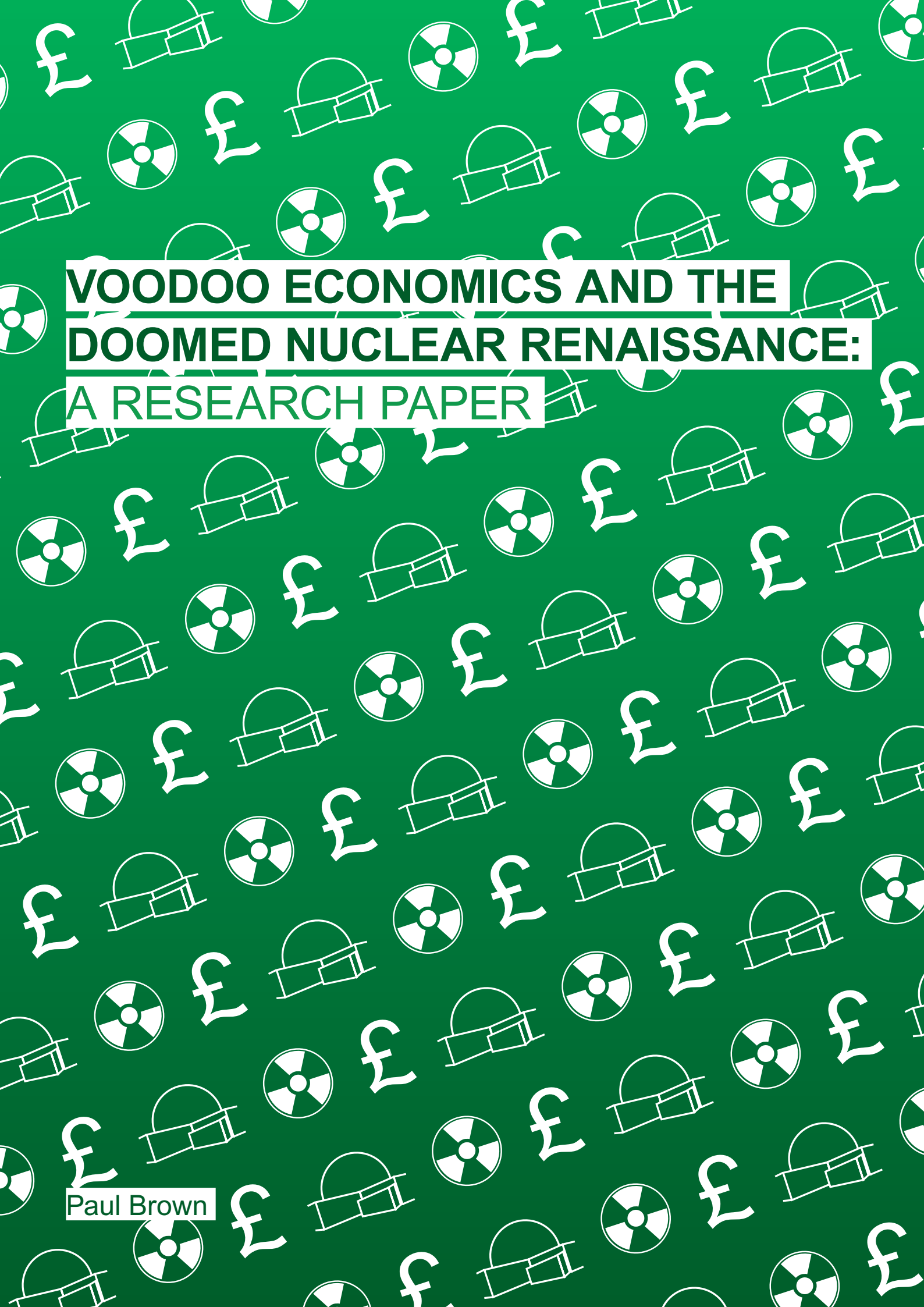

VOODOO ECONOMICS AND THE DOOMED NUCLEAR RENAISSANCE: A RESEARCH PAPER

Paul Brown

Paul Brown, former environment correspondent of *The Guardian* researched and wrote this paper when a Press Fellow at Wolfson College, Cambridge during 2007/08. The Fellowship was sponsored by British Petroleum. The views expressed in this paper are those of the author.

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EXECUTIVE SUMMARY

VOODOO ECONOMICS*

The economics of new nuclear power stations for the UK do not add up. It is not possible to achieve what the Government says it will do – build a new generation of nuclear stations in England without public subsidy.

New build will not be possible without large sums of taxpayers' money being pledged, and extending the unlimited guarantees to underwrite all the debts of the existing and future nuclear industry.

This paper exposes how badly the nuclear industry has performed over its entire 50 years of unfulfilled promises, and the already escalating bill to the taxpayer.

The key points are:

- The taxpayer has already underwritten all the debts and liabilities of British Energy so the company can never go bankrupt. This commitment dwarfs the risk to the taxpayer of the Northern Rock nationalisation.
- It will take 10 to 20 years before the first new nuclear stations can be built and are producing power in Britain. By that time the liabilities of the existing privatised industry will be so great that the Government will have had to renationalise it.
- The crisis may come much sooner. British Energy may have to start closing some of its 11 nuclear stations because the only remaining storage space for spent fuel at Sellafield, in Cumbria, is running out.
- Employing more than 10,000 people, the massive nuclear complex at Sellafield is in crisis. Its reprocessing works and a plutonium fuel plant are all failing at a massive cost – annually already £100 each for every taxpayer in the country – and this is rising.
- Three of the four new reactor designs being put forward for UK construction have never been built. The only "third generation" nuclear station that is under construction, and the favourite to be built in Britain, is half-built in Finland. It is two years behind schedule and million of pounds over budget.
- The nuclear industry claims that if planning is streamlined, nuclear licensing speeded up, and construction is on schedule, a new nuclear station could be up and running in 10 years. Civil servants estimate 2021, but previous British experience with untried nuclear designs suggests it could be up to a decade longer.

