má theastaíonn leichreachas uainn sna deicheanna amach anso, ach fuinneamh núicléach nó gual a úsáid. 350 million púnt an buille fé thuairim ar chostas an stáisiúin beartaithe ar Rinn an Chairn, a thugann na h-údaráis.

Ar an dtaobh eile den gceist, tá meastacháin eile anso - níos mó ná 1000 milliún púnt—ar an gcostas iomlán. Agus ní féidir praghas a chur ar láimhseáil an fhuílligh raidighníomhaigh ná ar threascairt an stáisiúin fédheirethair. Agus tá praghas an úráiniaim ag bolgadh ó bhliain go bliain.

Tá tuairimann chó maith nach féidir fuílleach an stáisiúin, ná fiú an breosla uráiniaim féin, a iompar ná a láimhseáil gan an-chontúirt do na hoibrí agus don phobal taobh amuigh den stáistiún. Cuireann láimhseáil an fhuílligh raidighníomhaigh sin na h-oibrí agus an pobal i bfheidir na h-ailse, bfeidir cúig nó fiche bliain ina dhiaidh. Agus beidh an fuílleach raidighníomhach, a bheag nó a mhór de na mílte blian.

Tá seans ann chó maith dá dtárlódh an-thubaist i stáisiún núicléach, go gcaillfear na mílte duine agus go scriosfar mór-chuid den tír. An bhfuil sé ceart a leithéid sin de dhúchas a fhágáil dos na glúnta le teacht?

Tá tuairim ann gur féidir fuinneamh a bhaint as solas na gréine, as na gaoithe, as tonnta na farraige agus ar mhodhanna eile—agus nach gá brath ar fhuinneamh núicleách in aon chor. Agus is cosúil go mbeadh mórán jobanna le fáil dá mbainfear leas as na gléasra fuinnimh sin.

Dar len alán daoine bheadh bagairt ar leasa sibhíalta agus leasa na gcéardcumann maidir leis an bhfuinneamh núicléach. Agus tá baint freisin ag an bhfuinneamh núicléach síochánta le rás na n-arm núicléach, rud a bhagraíonn an cine daonna uile le léirscrios.

Mar sin ní mór na ceisteanna tábhachtach sin a phlé go h-iomlán ag muintir na h-Éireann, roimh dul ar aghaidh le plean Bóird Soláthar an Leictreachais stáisiún núicléach a thógáil i Rinn an Chairn.

Iarracht tosaigh ar na ceisteanna sin a chíoradh atá san leabhar seo.

ENERGY

Basics

Our standard of living and continued well being are largely dependent on the future availability of adequate supplies of energy at reasonable cost. (9)

In a fully industrialized society such as Ireland is rapidly becoming, the energy question is not just concerned with the price of petrol at the pump or winter heating bills, but it is a question of the running of the entire economy.

As the 1973/74 oil crisis so graphically illustrated, when fuel supplies are seriously disrupted, everything is disrupted.

Ireland, according to the current Minister for Industry, Commerce and Energy, Mr. Desmond O'Malley, is more vulnerable to such interruptions than any other Western European country, running as it does an "energy deficient" economy, with 80% of all energy sources being imported, 75% of those being oil.

Oil supplies have been steady since the end of the oil embargo in 1974, but the government is concerned about the future. World oil reserves are not expected to last much beyond the beginning of the next century, and with sudden price rises and political manipulation, even present supplies cannot be depended upon indefinitely.

The largest consumer of fuel in Ireland is the Electricity Supply Board (ESB) which uses oil, turf, and coal (primary fuels) to generate electricity (secondary or end-use energy). The ESB uses about 30% of the total primary fuel in Ireland to generate electricity, which is about 10% of the energy the public consumes. The rest of the energy from the primary fuel burned by the ESB simply leaves the power stations as waste heat.

The ESB generates about two thirds of its electricity from oil. It can now produce more electricity than is needed, even at times of greatest demand (ESB capacity is 2,500 megawatts[1], peak demand in winter is 1,800 megawatts) so electricity supplies are safe for the present and will probably remain so until the mid-1980s.

But the future, as it is foretold by the present government, will requre the ESB to do more than simply maintain present capacity. The government predicts the future will hold more jobs, created by more industry, demanding more energy, particularly electrical energy.

Energy and economics

> *A high economic growth rate for the indefinite future with its corollary of increased energy consumption is the underlying assumption upon which all our forecasts of likely energy demand in the years ahead are based. (22)*

It is social policy, particularly jobs policy, which the government claims underlies its energy plans. Unemployment is the Republic's most pressing problem; industry is needed to create more jobs. In the government's economic analysis, productivity as measured by the Gross National Product (GNP, the total value of goods and services produced in one year) must be expanded to cure economic injustice and to fund social services.

The government plans that a rise in the GNP will mean an even greater rise in the consumption of energy, pointing out that in the economic boom of the last ten years, the demand for energy has risen by 50%.

Despite the recent rapid economic growth, there are now more people unemployed in Ireland than ever before. Advocates of a non-nuclear future say that economic growth does not automatically mean either more jobs or greater energy consumption.

The GNP simply measures growth, not what kind. It will

1. million watts, the amount of electricity it would take to light ten thousand 100 watt lightbulbs, or a thousand single-bar electric fires.

show a healthy increase if everyone is stuck in a car twenty four hours a day burning petrol, a state of affairs which would insure higher energy consumption, but would not create jobs and do little in the way of guaranteeing social justice. They also note that countries such as the United States now plan for an expanding economy linked to decreases in energy use.

Opponents of nuclear power argue that the issue is not just industrialization and economic growth, but what kind. A nuclear power plant which requires massive capital investment and directly creates very few jobs, they think, is heading in precisely the wrong direction.

There is no doubt that electricity is an attractive form of energy. It is high grade, clean and versatile at point of use, but much of the use to which electricity is put in Ireland is inefficient. Well over half the electricity used in this country goes for space and water heating. The ESB runs efficient power stations over all, but even in these about 70% of the energy stored in the primary fuels is not used to generate electricity, but is simply emitted to the environment as waste heat. Thus more heat is lost than arrives at the end of the plug, rather like carrying water in a bucket full of holes.

Some claim that heating would be better done with primary fuels and electricity saved for the few truly electrical uses, such as appliances, TVs, radios, computers and the like.

The Council of Ministers for the European Economic Community feels that the advantages of electricity use far outweigh the disadvantages of its production. Since the oil embargo of 1974, the Ministers have been working on an energy policy which includes among other things, the use of more electricity as nuclear power is developed.

Ireland, as a member of the EEC, will probably follow EEC energy policies. Mr. O'Malley claims that a switch away from electricity wouldn't be possible or desirable in Ireland and instead the ESB should plan to meet a demand for electricity increasing at about 8½% a year.

Although increased electrical output could come from a number of sources, conventional coal or turf stations or, if the ESB was feeling creative, alternative sources, Mr. O'Malley thinks that nuclear power provides the best bet.

REACTORS

How they work

There are now about 200 nuclear reactors generating electricity in twenty countries throughout the world and some 350 or more planned or in the course of construction. Nuclear power was first used for military purposes in 1945 but quickly adapted for peaceful uses. Essentially, nuclear power is basically suitable for electricity generation and has been used so for the past 20-25 years. (60)

The basic job of a nuclear power station is little different from that of a coal, turf or oil burning one. Heat produces steam to turn turbines to generate electricity.

In fossil fuel stations, energy comes from a chemical reaction, combustion, releasing what is essentially heat from the sun stored in the fuel. In a nuclear power station heat comes from a chain reaction in which the unstable element uranium 235 is hit by a neutron and breaks apart, releasing heat.

The process is more complex and many times more concentrated than burning fossil fuels. If all the energy contained in one kilogram of uranium could be released, it would be equal to the energy produced by burning 3 million kilograms of coal.

To understand how this is possible it is helpful to take a short look into the structure of the atom.

Nuclear power is so called because the energy is released through a process in the nucleus of the atom. Atoms are the smallest division of matter possible. For instance, if you could cut an atom of uranium in two, you would no longer have uranium. but two different elements, such as strontium and iodine.

In an extremely rough way, an atom looks like the solar system. The nucleus, full of positively charged particles called protons and neutral ones called neutrons, is rather like the sun. It is circled by a number of other particles with negative charges called electrons, somewhat in the same way the planets orbit the sun.

Inside the nucleus of the atom, the positively charged protons have a tendency to repel each other. The neutrons act as a kind of glue. But in the nucleus of an atom such as uranium there are so many protons (92) that the neutrons have a hard time keeping the protons from flying off in all directions.

The number of protons in the nucleus of an atom of a given element must be constant, but the number of neutrons can vary. Uranium 235, called an isotope of uranium, has 143 neutrons and is very unstable. If a stray neutron hits the nucleus of a uranium 235 atom, the nucleus will break apart with such force that a great deal of energy is released, some of it in the form of heat.

In the process of the nucleus breaking apart, called nuclear fission, usually three fifths of the atom will go one way and two fifths another with two or three stray neutrons shooting out in yet other directions. If one of the escaping neutrons hits the nucleus of another atom of uranium 235, it will also break open and start the process all over again. If this chain reaction happens where there is a high enough concentration of uranium 235 and it goes out of control, the result is an explosion that is the same as in an atomic bomb.

Fission in the reactor core is carefully controlled. Uranium is put in the core inside fuel rods, which are placed in such an amount and arrangement that they sustain the fission process. Eventually the uranium 235 is used up and must be replaced. Depending on the kind of reactor this happens in from one to five years.