The main problems at Sellafield are:

- The flagship Thorp reprocessing plant, built to extract plutonium and unused uranium from used nuclear fuel, was closed for three years from 2005. It remains under severe operating restrictions and cannot complete its long-overdue contracts to deal with spent foreign fuel.
- The closure of the elderly Magnox reprocessing plant has been postponed, leaving the UK unable to meet its international commitments to cut radioactive discharges into the Irish Sea.
- The plants for dealing with the residue of reprocessing, the volatile and dangerous heat-producing high-level liquid waste, do not work as designed. The evaporators for reducing the volume and the system for turning the liquid into glass blocks have constantly broken down and underperformed. As a result the whole Sellafield production line for dealing with used nuclear fuel from power stations is seizing up.
- The MOX plant that is supposed to make money by turning plutonium and uranium into new fuel has been a technical and financial disaster. The fuel was supposed to be the safe way of returning tonnes of plutonium recovered during reprocessing in the Thorp plant to its country of origin. This plan has failed yet the Government has no policy for dealing with the ensuing economic and political crisis.
- As a result, the promises of successive governments that Sellafield would not become the world's nuclear dustbin and all foreign nuclear waste would be repatriated cannot be fulfilled.
- While Britain piles up its own and foreign nuclear waste there are currently no plans or sites for a repository to store or dispose of it. The earliest dates for a deep underground intermediate waste repository are notionally 2045 and high level waste 2075. In reality there are no plans for either.

*** Voo·doo eco·nom·ics, [\'vü-(ˌ)dü\ \ e-kə-'nä-miks, ē-kə-\ ], noun**
1. Term coined by George Bush Snr to describe Ronald Reagan's economic policy because it promised to lower taxes and increase revenues at the same time. 2. Any use of economics based on contradictory ideas and gobbledegook.

INTRODUCTION

VOODOO ECONOMICS AND THE DOOMED NUCLEAR RENAISSANCE

Successive British governments have announced ambitious plans for a new nuclear age. Over 50 years they have promised to build families of identical reactors producing cheap power. Each plan has faltered. Delays, U-turns and cost overruns have turned each into a financial headache for the taxpayer – while electricity consumers' bills have been pushed up to pay the extra costs.

It is about to happen again.

The announcement in January 2008 of another new family of reactors is repeating the same mistakes. Against the evidence of history and the current knowledge of the nuclear industry the Government is displaying breathtaking optimism about the potential for the technology.

The economics of building new nuclear power plants, endorsed by the Government, are based on the figures provided by the industry – which of course has a vested interest in making them appear competitive. Yet the nuclear industry has never completed any project in Britain on time or on budget. The Government's own figures say a new nuclear power programme will cut gas imports by only 7 per cent and carbon dioxide emissions by 4 per cent. Yet the programme for four gigantic new stations will get political encouragement and public subsidy on the false claim that Britain needs them for security of energy supply and to reduce carbon emissions. Without government help these stations could not be built.

Ministers seem unaware that at the same time as endorsing a new family of reactors, to be designed and to be delivered by foreign suppliers, there is an unfolding crisis in the existing British nuclear industry.

SELLAFIELD IS FAILING

The Sellafield nuclear site in Cumbria, which houses two publicly-owned reprocessing works and a plant for making mixed uranium and plutonium fuel called MOX, is failing. Not one of its facilities is working as it was designed to do. Breakdowns are costing taxpayers millions of pounds a week. The bill for keeping this site running at a continuous loss is about £100 a year, or £2 a week, for every taxpayer in the country, amounting to £3 billion annually.

Sellafield's intractable problems are likely to rebound on the privatised part of the nuclear industry. British Energy is wholly reliant on Sellafield to reprocess and store spent fuel from the 14 advanced gas-cooled reactors (AGRs) that it operates. Sellafield Limited, which runs the site, denies space is running out and British Energy says it does not believe there is any "short term threat to its operations"; but spent fuel assemblies are being stacked three deep in the reception ponds because of a shortage of storage space. If Sellafield can take no more spent fuel, then British Energy's AGR stations will gradually have to close.

The Government last bailed out the privatised nuclear industry in 2001 to prevent it going bankrupt. This resulted in an open-ended commitment to meet all British Energy's liabilities should it become insolvent a second time. The Government's commitment to Northern Rock Bank savers is small by comparison.

For the new nuclear renaissance the Government says it will not load all

Credit: Don McPhee/Guardian Newspapers.

The 400 foot chimney of Windscale's Pile One, damaged by a fire in 1957 predicted to have caused up to 50 deaths. The picture is taken from the village graveyard at nearby Seascale.

the risks and costs onto the taxpayer while private investors pocket the profit. Yet that is, up to now, how the industry has been run. In fact there has been no reason, if nuclear stations were economic, why they should not have been built already. The conclusion is that the industry always needs the Government to underwrite it.

The impact of years of unfounded optimism and blind acceptance of the industry's unproven forecasts is already apparent. The Nuclear Decommissioning Authority (NDA) was founded on the notion that it would be able to fund part of the cleaning up of all the radioactivity once plant is shut down at Sellafield by income from reprocessing spent fuel, thereby creating even more

waste to deal with in the future. This strategy is failing because the plant does not work as planned. Technical flaws, some of which cannot be fixed because they are inside highly radioactive areas, have made nonsense of estimates of potential income from plants. This is causing a funding crisis at the NDA and a scaling-back of its clean-up operations.

Ministers will find themselves trying to deal with these escalating problems at the same time as asking MPs to rubber-stamp a revival of nuclear power. MPs might want to consider that all the available evidence suggests the Government's plans will mean higher electricity bills for their constituents.