The fission has created elements that were not in the original fuel. Many of these are unstable and continue to

break down, releasing heat, even after they have left the reactor core. Spent fuel rods are highly radioactive and deadly.

One of the biggest problems for the nuclear industry and the energy bodies buying its products is that no one has come up with a satisfactory and safe final resting place for the spent fuel from nuclear reactors.

Supporters of a non-nuclear future, pointing out that some of the radioactive waste will stay dangerous for half a million years, argue that at the very least, building new reactors should stop until some way is found of disposing of radioactive waste.

Reactor types

It is likely that the choice can be narrowed down to a light water reactor of either the pressurized or boiling water type or a heavy-water reactor, all of which are in satisfactory operation elsewhere and have a good safety and reliability record. (68)

There are several major types of reactors in operation throughout the world. The light water and heavy water reactors mentioned in the government's Green Paper on Energy, refer to reactors with different kinds of moderators.

If neutrons bouncing around inside a reactor core are travelling too fast, they bounce off uranium 235 and fail to cause fission. By hitting another substance, called the moderator, neutrons are slowed down to so-called thermal speeds, at which they can more easily react with uranium 235.

The heavy water reactor is the Canadian CANDU reactor which uses chemically different (heavy) water as the moderator. The light water reactors are manufactured by American companies or under contract to American companies. In these, ordinary water is used as the moderator.

In all three the moderator also acts as a coolant, taking heat away from the core and transferring it, in the case of heavy and pressurized water reactors, to other water to create steam. In the boiling water reactor steam from the coolant itself turns the turbines. The boiling water reactor is technically the simplest and least expensive. In the reactor planned for Carnsore Point, approximately half a million gallons of sea water per day will be used in this final stage.

Light water reactors are very popular with the nuclear industry; outsiders sometimes have difficulty in understanding why. Nuclear reactors, like ordinary power stations, convert only a quarter to a third of the heat generated to electricity. There is evidence that the light water reactor does this less efficiently than other reactor types.

Industry estimates of the cost of electricity generated from nuclear power are usually based on the assumption that the reactor will run at 80% efficiency. A 1974 report commissioned by the American Ford Foundation showed the efficiency rate for light water reactors was below 40%.

Nor is the safety record of light water reactors anything to write home about. Although the frequently heard claim that there has never been a serious accident with light water reactors is accurate, there is a growing list of near misses.

The biggest safety problem in light water reactors is their emergency cooling system–designed to keep the temperature in the core of the reactor from getting too high if for some reason the primary cooling system fails. Although the emergency core cooling systems have been tested in computer simulations, there is no convincing experimental evidence that they work. In one series of experiments carried out in 1970/71 with a table top model of a pressurised water reactor, the emergency core cooling system failed six out of six times.

The reactor planned for Carnsore Point would have a generating capacity of 650 megawatts, an amount equal to about a third of the electricity now being used at peak times in the Republic. The ESB says that it would probably be the first of four reactors projected for the site. If the entire complex is completed according to plan it will have a generating capacity of 2,500 megawatts.

The question, then, is not just of one reactor, but a full

committment to nuclear power. Whatever the arguments for and against a nuclear power station at Carnsore Point, they are multiplied many times by the idea of four.

SAFETY

Radioactivity

> *There has been public concern in many countries about the introduction and use of nuclear power. This concern has centered around a number of issues including reactor safety, the disposal of wastes, the possibility of proliferation of nuclear weapon capability, security against terrorism and decommissioning of a nuclear power station at the end of its useful life.* (61, 62)

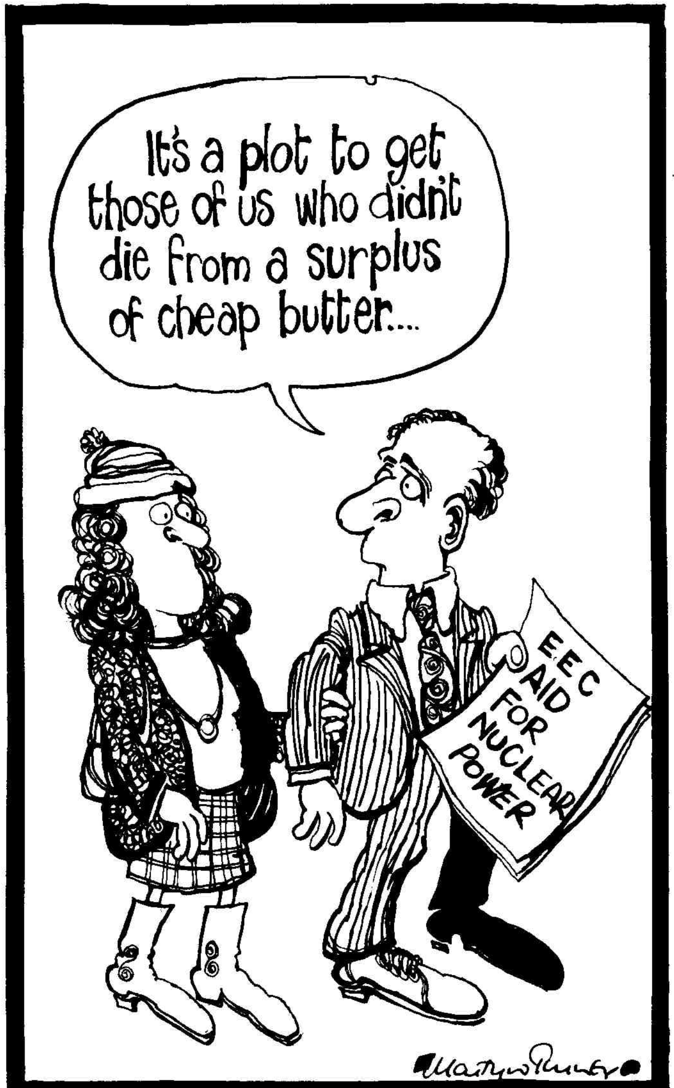
The numerous lists of objections to nuclear power are long and varied, but the issue of safety always comes at the top. There is concern about what can happen if there is a major accident and concern about what is happening if there isn't one. Either way the great villain of the reactor safety issue is the radiation produced by radioactive atoms.

No one disputes that radiation produces cancers and birth defects. But these effects can take years and even generations to develop, making it difficult to isolate one cause in an industrial society from hundreds of possible others.

The nuclear power safety debate centres on how many of the thousands of cancers and birth defects appearing each year come from the radiation produced by the nuclear industry and how many more will result from increased numbers of reactors.

Another short look inside the atom will help make it clear why these questions arise.

Very few radioactive atoms can undergo fission, but all radioactive atoms undergo 'decay'. The nucleus of any atom of radioactive matter is very agitated. In order to calm down, sooner or later the atom is likely to let fly a lump. If this lump, or sub-atomic particle as it is more properly called, is



made up of two protons and two neutrons it is an alpha particle and it can be stopped by a sheet of paper.

Sometimes an excited atom will have a gentler sort of breakdown, squirting out just an electron or a neutron. Neutrons keep their own names when they come flying out of the nucleus, but electrons are called beta particles. Beta particles can be stopped by a sheet of metal foil. Frequently accompanying these outbursts energy is emitted in the form of a wave like ordinary light, but invisible and much more energetic. Called a gamma ray, it is similar to the X-rays used in medicine. Gamma rays and neutrons can penetrate up to three feet of concrete.

The number of negatively charged electrons circling the nucleus is always equal to the number of protons inside the nucleus. Thus an atom has no electrical charge. But when hit by radiation which causes it to lose either protons or electrons, the atom becomes charged and is called an 'ion'. The radiation which makes an atom into an ion is called ionizing radiation, and is the kind of radioactivity produced by nuclear fission.

Although it is impossible to tell when a nucleus will begin emitting particles, one can predict that a certain number of atoms of a particular substance will do so in a certain length of time. The time it takes for half the total number of radioactive atoms present to give up their radiation is called a half-life. The length of a half life varies, in some substances it is a few seconds, in uranium 235 it is seventy-one million years.

The exact amount of ionizing radiation it takes to seriously damage living cells is a matter of controversy. Except in massive amounts where the radiation rips through the body's cells like an atomic whirlwind causing so much damage that death soon follows, the effects of exposure to ionizing radiation can be subtle and hard to detect.

By disrupting the atoms of living cells, radiation can interfere with a cell's delicate internal balance, destroying the cell's ability to use some substances, manufacture others and rid itself of the waste. Sometimes the body can overcome the damage. But if a large number of cells in a particular organ are hit, illness can follow. If the organ is a major one like the intestines or the liver, damaging the body's ability to function can cause death.

A cell only slightly hurt by radiation can remain where it is without serious problem. But if for some reason the cell is called upon to multiply—the way that cells of the skin multiply to heal a cut—it can grow abnormally because the radiation has disrupted the cell's memory. The cell can multiply too quickly or too slowly or it can grow in some abnormal fashion and become a tumor. Such abnormal cell growths are usually cancerous.

Reproductive cells damaged by radiation follow much the same pattern, but the birth defects caused may not show up for generations.

There is debate on whether the nuclear industry can be successful in designing reactors which keep all radiation contained in the reactor core. It is a debate made more difficult because radiation is invisible and its effects so frequently take such a long time to appear.