It is already known that the taxpayer faces a £72 billion bill to clean up the nuclear industry; yet this figure is sold as a problem of "legacy" wastes – as if the current Government has no responsibility for it. Although some of these costs are historic liabilities from Britain's 60-year nuclear programme, they are escalating precisely because current Government policy is to persist with reprocessing – even though it is demonstrably unnecessary, given that all spent fuel from the newer nuclear stations could be stored and disposed of at far less cost.

ABOUT THIS REPORT

This paper written by Paul Brown, while British Petroleum sponsored Press Fellow at Wolfson College, Cambridge in 2007/08, draws on 20 years of reporting the nuclear industry for *The Guardian*, numerous papers and documents collected over the period, and a large number of recent reports. The industry, Government and regulators have answered detailed questions.

The paper is divided into three parts.

Part 1 describes the crisis facing operations at Sellafield – the industry's flagship for 50 years. Technical failures across all its operations are driving costs up rapidly. Targets for reprocessing spent fuel, producing new fuel, and dealing with wastes are being missed. Despite Government assurances otherwise, the site has become the world's nuclear dustbin as increasing quantities of foreign and British nuclear detritus pile up. There is no disposal route for the British waste extracted at Sellafield, and as yet, no plans to return to the country of origin thousands of tonnes of foreign waste. This is from nations that have sent their spent fuel to the UK to be reprocessed. Repeated Government pledges that the plutonium, uranium and waste from reprocessing this spent fuel would be repatriated have still to be honoured.

The Chronology is a history of unfilled dreams and broken promises. It is a timeline of false optimism, grandiose and unrealistic plans, cost overruns and false assurances. It puts in context the naivety of the current Cabinet. The history of the nuclear industry makes one wonder how Gordon Brown could believe for a moment that his Government's decision to give the green light to more stations would usher in a new atomic age for Britain.

Part 2 examines the pitfalls ahead for existing and new nuclear power stations. The Government has been ignoring inconvenient information and well-researched advice. A complication is its open-ended commitment to underwrite British Energy's debts. This is the same company that owns most of the sites on which nuclear new build is expected to take place. Yet it seems inevitable that if a new building programme goes ahead British Energy will find itself with liabilities exceeding its assets a second time. Any shortfall and the costs end up with the taxpayer. The Government will have to take on ownership of any bankrupt nuclear stations; it can then choose to run them as a nationalised industry. Alternatively it could take on all the new liabilities and give back the stations to private ownership as it did only three years ago.

PART 1:

SELLAFIELD: A FLAGSHIP RUN AGROUND

Sellafield is the most closely guarded industrial complex in Europe. For more than 50 years this remote site in Cumbria, where 10,000 people are employed, has been at the frontier of nuclear technology; it is also a lynchpin of the industry in the UK. If it is not working properly the whole industry feels the effects.

Here the nuclear dream has turned into an economic and security nightmare for the British taxpayer. The extent of the problems at Sellafield has not been fully explained to the public; nor have the potential knock-on effects for the whole nuclear industry. But research shows the situation is rapidly getting worse.

HOW SELLAFIELD WORKS (OR DOESN'T)

Sellafield houses several different plants. Because they are all linked, leaks, malfunctions and failure to reach targets at one plant affect the rest. Below is a summary of the main operations required to keep the nuclear production line running; the over optimistic predictions made to justify investment in them; and a comparison with their current financial problems.

No electricity is now produced at Sellafield using nuclear power – all the reactors are being decommissioned. Instead the site's business is to receive spent fuel from British and foreign reactors. Some is kept in storage ponds. These are swimming pool-sized tanks into which spent fuel is lowered as it is delivered from power stations. To be safe, and avoid overheating, the fuel needs to be constantly monitored and kept cool. Some is held there indefinitely but most is destined to be reprocessed.

Reprocessing involves feeding thousands of tonnes of spent fuel into two giant works that chop up this highly radioactive material, dissolve it in nitric acid, and then separate and recover the plutonium and uranium, leaving a residue of liquid radioactive waste. This waste is very volatile and difficult to deal with. The recycled plutonium and uranium can be turned into new fuel (called mixed oxide, or MOX). In practice only a tiny quantity has been used in this way because it is far more expensive to produce than normal uranium fuel. Many reactors are not designed to use MOX and it is potentially more hazardous.

The Sellafield nuclear recycling centre has suffered many near disastrous episodes in its history; but accidents and technical and management failures in the past 10 years have brought this production line of linked nuclear factories to a crisis.

The Government's safety watchdog, the Nuclear Installations Inspectorate (NII), placed a legal requirement on the operators British Nuclear Fuels to reduce the volume of highly active liquors from 1,575 cubic metres in 2001 to a buffer stock of 200 cubic metres by 2015. (Buffer levels are the amounts of

Chronology

THE DREAMS, PROMISES AND PREDICTIONS FOR THE NUCLEAR INDUSTRY, AND HOW THEY TURNED OUT: A CHRONOLOGY

1954:
Lewis Strauss, chairman of the US Atomic Energy Commission, said atomic power would provide electricity "too cheap to meter". The UK tried to make this promise come true by combining plutonium and electricity production in one power station design. Plutonium was given much greater value than gold and so the "plutonium credit" for power stations meant that on paper the electricity produced was virtually free.

liquid waste in the system which would allow safe, efficient operation of the plant.) Technical failures in the evaporators required to do this have led to frequent and costly shutdowns – all funded by the taxpayer. The major clean-up priority at Sellafield is turning highly dangerous liquid radioactive wastes into safer glass blocks – so called vitrification.