The general population must base its opinions on the statements of a variety of experts, with whom they share little in the way of common experience, and who often appear to contradict each other. This is especially true in the area of accidents within nuclear power stations where the public is faced with a multitude of predictions, accusations, claims and counter claims of a host of arguing experts.

Accidents

> *Insofar as reactor safety is concerned it is well to make it clear that a nuclear reactor cannot explode like an a atomic bomb. However a range of accidents can occur, despite the many safety factors included in the design of nuclear stations to prevent accidents, which could release radioactivity. (62)*

No reactor currently in commercial use can explode like an atomic bomb, although fast breeder reactors now being tested may well do so. The worst accident that can happen to a conventional nuclear reactor is a core meltdown. A meltdown in the reactor planned for Carnsore Point would release into the atmosphere as much radioactivity as 200 Hiroshima bombs.

Supporters of nuclear power are usually quick to point out that no such accident has ever occured; frequently they are not so quick to admit it has come close.

During normal reactor operation the fission and radioactive decay going on inside the reactor core generate vast quantities of heat. Even when fission is halted by shutting the reactor down, decay continues to produce heat.

A coolant, usually water, must be constantly circulated through the pipes in the reactor core to keep temperatures at a safe level.

If both the primary and the emergency core cooling systems fail and not enough coolant is applied to the reactor quickly enough, the resulting heat can melt the uranium inside the fuel rods and eventually melt the outer metal casings of the fuel rods themselves. In a complete meltdown a stream of radioactive liquid can burn through the reactor's outer steel walls and concrete casings, eventually boring deep into the earth below.

Any water encountered on the way will turn to steam. If the outer wall is not already breached, the pressure from the steam may rupture it, releasing a radioactive cloud to the outside air.

Potentially the most serious accident to date happened in the United States at the world's largest reactor complex in Browns Ferry, Alabama. In March, 1975, an electrician checking the flow of air in a cable duct with a candle started a fire which burnt for seven hours and took out all five emergency cooling systems in one reactor core.

There have been many other accidents and near accidents at reactors about which anyone deciding for or against nuclear power ought to be informed. A short list of the more spectacular accidents follows.

1952, Chalk River, Canada, a technician mistakenly opened the valves which removed 3 or 4 of the shut off rods from the reactor core. The chain reaction speeded up to such an extent that heat melted some of the fuel rods. The molten metal reacted with water causing an explosion. It took 14 months to repair the damage.

1957, Windscale, England, an engineer withdrew a control rod which raised the temperature in the reactor core to such a point that a fuel rod ignited. At the height of the fire 11 tonnes of uranium were burning. When the fire was extinguished 24 hours later it was discovered that unknown quantities of radioactivity had escaped into the surrounding atmosphere. Over 2 million litres of milk had to be destroyed.

1966, Detroit, Michigan, an inadequately installed reactor part blocked the flow of coolant in a fast breeder reactor core, raising the temperature to the point where some of the fuel melted. Because a fast breeder reactor can explode like a bomb, police and civil defence authorities claim they were warned they might have to evacuate Detroit. The reactor was not started up again until 1970 and was closed for good in 1972.

1969, Lucens, Switzerland, a pressure tube burst, seriously damaging the reactor core and causing a loss of coolant. Although there was no fire, leaking radioactivity reached the machine hall, fuel storage chamber and eventually the control room. The reactor was later completely dismantled.

1970, Chicago, Illinios, pressure valves and gauges worked improperly in a light water reactor and in a series of mis-adventures, pressure inside the reactor core dropped. To correct the situation engineers in charge of the reactor had to take steps that went directly against the terms of their operating license. For two hours radioactive iodine 131 was discharged to the outside air at 100 times the maximum permitted concentration.

Probabilities

The risks and consequences of accidents in nuclear power stations have been closely examined in many studies in recent years and these conclude that the risks of a serious accident are extremely small and considerably lower than the level of risk normally considered acceptable. (62)

Although some studies indicate increased numbers of cancer deaths over a large area downwind some years after the escape of radioactivity at Windscale, and the same may hold true for other of the accidents listed here, no one was immediately injured or killed. The big question is whether we can expect to avoid a truly catastrophic accident in the future when there will be many hundreds more reactors around the world.

Answers range from predictions that a core meltdown is inevitable, to predictions that it is impossible.

Of the studies on the probabilities and effects of such an accident at a nuclear power station, the most famous is the Rasmussen report, published in 1973. It is one of six major studies on nuclear safety, and its fame is due at least in part to its popularity with the nuclear industry because it predicts lower fatalities from an accident at a nuclear power plant than do the other reports.

Professor Norman Rasmussen, who sits on the boards of three companies involved with nuclear power, says that the highest fatality rate from any one reactor accident would be 300 deaths, as opposed to a German study, for example, which predicts 100,000 deaths from an accident in a reactor near Mannheim. It was the Rasmussen report that was used in the study for An Foras Talúntais: *Nuclear Power at Carnsore Point, the Agricultural Implications.*

There are two major areas in which Rasmussen is open to serious question. He estimates the chances of the worst kind of accident happening as one in a hundred thousand. Rasmussen's method of calculating the likelihood of accidents was used and rejected by the United States National Aeronautics and Space Administration (NASA).

By this method NASA predicted one launch failure in every ten thousand missions. The actual performance rate was four failures in 100 launches.

Rasmussen's methods applied to the accident in 1966 near Detroit, Michigan would estimate it as having a chance of occurring once in a million years. An incident such as the one near Chicago in 1970 "could" only happen once in a million, million, million years, actually it happened twice in one year.

Rasmussen's assumption that no more than 300 deaths would occur in the worst possible reactor accident is based on an assumption about the relationship between radiation and cancer which has been questioned by the United States Environmental Protection Agency, which lodged an official protest at Rasmussen's "distortion" of their data.

A 1975 report by the American Physical Society estimated between ten and twenty thousand deaths in a major accident, confirming the figures of a 1957 report. They also estimated sixty times more birth defects than Rasmussen had predicted.

Rasmussen predicted a small number of fatalities based on rapid evacuation. As Dr. Robert Blackith points out in his book *The Power that Corrupts*, in Ireland one cannot assume that everyone will have a car in which to leave the contaminated area quickly. So even accepting Rasmussen's probabilities, fatalities here might be higher.

If one trades the findings of Rasmussen's study for the 1957 Brookhaven Report, one would come up with the following figures for Ireland:

up to 15 miles from the reactor 3,400 dead
up to 44 miles from the reactor 43,000 cases of radiation sicknes.
up to 205 miles from the reactor double the risk of cancer for 182,000 people

If an accident did not involve a complete core meltdown, the results though less dramatic could still be serious. After a fire at a plant manufacturing nuclear weapons components in Rocky Flats, Colorado, the soil around the plant was found to be heavily contaminated by plutonium.

Since that time farmers report a significantly higher number of birth defects in livestock—such as a mare born with no front feet and lambs born with no bones in their hindquarters.

Far more likely than large-scale accidents are malfunctions in the normal running of the reactor in which small amounts of radiation are released to the atmosphere.

Normal operation

The best advice available is that the normal operation of a nuclear power station does not represent a hazard insofar as the discharge of radioactive effluents or wastes to the environment is concerned, because such effluents are easily controlled to minimal levels. (62)

If you lose faith in human error, dismiss the expanding collection of stories about reactors misbehaving, and, against all reason, assume that a nuclear reactor in Ireland will work perfectly forever, the question of the radioactivity emitted during normal operation of a reactor must still be raised.

No one denies that emissions happen. It is the effects they argue about.

Supporters of nuclear power claim that a nuclear power station is less polluting and dangerous than a normal coal or oil burning one. In terms of visible atmospheric pollution, they are certainly correct. With some accuracy they claim the radiation released in normal reactor operation is only a tiny fraction of the normal background radiation that everyone is getting all the time anyway.

It is a bit like arguing that if a lot of poison will certainly kill you, a little shouldn't do any harm.

In Ireland, normal background radiation in the form of gamma rays from the stars, ultraviolet radiation from the sun and assorted radiation from various radioactive atoms results in between 150 and 750 cases of fatal cancer and leukemia a year. These figures are based on the BEIR Report, from the United States National Academy of Sciences. Background radiation is also estimated to cause between 1,000 and 10,000 genetic deaths (such as miscarriages) and between 30 and 700 birth defects a year.

In the past thirty years, background radiation has been increased by another of the uses to which humanity has put the atom, atomic bombs and atomic bomb tests.

Although most radioactivity is created inside the reactor core, the entire fuel cycle—mining, processing, fissioning, re-processing, disposing—must be taken into consideration.

In Donegal, explorations for uranium are now being undertaken with a fair chance of success.

From the moment the shafts of uranium mines are sunk, increased human exposure to ionizing radiation begins. In the ore body are many radioactive products of uranium decay, such as radium 226 and radon 222. The gas, radon, is thought to have a high likelihood of causing lung cancer when inhaled.

The United States Public Health Service has estimated from 600 to 1,000 men who worked as uranium miners in Colorado have died or will die of lung cancer caused principally by breathing radon on the job.

After mining, uranium is extracted from the ore leaving vast quantities of radioactive liquid and solid waste (tailings). Disposal of this waste has presented problems in the United States where vast mountains of radioactive tailings were left

to blow about in the wind, waste contaminated a city's water supply, and sandy tailings were used in housing construction, exposing residents to the possibility of cancer.

The processed uranium ore is called yellow cake. Depending on the kind of reactor it is bound for yellow cake either goes to be fabricated into fuel rods or into an enrichment plant, where the concentration of uranium 235 is increased from about .7% to 4%. After enrichment the uranium is placed in fuel rods. Up to this point the uranium has a low level of radioactivity.

Routine release

The exposure of persons, both workers and members of the public, to low level radiation would be fully controlled under the licensing arrangements envisaged for Carnsore to ensure that no person undergoes an unacceptable level of risk. The standards to be observed would be built on international recommendations and *the most recent developments in the knowledge of radiation and its effects. (71)*

Once in the reactor uranium begins the process of fission and its radioactivity increases dramatically. During the course of normal operation, cooling water carries away quantities of radioactivity, particularly carbon 14 and iodine 131, some of which filters through to the outside world, in what is termed 'routine release'. Some reactor designs also call for a constant stream of air to be blown past the reactor core and then released to the outside air again.

Naturally every effort is made to keep emissions to a minimum. But small accidents and operational errors (more than 400 in the United States alone between 1969 and 1977) have on numerous occasions allowed radiation beyond the specified limits to escape.

Even if radiation did not escape, there are too few studies of the effects of long term exposure to low level radiation. However in the past year evidence has been found of increased deaths from cancer in areas around nuclear power stations in the United States.

According to Dr. Sternglass of the University of Pittsburgh in the United States, a 58% rise in cancer mortality occured in Waterford, Connecticut after a nuclear power station had been in operation there for five years. The rise in cancer deaths was linked to radioactive emissions from the station and the finding in milk of elevated levels of strontium 90–a radioactive isotope which settles in bones and is particularly dangerous to children. Further down wind the levels of strontium 90 in milk were lower and the increase in cancer mortality less.

When large amounts of radioactivity leaked into the Columbia river in the United States, it was found that insect larvae in the river concentrated the radioactivity by a factor of 350,000 and birds which ate the larvae by a factor of 500,000 times more than the radioactivity in the water. The

same increase was true of fish and plants and probably true of the people who ate the fish.

People will naturally be uncomfortable with the idea of concentrating radioactivity in their bodies, but due to the invisible nature of radiation and the large scale statistical analysis that is needed to gauge its effects, they have little way of calculating what is happening to them. The public finds itself dependent on experts whose opinions and advice they have little way of judging.

Judgement on the nature of the information and opinions reaching the public is further confused by the realization that the nuclear industry itself plays a large role in setting the standards by which it is to be governed. No industry is likely to make recommendations that are so stringent it risks going out of business.

The problem for the ordinary person trying to make sense of the experts is highlighted in the history of the setting of the limits of safe exposure to radiation.

Exposure to radiation is measured in rems. The maximum amount allowed for someone working in the nuclear industry is 5 rems a year. For the average citizen it is .5 rem.

But in 1925 the amount considered safe was 70 rems, in 1934 it was 50 rems, 1950 it was 15 rems and in 1956 it was 5 rems. There is now a campaign in the United States for a reduction to .5 rems for workers in the nuclear industry because evidence is beginning to accumulate that those exposed to official levels have unacceptably high rates of cancer.

Those setting the official safety standards are asked to balance the evils of a certain number of cancer deaths against the social good of electrical power generated by nuclear energy.This is no different than the thinking about many other aspects of modern society, of which the private car is an outstanding example. Everyone knows that hundreds of thousands have been killed by the automobile, but cars are not banned because the social good of private transport is thought to outweigh the evil of death and maiming in car accidents.

However, while admitting the need for new forms of energy or energy use, questions must be asked about whether atomic energy best meets these needs and is worth the price.

Left overs

There are, however, problems relating to the management of spent or waste fuel which contains quantities of long lived radioactive products. These products, because of the harm they can cause, must be kept in isolation for extremely long periods. The necessary management technology is being extensively developed at international level and though, as yet, no generally accepted solution has been conclusively demonstrated there appears to be a broad consensus of opinion emerging that the problem will be solved by storage of radioactive wastes (suitably packaged) in stable, geological formations. (62,63)

Fuel rods serve their time in the reactor core to emerge highly radioactive. At this point the question arises of what to do with the left-overs, a problem complicated by the fact that spent fuel is lethal and, in the view of the nuclear industry, very valuable.

Within the fuel rods is a witch's brew of long-lived radioactive isotopes—strontium 90, iodine 131, caesium 137, plutonium 239, uranium 238, among others—some of which are not found in nature.

Some of the isotopes decay to safety in 300 or so years, others like iodine 131 have a half life of only 8 days. Iodine is concentrated in the thyroid gland which cannot tell the difference between radioactive and non-radioactive iodine. Because the thyroid gland controls growth, iodine 131 is especially harmful to children.

In one school in Britain, located near a nuclear power station, iodine pills are kept in reserve for the children to take in case something goes wrong with the reactor.

Plutonium 239 is undoubtedly the most important element from reactor waste. An almost totally man-made element, it is looked on by supporters of nuclear power as an important future resource and by supporters of a non-nuclear future with exceptional distaste. The nuclear lobby wants plutonium as the fuel for the next generation of nuclear reactors, the fast breeders. Those opposed to the nuclear industry's plans think plutonium is a uniquely dangerous poison.

Although plutonium emits alpha particles which may be shielded in any air tight container, it is so poisonous that a kilogram of it, if it were evenly distributed and inhaled by every person on earth would be enough to produce lung cancer in everyone. Plutonium remains dangerous for up to half a million years.

There are two reasons for re-processing the waste from nuclear reactors, rather than storing it in tanks until the technology is developed to dispose of it completely. One is that the plutonium in spent fuel is used in nuclear weapons programmes. The other is that the nuclear industry's plans for plutonium as the fuel in fast breeders will make it very valuable if fast breeders ever run on a commerical basis.

Because of the association between re-processing and weapons programmes, some countries, such as Canada have said they will do no re-processing of their nuclear wastes.

Even when re-processing is planned problems of what to do with waste before fast breeder programmes get under way remains.

When fuel rods are first removed from the reactor core they are stored in cooling ponds. The ESB no doubt plans to export spent fuel from Carnsore for re-processing. But it is a plan that may not be so easily carried out.

Austria's nuclear programme until recently was halted because there was no where to bury the waste, and Japan ended up spending £600 million more than planned when an American re-processing plant defaulted on its contract.

Exported waste might also come back. Britain is reported to be examining sites in South Armagh as possible nuclear dumping grounds. And for the past several years radioactive waste has been dumped about 400 miles off the Cork coast.

Experiments are now going on to devise a safe way of placing radioactive waste in glass or ceramic blocks for burial deep underground. But neither the method or the sites are yet thought foolproof.

Re-processing of spent fuel is easier said than done. At present there is no re-processing plant operating in the Western world capable of handling the spent fuel from the proposed power station at Carnsore Point. The new British plant under construction at Windscale, seventy miles across the Irish sea, will be suitable.

Re-processing is a chemical process which separates plutonium and uranium from other radioactive waste. It is usually claimed to be a military secret, but some nuclear scientists claim that anyone can do it.

Re-processing plants, like reactors routinely give off low level radiation in the form of gas and liquid waste. In 1973 and 1974 accidents at Windscale caused a release of ten times the amount of radioactivity normally concentrated in the 500 liters of waste it releases into the Irish sea each day.

For every tonne of reactor waste re-processed, about five cubic meters of high level radioactive waste are left. This too is now stored in cooling tanks.

The idea that Ireland might be used for such burials might cause concern. In 1957 a steam explosion occurred in an underground nuclear waste store in the South Urals in the Soviet Union. Vast amounts of radioactivity were released and spread by the wind over thousand of square miles. It is not known how many people were killed or the full extent of the destruction, but it is known that a huge area is still radioactive.

It is shamefully clear why the Soviet Union censored

An Irish Sea Fisherman Discovers the Benefits of Windscale

news of the explosion, but it is less understandable that the CIA, which now admits it knew of the catastrophe, did the same.

For the most part, radioactive waste is simply sitting around in storage tanks. None of the re-processing plants in the United States are working and reactor waste in America is now accumulating at the rate of 100 tonnes a month. Reports from the Environmental Protection Centre in Washington D.C. are that some reactors will have to close because nothing can be done with their waste.

Waste disposal is not the profitable end of the nuclear fuel cycle and therefore it has been somewhat ignored by the nuclear industry. There is one possible end for nuclear waste which has, however, attracted the industry's attention: the fast breeder reactor.

The present generation of nuclear reactors extracts a very small percentage of the energy stored in uranium. The fast breeder reactor is hailed by the nuclear industry because it can extract energy from uranium 238–currently useless but much more plentiful than uranium 235–and can extend uranium resources by many years.

Fast breeder reactors use plutonium 239 as their fuel and wrap a "blanket" of uranium 238 around the reactor core. As fission takes place stray neutrons combine with uranium 238 to produce more plutonium. As fission goes on more plutonium is produced than is actually burnt. In about 25 or more years the reactor has made enough plutonium to fuel another fast breeder.

The Government's Green Paper on Energy makes no mention of fast breeder reactors. However, if the four reactor programme planned for Carnsore Point is carried through, at least one of the reactors will be a fast breeder. Therefore when discussing the further implications of nuclear Ireland, political and economic, the significance of the fast breeder reactor will be included.

ECONOMICS

More electricity

> *To opt for economic growth in the future as we have effectively done is to opt for significantly increased energy consumption.* (23)

Born out of the race to invent the atom bomb, which was billed by the only government ever to use it as the only way to save the world from barbarism, nuclear reactors are now being sold as the only way to save the world from the dark ages.