These five important operations at Sellafield – the two reprocessing plants, the MOX plant, the evaporators and the vitrification plant – are all in trouble. They are part of the same nuclear production line to which spent nuclear fuel from the UK and countries across the world is delivered. At the other end of this reprocessing conveyor belt neatly packaged new fuel and waste are supposed to be delivered back to customers. It has never worked liked that. Instead the production line has repeatedly broken down, and there are too few customers for the MOX fuel. As a result Sellafield is the home of the world's biggest stockpile

Credit: Guardian Newspapers

1962, Cumbria, England – Calder Hall, Britain's first nuclear power station, which opened in 1956.

1956:

The Queen opened the first two 65 megawatt dual purpose reactors at Calder Hall at Windscale (later Sellafield). "The first station anywhere in the world to produce electricity from atomic energy on a full industrial scale," according to Rab Butler, for the Government at the time. The public was not told the reason for the station being built was to produce plutonium for the UK's nuclear weapons. Because of the plutonium credit the electricity was regarded as a cheap by-product.

1957:

Government promises a nuclear building programme to achieve 5,000 to 6,000 megawatts capacity by 1965. That would mean 20 nuclear stations with four reactors each the size of ones at Calder Hall.

1957:

After a disastrous fire at Windscale, the world's worst nuclear accident until Chernobyl in 1986, Prime Minister Harold Macmillan told the Cabinet he was suppressing the report that detailed the full extent of the disaster, defects in organisation and technical shortcomings. The facts were not made public for 30 years.

of plutonium and uranium for which there is currently no use. In addition there is an ever increasing quantity of nuclear waste, which, despite billions of pounds of investment in hardware, the industry is struggling to deal with.

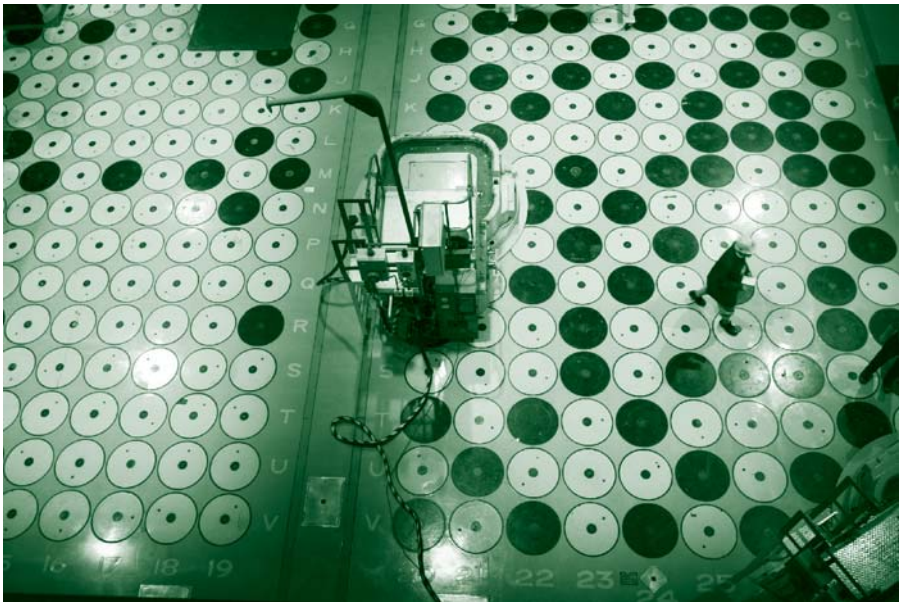
TWO KEY PROCESSES FAILING

There are two ends of the line for Sellafield production. Neither is working properly.

The first is the high-level nuclear waste stream, intended to produce packaged waste for deep geological storage and eventually disposal. This begins with evaporating the highly dangerous liquid nuclear waste to reduce its volume and eventually turning it into glass blocks.

The second is the end-product for recovered plutonium and uranium – the fuel called MOX. The Sellafield MOX Plant (SMP) is supposed to earn foreign currency by turning mixed oxides of plutonium and uranium derived from reprocessing spent fuel into new fuel. The SMP is virtually brand new but is already proving a millstone around the taxpayer's neck. Officially its losses are "commercial in confidence".

Below is a description of how these two plants are failing to achieve what the nuclear industry claimed they were being built for. From there the story turns back up the production line to describe the crippling effects for other plants and processes – which are in turn handicapped because of their own design flaws



Credit: Christopher Thomond/Guardian Newspapers

Flasks in the Vitrified Product Store at Sellafield. Light circles denote full flasks, dark are empty.

1960:

Government White Paper scales back nuclear building plans to 3,000 megawatts, acknowledging that coal generation was 25 per cent cheaper. In fact it was admitted to the House of Commons in 1963 that nuclear generation was more than twice as expensive as coal. Among other things very large research and development costs were written off when calculating the cost of nuclear energy. Planning restrictions for nuclear plant were relaxed and a total of 11 Magnox stations were built, the last at Wylfa, Anglesey, completed in 1968. It was three years late.

1964:

Government White Paper, The Second Nuclear Programme, says 5,000 megawatts of new plant will be built between 1970 and1976. This turned out to be the era of the advanced gas-cooled reactor (AGR). Other designs were rejected after much dithering. Minister for Power Fred Lee told the House of Commons of the AGR design: "We have won the jackpot this time – we have the greatest breakthrough of all times."

1964:

Magnox reprocessing plant opened at Windscale for dual purpose of producing plutonium for nuclear weapons and for fast-breeder reactor fuel.

1965:

Proposed building programme for AGRs increased to 8,000 megawatts.

and technical failures. At every stage it is the taxpayer who picks up the bills for cleaning up. This is currently about £100 a year, or £2 a week, for each and every UK taxpayer, and this figure is expected to continue rising for the foreseeable future, for a clean-up that will last at least another 100 years.