Although there are disagreements about the precise amount of fossil fuel left in the world, no one expects it to last forever. Without the development of alternative forms of energy, frightening stories are told of hospitals without power, public transportation stopped, and massive unemployment. No doubt if patterns of energy use are not changed many of these predictions will come true.

In Ireland, however, the government links the energy question not to maintaining the current standard of living but to raising it.

The current government plans to create 25,000 new jobs annually in the next three years. Meeting this goal, they say, means increases in the gross national product of 7% a year. The pattern for the 1980s is expected to be much the same.

The government predicts that this rate of growth will be linked to a rise in the consumption of electricity at the rate of 8½% per year.

It is possible that the increased demand may not materialize. Both Northern Ireland and England have an over capacity of 40% because of over-estimating electricity demand some years ago. Every electricity system requires back up power. But too much idle capacity is expensive since loans are used to build power stations, and interest must be paid on these whether the stations are used or not.

If energy demand does rise in the next decade and the GNP along with it, Ireland's social ills may not vanish. In the United States the GNP has tripled in the past twenty years, but elementary social services, especially in big cities are closer to breaking down than ever before.

The assumption that increased energy use equals a higher standard of living is by no means proven. In countries like Sweden and West Germany the populations produce about the same amount per member as in the United States, but electricity consumption is about half, their social services better, and unemployment less.

Even if one accepted that more energy were necessary, particularly electrical energy, it is possible that nuclear power may be the most expensive way to provide it.

Building costs

> *Most estimates predict that the total cost, i.e. the sum of the capital and operating and fuel costs of electricity generated by nuclear power will be at least competitive with that from other fuel sources and should in fact be significantly cheaper. (65)*

In the early days of nuclear power it was claimed that electricity from nuclear fuel would be 'too cheap to meter'. This prediction turned out to be overly optimistic, but supporters of nuclear power still quote figures which make nuclear power appear the front runner in the cost stakes.

Supporters of a non-nuclear future claim that figures such as those supplied by Britain's Central Electricity Generating Board which show nuclear power to be half the cost of coal and oil are established by sleight of hand. They point out that a number of real costs, such as research, security, re-processing, waste disposal and decommissioning are left out when presenting the balance sheet

The United States Energy Research and Development Administration disputes the figures outright, saying that nuclear power, even on a cost per unit basis, let alone on an initial investment basis, is generally more expensive than its competitors.

There is evidence that the fact that nuclear power stations are more expensive to build and run than had been initially expected has had a severe impact on the nuclear power industry. The orders for reactors that American companies are so busily exporting have, within the United States, fallen off. There have been no new orders in America this year. Of the twelve new orders around the world, six were in France, which is legally bound to buy them, and the rest were in the third world.

It is much more expensive to build a nuclear power station than a coal or gas burning one and the £350 million the ESB estimates for Carnsore Point will probably have to be revised upward.

In the Phillipines two reactors were originally estimated to cost £250 million, but when the contract was signed the Phillipinos were getting one reactor for £550 million. In the United States cost overruns in excess of 100% are usual. If Ireland has a similar experience the final cost of building the reactor could multiply to 30% of the GNP, making it by far the largest single investment in the Republic's history.

A nuclear reactor can run about twenty-five years before it is too radioactive to be used, thus the investment will have to be repeated in the future. Perhaps the world's most expensive example of built-in obsolescence.

Running Costs

> *The total cost of electricity generated by nuclear power is much less sensitive to fuel cost escalation than that produced from coal or oil. This arises because the nuclear fuel cost is somewhat less than one third of the total generation cost for those types of stations. (65)*

Three things determine the cost efficiency of a nuclear reactor: construction costs, fuel costs, and capacity factor—the number of electrical units produced as a percentage of the number the station was designed to produce.

The cost of uranium fuel, unlike coal or oil, includes not only the ore and transporation, but also the cost of fabricating it into fuel rods and enriching it—a process which in itself uses enormous amounts of electricity and is the single largest factor in fuel costs.

Supporters of nuclear power have said that uranium will not be subject to the same kind of price rises as oil. But uranium resources are also limited and decreasing uranium supplies have raised the price of un-enriched uranium from six dollars a pound in 1973 to over forty in 1977.

The idea that there may be a uranium squeeze like the oil crisis has been suggested. The American multinational oil companies, which, it has been proven, were instrumental in bringing about the oil crisis of 1973, also control most of the world's sources of uranium. Although the actual amount of fuel needed by a nuclear power station is less than the amount needed by a conventional power station, limited supplies and dependence on foreign processing technology mean that vulnerability to foreign control will probably remain.

Most of the nuclear industry's calculations of the cost of nuclear power are based on a capacity factor of 80%, but in the United States this figure has been found to be around 40% or 50%.

Repairs on reactors can significantly add to running costs. Because the reactor is increasingly radioactive, more and more repairs have to be carried out by remote control or by a large number of workmen to make certain that no one is exposed to undue amounts of radiation. Thus making repairs complex, time consuming and expensive. A reactor in the United States had to be closed for three days when a workman's shoe fell into the pressure vessel.

About one in ten reactors never works properly at all. In such a case the reactor is frequently closed down for good. The purchaser of the reactor has no recourse except to write off the investment.

Decommissioning & waste

The basic technology for the future decommissioning of nuclear power reactors is being developed from experience gained in the decommissioning of small experimental reactors and the operation of nuclear power stations. The available options vary from placing the reactor in a partially dismantled condition with continuous surveillance through increasing states of dismantling to removal of the reactor and resting the site. (64)

By the time a nuclear power station has operated for twenty-five years or so everything about it is too fiercely radioactive to handle.

No one really knows what to do with a reactor whose time has come. Some say that technologies for dismantling do not exist, are unlikely to be developed and there is nothing safe that can be done except pouring concrete through the entire complex and leaving it. By 1973 seven American reactors were walled up because they were too dangerous to repair.

If decommissioning is developed, which will still mean leaving the station isolated and guarded for ten to twenty years, estimates of the cost of dismantling it are between 10% and 100% of the original cost. Decommissioning is not included in the original price estimates, but it is included in the price the customer pays.

The same is true of the wastes the reactor creates during its life time. Disposal of this will also be costly.

If radioactive waste is simply put into storage tanks, as is now the case in the United States and Canada, money will have to be spent on land, tanks, and handling equipment.

Acquiring a site for the tanks will probably arouse opposition that makes the Raybestos controversy look like a Sunday picnic.

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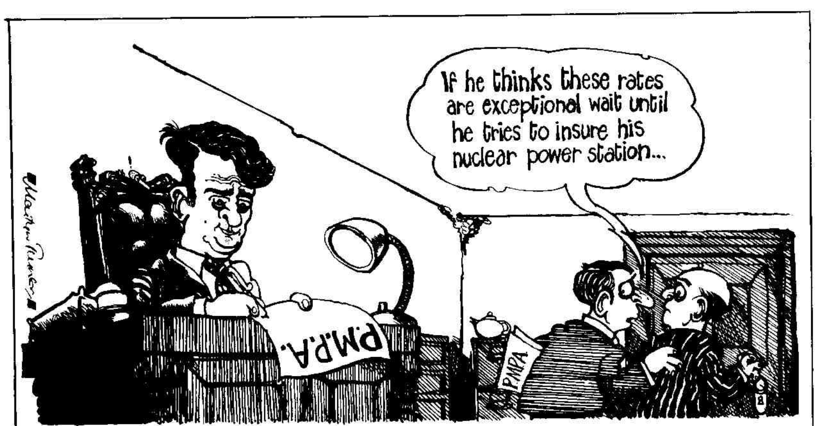
There are no calculations of the cost of the backup services needed to make a reactor run. Roads, port facilities, storage sites and the like are mentioned as necessary for smooth reactor running. But there is a host of other items which must be provided in case a reactor doesn't operate to plan.

Hospital facilities may be needed for the treatment and care of radiation injuries; there are now no such specialized facilities in Ireland. Emergency evacuation organizations for early warning and transporation will have to be set up in towns within at least thirty or forty miles of Carnsore Point.

Of all the side costs ot nuclear power insurance for third party liability is the most controversial. In the mid-1950s in the United States, prospective buyers of nuclear power stations shied away, worried about the amount they would have to pay if there were an accident. The American government responded by limiting the amount of damage that



would be paid in the case of an accident. British and European governments now have similar arrangements.

Two questions arise: if nuclear power is so safe, why did energy bodies lobby for the limitation and in the case of an accident who is to pay the difference between insurance coverage and actual damage.

Jobs

One of the advertisements for nuclear power is that it will create jobs both indirectly by attracting industry with cheap reliable energy and directly by employing Irish people in the running of the station.

The question arises of whether massive capital investment in a power station is the best way to create jobs.

Studies done by French trade unions indicate that nuclear power increases unemployment by using capital that could go into more labour intensive industry. The massive capital investment required to build a reactor pays for machinery not jobs.

In fact it is reported that one of the attractions of nuclear power in Britain in the 1970s was the uneasy labour relations in the coal fields.

Nuclear power will undoubtedly create some jobs. The government's gamble to raise Irish prestige by installing the latest in technological gadgetry may pay off by attracting foreign investment.

A nuclear power station does create direct employment, but it employs fewer people than would a conventional power station and at much greater cost per job.

Job creation by the nuclear industry, going by the American experience, is two and a half times more expensive than creating jobs in the manufacturing sector.

Official estimates are that between 100 and 200 people would be employed on a permanent basis. Using official estimates of the reactor's cost, as an employment scheme, the nuclear power station would spend over £1.5 million per job.

Employment during construction of the power station is estimated at 400 to 500 hundred jobs. Because much of the work would have to be done by experts brought in from outside, many of these jobs would be short lived.

This is apparently what happened in Anglesey, when the Central Electricity Generating Board said that from 2,000 to 3,000 jobs would be needed during the construction of a nuclear station there. Records show that during construction unemployment in the area went down by only 282.

There have been no studies to date of a full list of occupational hazards associated with work in the nuclear power industry. Few opponents of the industry claim that it is or has been an occupational disaster area. But the nature of the diseases—cancer and birth defects—caused by exposure to radiation means that there are still a good number of years in which fatal patterns can emerge.

Like workers in other high technology industries, workers in nuclear power take risks, the nature and danger of which they are not aware. In the nuclear industry where its close association with the military and weapons industry makes for secrecy, employees may be instructed only partially on the context in which they perform thier duties. Even without imposed secrecy, many major industries have exhibited an appalling pattern of keeping employees in the dark about the dangers they face.

In the United States the management of companies manufacturing insecticides and asbestos deliberately failed to inform workers of the dangers and a number of workers are now dying from the effects of poisons in the work place.

In England a law will be coming into effect which will excuse the employer from having to inform union safety representatives of "any information the disclosure of which goes against the interests of national security."

POLITICS

Proliferation

The possibility of proliferation of nuclear weapon capability arising from theft or misuse of nuclear fuel is a matter of prime concern to any administration or authority considering the adoption of the nuclear option. If a nuclear power station is to be built in Ireland it must be remembered that apart from tight control and supervision that will be required by the Nuclear Energy Board, Ireland is a signatory of the Non-Proliferation Treaty. (63)

Reactor technology was born during World War II in the search for a better bomb; opponents of nuclear power suggest that it has never properly risen above its origins.

India proved the point when she re-processed the waste from her nuclear reactor and used it to set off an atomic bomb in 1974.

Other countries may not be far behind. Reports are that West Germany is collaborating with South Africa on a new re-processing method and that South Africa has or is about to have nuclear weapons. It is probably not co-incidental that many of the best customers for nuclear reactors feel they have troublesome neighbors—Brazil/Argentina, India/Pakistan, Egypt/Israel, Iran/Soviet Union—and may be in hopes of following India's example.

Many observers of the international situation now consider that nuclear power is the main driving force behind nuclear proliferation.

This is not to say that Ireland is thinking of becoming a member of the nuclear armaments club. But with the tremendous 'over-kill' capacity already in the world—the USA has enough nuclear weapons to kill everyone in the Soviet Union twenty times, the Soviet Union can only kill everyone in the USA ten times—even a remote involvement with nuclear weaponry is an awesome step.

Unless Ireland builds a fast breeder reactor to use its own plutonium, it is likely that plutonium from the nuclear waste would end up in a weapons programme.

Since all the countries in the EEC except Ireland are members of the North Atlantic Treaty Organization, it is likely that re-processed 'Irish' plutonium would be used in a NATO weapons programme thus bringing Ireland one step closer to membership in that organization and further undermining Ireland's hard won neutrality.

As world nuclear capability increases, so that the majority of the developed nations, and a number of the underdeveloped ones, have atomic weapons, Ireland might no longer feel safe outside of the nuclear club.

The Non-Proliferation Treaty is seen by many countries not as a way of reducing the number of nuclear weapons in the world but of restricting them to those who already have them. These countries continue to make and deploy as many nuclear warheads as they feel meets the needs of their national security, while criticizing less developed nations for trying to do the same.

Signing the Non-Proliferation Treaty will not prevent any country that wants them from developing atomic bombs. There is nothing that can be done to a country which breaks the terms of the treaty except to impose trade sanctions, and there has been recent evidence, in the case of Rhodesia, that international sanctions can be ignored with ease.

The Treaty says nothing about making components for weapons, and any country can legally withdraw with three months notice. One American scientist said that many countries who had signed the Treaty can come closer to having a bomb than the US was in 1947.

For awhile it was widely claimed and believed that atomic bombs could not be manufactured out of the kind of plutonium used in nuclear reactors. However the United States exploded a bomb made with reactor grade plutonium.

Obviously there is nothing to stop a country which has nuclear reactors from having the bomb, except knowing how to build it, and an undergraduate American university student designed one suitable for contruction in a neighborhood basement.

Security

> *Security of nuclear stations against acts of terrorism is a matter of prime concern warranting the closest possible attention. Security against terrorism at a possible Irish nuclear station has already been considered and would if a station is built, receive the full measure of attention and priority which clearly should attach to it so that the highest possible degree of security is achieved. (63)*

Taking the plunge for nuclear power, may produce some rather murky political consequences.

A government deciding to "go nuclear" must be sure of its stability and the excellence of its technology.

Because of the tremendous consequences if anything should happen to a nuclear reactor, or to a large amount of radioactive material, nuclear power stations are an ideal target for any group which feels that it has no voice outside of spectacular violence.

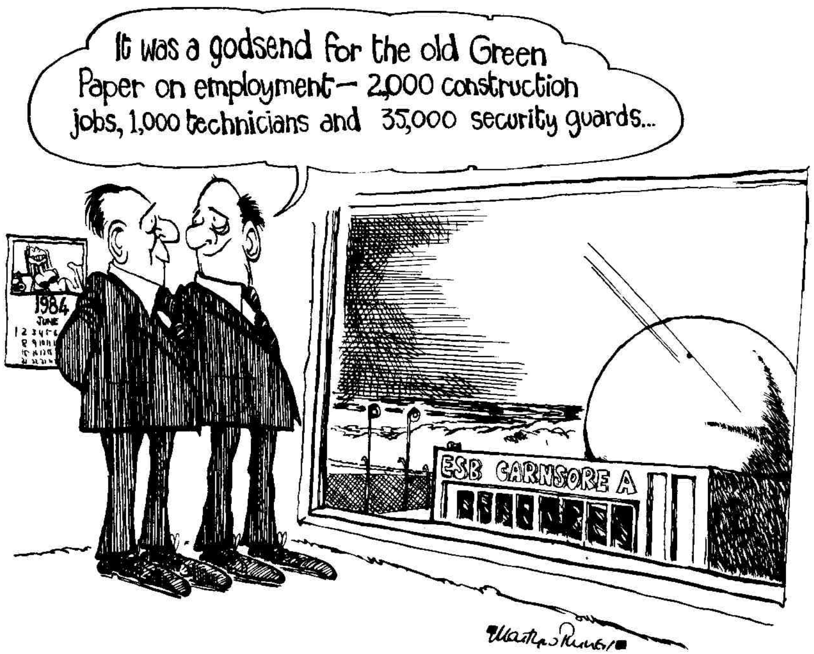
There have already been several attacks on nuclear facilities. In Argentina urban guerrillas took over a newly constructed nuclear station near Buenos Aires. They held it for twenty four hours and released it unharmed except for the addition of revolutionary grafitti.

In Italy, military and intelligence officers allegedly planned to start a coup by releasing large amounts of stolen radioactive material into water supplies.

Plane hijackers in the United States threatened to crash a jet into a nuclear reactor in Tennesesse. All their demands were met.

Ireland, with its history of civil conflict and with the unresolved political situation in the North, would have to plan on Carnsore Point being the focus of this kind of attention.

In the United States discussions are underway to set up a special armed police force and there is evidence that the Federal Bureau of Investigation already has a special section dealing with nuclear dissidents.



Under the Atomic Energy Agency (Special Constables) Act 1976 Britain set up an armed police force to guard the facilities under the control of the Atomic Energy Authority. The force has the right to engage in 'hot pursuit' of thieves or attempted thieves of nuclear material and to arrest on

suspicion. They are not directly subject to the Police Authority or to Parliament.

Any such increase in police power naturally threatens civil liberties.

In Ireland, similar steps would probably be taken. On the American model the goverment might decide that the reactor and nuclear material, especially when being transported, needed armed guards. Guards at American nuclear facilities are armed with machine guns.

To insure reactor security, the government would probably institute a screening procedure for employees. Investigations into employees' backgrounds, including their feelings and the feelings of their family and friends about the Republican movement, among other things, might become routine.

In an organization such as the ESB with a rather troubled labour history, screening could be used to sort out trade union activists.

Because decay heat continues for some time, a nuclear power station can not be completely shut down once it has been started up. Strikes might be seen as posing a very real danger and it is possible that union activity itself might become an admitted reason for not hiring.

In the recent public disclosure of plutonium poisoning at Aldermaston the unions have insisted that the plant be closed until workers' safety can be guaranteed. Since it has also now been alleged that management knew for some years that some workers had received over the maximum allowable exposure and did nothing to inform those workers, any pattern which did restrict union activity could have a bad effect on nuclear workers' health and safety.

In Britain it is now legal for employers in the nuclear industry to deny safety information to union representatives if giving out this information could be said to endanger national security.

Nuclear facilities in Britain are covered by the Official Secrets Act, and anyone passing even trivial information to ousiders may be subject to prosecution. The British Atomic Energy Authority goes further and tells employees that they must be discreet in their contact with the outside world.

Ireland, as vulnerable as Britain to the threat of civil violence, would probably adopt laws equally as strict.