Vitrification plant

For more than 40 years high-level liquid waste has been stored at Sellafield with constant stirring and cooling to stop radioactive elements combining and causing an explosive reaction. The NII became concerned more than 10 years ago that these storage practices might become unsafe because of the state of the tanks. This concern was repeated in the NII's 2007 report. The tanks are considered the single installation most vulnerable to terrorist attacks and together contain far more dangerous radioactivity than the Chernobyl reactor. The Irish Government has often expressed concern about the danger of a collapse of the tanks or the consequences of an interruption in the 24-hour-a-day supply of electricity and water that are required to keep the tanks cool. Liquid storage of such dangerous wastes is not a permanent solution.

In 1990 a plant was built to convert 1,355 cubic metres of this liquid waste into 8,000 glass blocks – although even in this much safer state the blocks would have to be closely monitored for a further 50 years before they could be placed in a long-term repository. The plant, costing £240 million, was designed to clear the backlog of waste and allow reprocessing to continue by producing 600 glass blocks a year from two production lines, with each glass block being placed in a container, known as a can. The plant did not function correctly. In the first two years to 1993 output was limited to 114 containers a year. The Nuclear Installations Inspectorate (NII) said a large number of "melters" in which the liquid waste, sand and other materials is made into glass blocks have failed earlier than expected. Inside the sealed nuclear units, or cells, in which these processes take place the cranes and other remote handling equipment frequently broke down – probably because of the intense radiation. Modifications improved the plant to an output of 332 containers a year by 1995 but it was still not enough to clear the backlog.

A third production line was ordered in the mid-1990s when it was clear that the technology was not working as designed. The volume of waste was supposed to be reduced by 350 cubic metres over 14 years to get it down to safe and manageable levels. Instead, in 2001 the volume increased because the company continued reprocessing; meanwhile failures in the vitrification plant meant production of glass blocks could not keep pace. The situation became so bad in September 2001 that both reprocessing plants were closed to avoid legal sanctions by the NII. At this time there were

1966:
First AGR construction begins. Dungeness B in Kent becomes an industrial legend for cost overruns and delays and the first reactor is not commissioned for 19 years. It was still operating at only 50 per cent capacity in 1991.

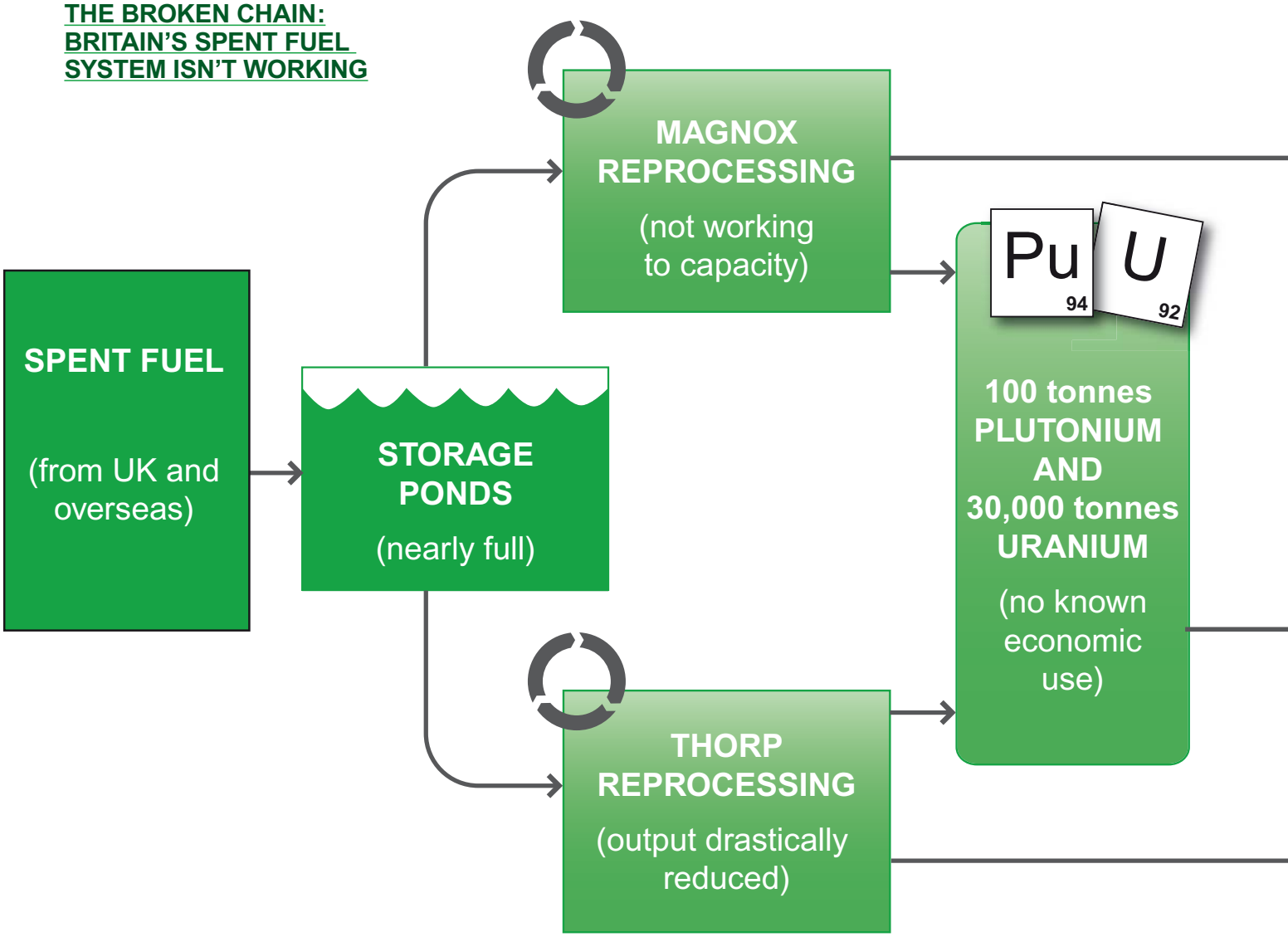
1977:
Last of seven AGR stations is ordered for Heysham, Lancashire, to complete the 8,000 megawatt programme. The official CEGB history described them as "one of the major blunders of British industrial policy".

1977:
Windscale Inquiry inspector Justice Parker recommends Thermal Oxide Reprocessing Plant (Thorp) at Sellafield go-ahead on the (erroneous) assumption that plutonium would be needed for the fast-breeder reactor programme.

1979:
Conservative Energy Secretary, David Howell, announces 10 new Pressurised Water Reactors (PWRs) to be built and says that nuclear power "is a cheaper form of electricity generation than any known to man".

1983:
Planning inquiry for first PWR at Sizewell in Suffolk starts. It lasts two years.

THE BROKEN CHAIN: BRITAIN'S SPENT FUEL SYSTEM ISN'T WORKING

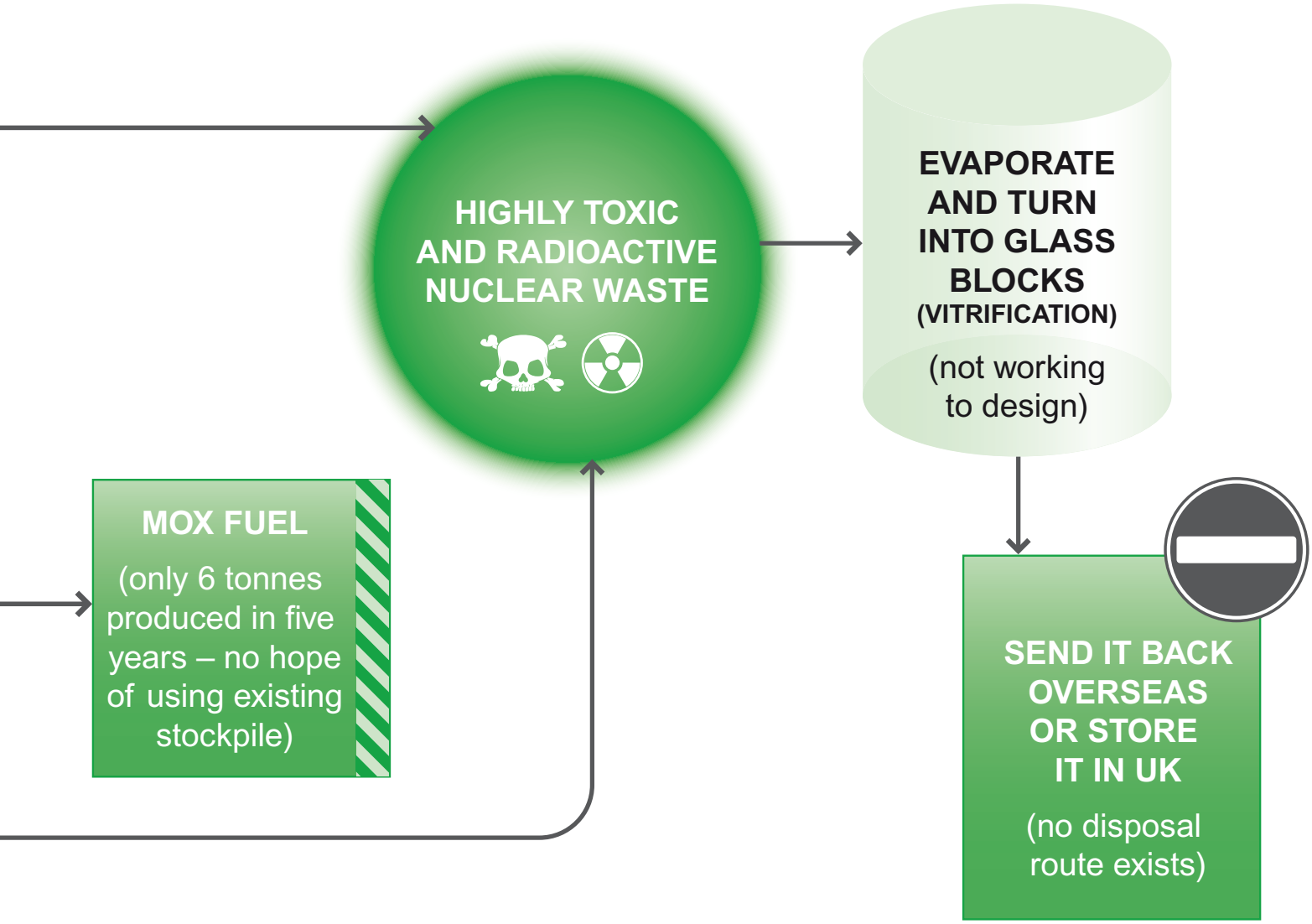


1983:
Government forced to abandon dumping low- and intermediate-level nuclear waste in the Atlantic because of combined environmental and union pressure.

1986:
The world's worst nuclear accident occurs at Chernobyl, turning public opinion against nuclear power. In areas of North Wales and Cumbria, where rain fell heavily after the accident, sheep cannot be sold to market for 20 years because of contamination. In 2008 there are still 11 farms and 10,000 sheep under restrictions.

1987:
Sizewell B (to go alongside the Magnox station Sizewell A) approved after the Department of Energy claims: "Sizewell B is likely to be the least cost option for new generating plant".

1987:
Nirex, a company owned by the nuclear industry, formed to find ways of getting rid of nuclear waste.



1988:
Government abandons plans for a fast-breeder reactor programme to use plutonium stocks, because it is uneconomic "for the foreseeable future".