One of the effects of these laws is to reinforce a trend already present in the nuclear industry of making as many decisions in secret as possible.The links between the military and civilian nuclear programmes in many countries means that much of what goes on in a nuclear programme is kept from the public.

In the words of the current British Minister for Energy, Tony Benn, MP, "I think it would be very frightening indeed if we were to say that our fuel policy required us to adopt a technique of production like nuclear power which in its turn required the decisions to be taken away from the process of Government answerable to Parliament and the public, and put into the hands of those whose special qualifications for deciding them would rest upon their technical knowledge."

Secrecy and dependence on technocrats can rebound on the government that institutes them. A reactor in Ireland will be built largely with foreign technology and at least a number of foreign technicians. Decisions about design specifications, safety requirements and the like will have been made in some country other than Ireland, and there is no guarantee they will be open for discusion..

Not only will many of the procedures be set up by foreigners but they will be set up to last longer than anything human has ever lasted before. As one famous American physicist, who is very much in favour of the nuclear programme put it, "we will have to have guards for our salt mines if just to keep people from drilling in the burial grounds."

Current government institutions will have to be around for thousands of years, if future generations are to be kept from poisoning themselves with radioactive waste.

Nuclear programmes have already meant increased surveillence in the United States. Local police forces have kept files on those actively objecting to nuclear power stations. One man was killed and two seriously hurt at an anti-nuclear demonstration in Malville, France in July,1977. As the number of reactor increases and so do the protests, governmets will likely feel called upon to use whatever force necessary to protect nuclear facilities. eventually seeing any form of protest as a deadly threat.

The plutonium used in fast breeder reactors shares with many other radioactive materials the characteristics of being long lasting and deadly. But it adds to these two others: it can be used to make nuclear bombs and because it emits alpha particles it is easy to handle and thus much easier to steal.

This combination means that if large scale nuclear development includes the fast breeder reactor, the political consequences will be similar to deciding to base electricity generation on smallpox virus.

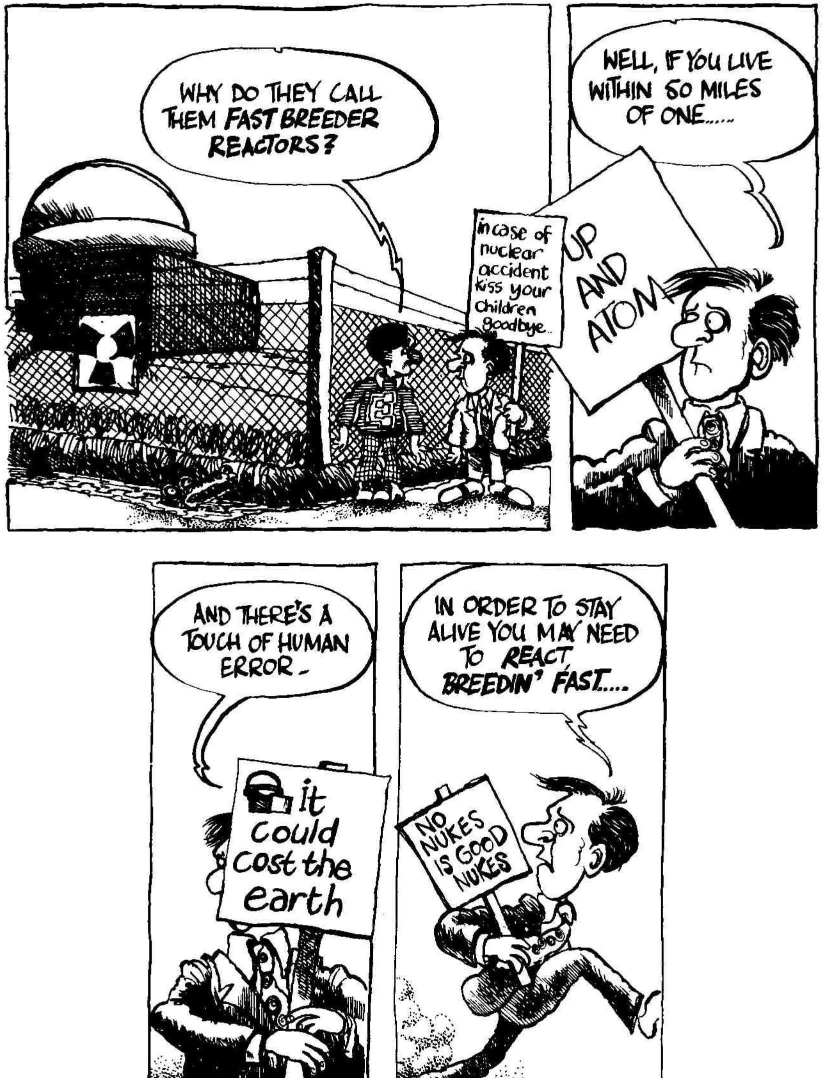
Not controlling plutonium will be seen as far worse than anything done to control it.

All the restrictions on political liberties introduced with a conventional reactor programme will be multiplied.

Surveillence will be increased. Information about nuclear material will be restricted–even now no questions about the movement of plutonium can be answered in Parliament.

Plutonium workers' rights will be more restricted than those in other branches of the nuclear power industry. Background checks will be inevitable, searches entering and leaving work will be necessary, and the right to communicate with the outside world further restricted.

In the United States Karen Silkwood, a woman working in the plutonium industry, was killed in suspicious circumstances on her way to publicize safety violations in the manufacture of fuel rods and the documents she carried supporting her allegations were stolen from the wreck of her car after she died.



If any plutonium is stolen attempts to recover it may include house to house searches, on the model of the British army searches in the North, wide scale detentions, and perhaps even torture.

Besides the increased danger from the manufacturing and transporting tonnes of highly poisonous material, fast breeder reactors will add to the general sense of risk because if anything does go wrong with them they can explode like a nuclear bomb.

Thus not only will they have to be constantly guarded, but society will become increasingly dependent on the technicians who can control this danger in its midst.

Alternatives

> *Forecasts of the contributions which these "natural" sources of energy can make towards meeting future energy requirements have tended to vary considerably. This is an indication of the uncertain state of knowledge of their realisable potential. The potential of alternative sources of energy have been considered by the International Energy Agency whose view is that having regard to the current state of knowledge of the relevant technologies, the contriubtion from all these sources is not likely to exceed 3-5 per cent of the energy requirements by the end of the century.* (47)

Supporters of nuclear power are fond of wheeling alternative energy sources to stage centre to show how well they will not work.

Imagining alternative technologies as replacing the nuclear reactor in the center of an enormous electricity system, they find their immediate potential output small and their reliability untested.

But the key idea of alternative energies is not to design a giant windmill which would out-produce Carnsore Point at lower fuel costs, but to design energy programmes from the point of view of the energy that is needed rather than from the point of view of the energy that is produced.

It is not necessarily true that the more energy we use the better off we are. In his book *Soft Energy Paths,* Amory Lovins points to a curious pattern of energy use among the Danes.

In 1500 they used 7-15 units of primary fuel per head for heating and cooking.

In 1900 they used only 3.

It was only in 1975, with the widespread use of electricity that the number of units of primary fuel used by each person for heating and cooking returned to the level of 1500.

It is not that the Danes enjoyed such a level of prosperity in 1500 that it took them almost 500 years to regain it, but that in 1500 they burned turf and wood and most of the heat went up the chimney and they needed more of it to do the job. In 1900 Danes were burning coal in tight bodied stoves and most of the heat went where it was supposed to.

Lovins does not recommend that everyone start lugging bags of coal around as their contribution to fighting energy waste, but that they take an intelligent look at their energy needs.

An example of matching energy supply to energy need can be found in the universal problem of home heating.

Nuclear power arrives at the consumer's door in the form of electricity, a high quality energy. In Ireland 79% of it is used for space and water heating, lower quality uses. Only 20% of the electricity used in this country goes for lighting, electronics, telecommunications and similar things now requiring electricity.

Electricity is being used in many cases where its high quality is unncesseary, expensive and wasteful.

Supporters of alternatives to nuclear power would say that the answer to the problem posed by home space and water heating would be to use an energy source that provided the kind of low grade. heat (about 60 degrees Celsius) necessary. There are several such sources, the most

well known of which would be solar.

Solar energy arrives on the earth in a rather diffuse form. Applying it to heating problems is a matter of collecting it. Building individual solar collectors would avoid energy loss by conversion or transmission (about 20% of the electricity generated is lost in transmission).

The basic idea of alternative energies is to allow the development of a variety of solutions to meet a variety of problems in a variety of situations.

Although a variety of technologies and energy generated from a number of sources makes the job of planning the overall electricity system more difficult, it does keep decisions about price, kind and allocation of energy from being made and imposed in some place remote from the actual users.

There may be times when a greater input of primary fuel does represent a higher standard of living and there may be times when it results in a lower standard. Insulating a house means that less fuel is needed, not a colder house.

Solar heating, good insulation, and numerous other alternatives, may or may not account for a significant percentage of the national energy bill, but to replace the amount of energy to be produced at Carnsore Point, they don't have to produce spectacular results. Although the ESB is the largest single consumer of primary fuel in the Republic, its total output accounts for only about 10% of all the energy used. At present rates of energy use Carnsore Point would provide only about 3% of the total energy consumed. The ESB plans to increase its output by the time that a nuclear reactor is in operation and then Carnsore would represent only about 1.5% of total energy use.

Sensibly applied alternative technologies could save enough energy to keep energy prices down and to attract new industry which might want cheap, centralized power. Nuclear power is seen by nearly everyone as a stop gap measure—some thinking it will have to do for thirty years or so, others, two hundred—and what are now called alternative energy sources will have to be developed at some point.

One reason alternative technologies do not look as promising at first glance is that no one has spent any money to research and develop them. Last year, when solar energy received its highest amount ever, only one dollar went to solar power for every eight that was spent on nuclear.

It is important to remember in the face of threats about awful changes in current life styles if nuclear power is not adopted, that complex high technology energy sources are the new comers, the so-called alternatives have been around for centuries. High technology, centralized sources of power, especially nuclear power and the inevitable fast-breeder reactor and the plutonium economy represent in the end far more extreme changes in life style than developing technologies with end-use efficiency.

A closer look at the alternatives may make them seem more technologically and socially acceptable, especially taking into account that they employ less money and more people to produce energy than does nuclear power.

Conservation

For many people conservation of energy has become synonymous with scarcity; using energy wisely has become confused with not using it at all.

Conservation is concerned not with reducing needs, but with reducing the amount of energy used to fill those needs.

Irish houses are among the worst insulated in Europe. Heat is lost by draughts in badly fitting doors and windows, through uninsulated walls, windows and attics. It is estimated that insulating walls, windows, and attics would halve domestic energy consumption.

Nick Warren of Voluntary Services International conducted a study which estimated that a more thorough program of insulation could save over 80% on basic home heating demand. A similar study done for Britian estimated that full insulation could cut electricity demand for homes by 86%.

For Ireland, insulating houses would mean a savings of at least 20% on the total primary energy input, which is equal to eight or ten Carnsore Point power stations.

If such a conservation programme were undertaken, and the £350 million earmarked for the nuclear power station were devoted instead to house insulation there would be about £500 for each house in the Republic.

This amount would finance adequate insulation in each of these houses, and its installation would, Dr. Robert Blackith estimates, provide 10,000 jobs for about 10 years.

Although heat leaving conventional power stations is low grade, its temperature could be raised slightly and it could be used in nearby housing for heat. Such a plan was developed for the Ringsend station in Dublin in 1975 which showed that it would cost residents 20% less than other forms of heat. However, the plan seems to have died on the drawing board.

There is now a plan to use ESB waste heat from a turf station near Athlone to heat ten acres of green houses starting in the summer of 1979.

The Danes, who already consume much less energy per person than the Irish, make use of district heating schemes, where one energy source provides for a number of buildings. This was tried in Ballymun, but it was not designed to give individual households control over the temperatures they had to live with, and therefore proved very unsatisfactory. The fact that it is used sucessfully in other countries is a hopeful sign.

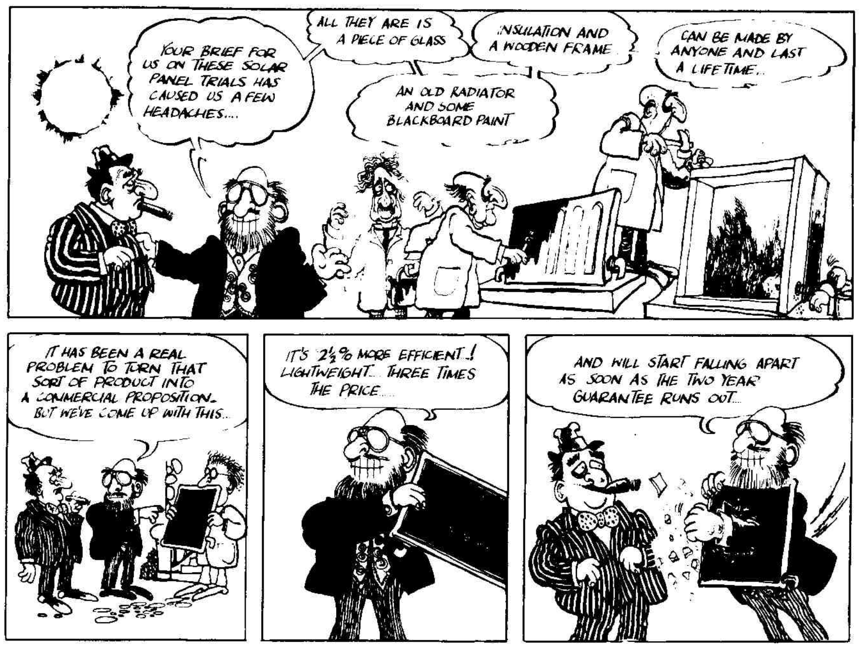
There are obviously a vast number of other areas where energy conservation could be applied.

Solar

It should soon be possible to provide temperatures of 600 degrees Celsius with a solar collector on a cloudy day in the winter in Scandinavia. In India one can buy a solar cooker for £6.70.

Each year the energy the sun sends to earth is 100,000 times more than the total amount of energy humanity uses.

Surprisingly, Ireland is well suited to developing solar power. The ratio of solar energy available in relationship to primary energy consumed is higher in Ireland than in any other country in the EEC.



DR. BORIS by Martyn Turner

Most of the solar radiation reaching Ireland is diffuse, rather than direct. Such energy would be ideal for relatively low temperatures such as those required for water and space heating (about 60 degrees Celsius) which can easily be achieved by solar collectors.

A solar collector is basically a blackened metal plate in a shallow glass or plastic covered box. Water circulates through tubes attached to the metal plate. Light passes through the glass unhindered but is changed when it hits the black surface and cannot pass back out through the glass. Thus the temperature inside the box is raised, heating the water.

Although solar panels are now rather expensive, installing them just to take care of domestic hot water needs would cut down on electricity use by 12%. Japan, which is certainly not a tropical country, has 3.5 million solar heaters in use. St. George's school in Britain has been operating with solar collectors for fourteen years.

Costs of solar panels could be reduced by making them in Ireland. The simple technology involved is available here and so are the skills–plumbing and construction. A scheme of installing solar panels could provide thousands of jobs.

There are schemes to use solar energy to produce high grade heat. A solar furnace in France used to manufacture refractory material reaches temperatures of 3,800 degrees Celsius and in the United States there are now plans to build a 500 megawatt solar electricity generating station.

Research is now going on into the use of photovoltaic cells, such as those used in nearly all spacecraft. These create electricity directly from sunlight. The cost of photovoltaic cells is about 200 times higher than competing energy sources and this has made them much too expensive to consider for widescale use. But new technologies already developed will mean the price of solar cells will be drastically reduced in the next few years. Solar cells would probably not be a good idea for centralized electricity production. A 100 megawatt station would cover a two and a half square mile area.

Eamon Lalor in his book *Solar Energy for Ireland* suggests that solar power could meet all of Ireland's primary energy needs by the year 2000.

Wind

The wind blows more consistently in Ireland than in most other countries.

Even the ESB, normally wary of approaching the unconventional kept a 10 kilowatt aerogenerator (windmill to the rest of us) at Vershoyle's Hill running from 1956 to 1960.

Although windmills can, and have for centuries, done mechanical work such as pumping water, most modern systems use wind to generate electricity.

It would be possible to supply the 650 megawatts which Carnsore Point is to provide through wind generation. 10,000 45 kilowatt windmill systems dotted about the country would supply as much elecricity at less cost.

Denmark once had 100,000 wind machines supplying local electricity, but cheap oil put them out of business. Sweden plans to supply 10% of its electricity needs with wind by the year 2000.

Wind power is well suited to a country like Ireland with low population density since it can be used on an individual basis. Being an on and off again thing, wind power might be coupled with solar convertors and wave generators.

With companies as prestigious as Lockheed in the United States investigating the possibility of wind power, indications are that a good market for wind machines can be developed Ireland might be able to develop a technology and export market for medium sized wind machines for export to Europe and the underdeveloped countries.

Although not fully perfected there are possibilities of using wind energy as direct heating for green houses, which would have a major impact on industry in the West and South.

Waves

Wave power in the West and North of Ireland is the best in the world. The technology for harnessing these waves to produce electricity already exists. Twenty five miles of wave

generators could supply as much electricity as the total output of the ESB. Six miles of wave gernators would be equal to the proposed output of Carnsore Point.

Wave power could be centralized and used for expanding energy supplies.

If the government would invest the necessary research and development money, Ireland could become a world leader in the field and export the technology.

All the Rest

Hydropower–20% of the world's electricity is generated by water.

Biogas–China claims to have 2 million biogas plants in operation converting cow dung, human waste, argricultural residues.

Biomass–burning organic matter: trees, waste vegitation, garbage. Ireland has one of the fast rates of tree growth in Western Europe.

Tidalpower -with present technology perhaps not yet useful for Ireland, but other countries are trying it.

Thermal–Pacific Gas and Electric Company in California uses steam from below the earth's surface to generate electricity. Engineers in the United States are developing ways to use the differences in ocean temperatures.

And lots more to come.

CONCLUSION

The Irish people should have the right to decide on whether or not they want Ireland to 'go nuclear'. To make this decision they should be given all the information about nuclear power as fully and as openly as possible. In this process they should draw as much as possible on the experience of other countries who have chosen or not chosen nuclear power.

Structures should be set up to make possible full and open public debate which will in turn have a real impact on the final decision.

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The Irish Writers Co-operative is a group of writers whose main aim is to provide outlets for new Irish writing through publication and readings. Commerical publishing houses are reluctant to take risks with new authors, but with the indispensible assistance of the Arts Council we have succeeded in making the work of new writers available to a wide public at a reasonable price.

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