1988:
Building of Sizewell B begins. It is the first of a planned, but soon abandoned, family of four PWR nuclear stations. The second was to be at Hinkley Point in Somerset – where at the planning inquiry the price for nuclear generation at Sizewell is quoted as 2.3 pence per kilowatt hour, later adjusted to 3.09 pence.

1988:
After the Government decides to privatise electricity production a "nuclear tax" is proposed by financial consultants Solomon Brothers. They say this will be necessary when the electricity industry is privatised to pay for extra cost of nuclear power generation compared with coal.

1,550 cubic metres of high-level liquid waste, far more than there should have been. In 2002 Laurence Williams, the NII's chief inspector, said it would take 15 years to clear the backlog of high-level liquid waste. The third vitrification plant, built at a cost of £320 million, came on line in 2003 to tackle the waste backlog.

Together, the three lines are designed to process 900 cans of vitrified blocks a year. The target output for this production line has been reduced repeatedly by British Nuclear Group, the British Nuclear Fuels subsidiary which runs the site on behalf of the NDA, and now known as Sellafield Limited. Journalists and campaigners have learned over the years that this is standard procedure at Sellafield so managements can claim targets have been met. An example came in 2003 when the chief executive of British Nuclear Fuels, Norman Askew, referred in his annual report to the production of 333 containers of vitrified waste against a target of 250 as being one of a "wide range of excellent performance achievements". In fact the "target" of 250 had been arrived at after higher targets had been abandoned twice in the previous two years because the plant was failing even then to reach dramatically reduced expectations. Subsequently performance did improve slightly. The best output the plant has achieved still remains 482 cans of vitrified waste in 2005/06, just over half the original design target of 900. But even this was a short-lived level of output. The numbers dropped back again to 322 in the year to 31 March 2007. The target for 2007/08 was 450 cans, later reduced to 380; yet on 7 February 2008 only 223 cans had been produced making even this reduced target difficult to reach.

Overall in its first 11 years the vitrification plant throughput should have been 6,600 cans. In fact the plant made just 2,400. Hundreds of millions of pounds were spent on improving production. In the subsequent five years to March 2008 the three lines should have produced 4,500 cans of vitrified waste; yet the total was just 1,956 according to the NII, which continues to express concern at the plant's operation.

Had the plant functioned as designed then the backlog of waste would have been cleared by now; but production has been less than half that required by the Government's safety inspectors. British Nuclear Fuels and its successor companies have said again and again that they were confident they would achieve the target set by the NII of reducing waste to "buffer levels" by 2015. It appears on current performance this will only be achieved by stopping or severely curtailing the operations of the reprocessing works.

Evaporators

The vitrification plant is not the only technical headache in this most difficult of waste streams.

1989:
Magnox reactors are withdrawn from electricity privatisation. The city would not buy the older stations because of looming decommissioning costs. The taxpayer is left with the bill.

1989:
AGRs and Sizewell B are withdrawn from privatisation because city investors discover that the cost of generating nuclear power is far greater than that of coal.

1989:
Government suspends building of new (PWR) nuclear plant beyond Sizewell even though £30 million worth of parts have been ordered for Hinkley C.

1990:
Nuclear levy is introduced to cover the difference between the cost of generating nuclear energy and coal – adding 11 per cent to electricity bills. Even this does not truly cover the extra cost because the original capital cost of most stations had already been written off. The idea of the levy was to pay for decommissioning stations.

The volume of highly radioactive liquid first has to be reduced by the use of evaporators. These are like giant kettles, which concentrate the liquid down so that it can be stored in readiness for turning into glass blocks. This is another technology on which the wear and tear caused by intense radiation seems to have been underestimated. Whatever the problem, the technology has not performed as planned and the three evaporators have had successive faults and proved unable to deal with the volume of waste coming from the two reprocessing works. One of the evaporators has been shut since 2005 although there are hopes of restarting it in 2008. Problems with corrosion shut another evaporator in October 2006. These have now been repaired but the third evaporator also had to be shut as a precaution because of similar concerns; it is expected to re-open soon. Because of the poor performances of all three evaporators a fourth evaporator has been ordered at a cost of £90 million. This will not be completed until 2011.

The failures of the vitrification and evaporator plants have forced Sellafield to scale back its reprocessing operations to avoid high-level waste accumulating. Not to do so voluntarily would trigger legal action by the NII. This has serious implications for the industry. As well as extra costs and potential job losses, the rest of the nuclear production line is affected.

THE SELLAFIELD MOX PLANT

The production of MOX fuel is the sole industrial and economic justification for the continued operation of the reprocessing facilities at Sellafield. The plutonium and uranium recovered from spent fuel in powdered form are together turned into pellets. These are then made up into new fuel rods for use in existing reactors. This is more costly than traditional uranium fuel made from raw and newly mined ore. British Energy has refused to use it for the one British reactor that can take it, Sizewell B, because it is too expensive and would drive up the cost of electricity. However, it is a way of returning plutonium relatively safely back to its country of origin. For countries like Switzerland, Germany and Japan, this is a better alternative than deliveries of raw plutonium from Sellafield. The only current use for plutonium in this raw state is for nuclear weapons and its import would be a serious political embarrassment for these countries, all committed to nuclear non-proliferation. MOX fuel was seen as the solution to returning plutonium in a safer form.

Without the MOX plant, reprocessing to produce more and more surplus plutonium and uranium that has no use is difficult to justify – even though Sellafield Limited, which operates the plant, still has money-making contracts to do so.

The MOX plant, which employs 660 people, has gone disastrously wrong partly because of poor management, and partly through legal and technical problems. First, the plant's

1990:
Cost of building Sizewell B increases from £1.69 billion to £2.03 billion.

1990:
Department of Energy admits that wave power is cheaper than nuclear, six years after researchers at Harwell put the price of wave power at 9.8 pence per kilowatt hour. Current estimates are 4-5p. As a result of the 9.8 pence calculation all research into wave power was cancelled.

1990:
Days after a leaked paper reveals that £2 billion could be saved if Sizewell B was cancelled the House of Commons Select Committee on Energy says it is "profoundly concerned" about misleading statements on the cost of nuclear energy. The Central Electricity Generating Board tells the public inquiry into the building of Hinkley Point C PWR that the electricity would cost 3.09 pence per kilowatt hour. During the subsequent privatisation debate the board puts forward a figure of 6.25 pence. The Department of Energy "apparently made no attempt to obtain realistic costings".

Steve Bell, political cartoonist and creator of the If… cartoon strip has been lampooning the nuclear industry for 20 years. When the Government claimed that the Thorp Reprocessing works would be a money-spinner the building formed a background as a white elephant roamed across the pages of *The Guardian*.

value for money was called into question. The National Audit Office revealed that the original 1993 estimate of £265 million for the cost of the plant had risen to £490 million by 2004. The Environment Agency's chief scientist, Dr Jan Pentreath said in October 1998 that the agency would never have sanctioned the plant's construction had officials been asked for a licence in advance. He said he would ask for a change in the law so that in future the agency could prevent "taxpayer's money being spent on speculative ventures".

In 2001 the consultant Arthur D Little, acting on behalf of the Department of Trade and Industry, produced a report for the Government that was a classic example of the nuclear industry's approach to economics. The report wrote off the capital cost of the plant and said that over a 10-year period the expected orders for MOX would show a profit of £216 million over operating costs. The figures to justify this report were not made public and many

1990:
The Science and Policy Research Unit at Sussex University describes as "misleading and inaccurate" claims that Thorp would make a profit of £500 million in first 10 years. The extra cost of reprocessing spent fuel at Thorp rather than storing it is £1.7 billion to the taxpayer, the researchers say; and reprocessing produces 160 times as much nuclear waste compared with storing spent fuel, and is three to four times more expensive.

1991:
Government announces plans for a nuclear waste repository costing between £2.5 billion and £3.5 billion to be completed by 2005.

1991:
Christopher Harding for British Nuclear Fuels says the first waste will be sent back to countries of origin before the end of the decade. By 2008 none has been sent back.

1992:
International Atomic Energy Agency says the building up of vast stocks of plutonium at reprocessing plants "poses a major political and security problem".

doubted their reliability, because profit predictions were based on the assumptions that there would be firm orders for MOX for the first decade, and that the plant would work as designed. Neither assumption was correct. Nonetheless, faced with a Government consultant's report on its potential profitability and the fact it was already built, the Environment Agency granted an operating licence. The Government then gave the plant the go-ahead to start up in 2001.

In the event orders from Japan, expected to be SMP's biggest customer, and on which the profit forecast was made, have never materialised. Quality control documents dispatched from Sellafield with the first small consignment of MOX fuel, made in a demonstration plant, were found to be falsified. In the subsequent scandal, Japan insisted the fuel be sent back to England in the armed ships which had originally delivered it but which had already made the return trip to Britain. Returning the ships and collecting the eight strings of fuel (weighing only 4 tonnes) cost the taxpayer £113 million. To date the Japanese have not re-ordered MOX and that country's plutonium remains in store at Sellafield. There is now no policy in place to deal with it. It is guarded by the British armed nuclear police force – again at the taxpayer's expense.

Perhaps the most devastating problem is that the MOX plant does not work – at least not as designed. In fact commissioning has taken so long that the first few orders from Switzerland and Germany for the fuel could not be completed on time. To avoid penalties under breach of contract this fuel had to be made in a MOX plant in Belgium at British taxpayers' expense. In July 2004 the plant had still not produced any useable fuel and its losses were put at £600 million. In 2007 the plant had still not got a full operating licence, even though this was originally expected to be granted in 2003. In February 2008 in answer to a parliamentary question, Energy Minister Malcolm Wicks admitted that the plant had only managed 2.6 tonnes of production in 2007 – and a total of only 5.2 tonnes since opening in 2001.

The Royal Society reported in September 2007 that the MOX plant, designed to produce 120 tonnes of MOX fuel a year, was now expected to produce only 40 tonnes a year. This was according to evidence presented by the Nuclear Decommissioning Authority (NDA), the Government quango in charge of Sellafield, to the Royal Society; but on current form it may never produce anything like that amount. Sellafield Limited's spokeswoman said it was still early days and the company hoped to ramp up production. However, the accumulated financial losses on the MOX plant since it was built have now become "commercially confidential". This is a classic blocking tactic for refusing to reveal information under the Freedom of Information Act.

1993:
It is revealed that the 11 per cent nuclear levy on electricity bills has not been put aside for dealing with decommissioning costs and waste but spent on building Sizewell B. Nuclear Electric, the Government-owned company formed to run the nuclear stations when the rest of the electricity generating plant was privatised, claims income from the new reactors would pay for decommissioning old stock. MPs liken this to Robert Maxwell's stealing from the company pension fund to finance his business.

1993:
Economists estimate that the projected income from the nuclear levy between 1990 and 1998 will represent a £9.1 billion subsidy for the nuclear industry.

1993:
Completion date for Sizewell B slips to November 1994, 11 months later than planned.

1993:
Thorp order book for the first 10 years (in tonnes of spent fuel to be reprocessed) is Japan 2,673, UK 2,158, Germany 969, Switzerland 422, Spain 145, Italy 143, Sweden 140, Netherlands 53, Canada 2. By 2008 none of the resultant waste has been returned to the country of origin.

1994:
Government announces nuclear reviews, one into whether new nuclear stations can be built and the second into whether the industry can be privatised.

The result of technical failure, falsification of quality control data and shortage of orders is – apart from mounting financial losses – large and increasing quantities of unwanted and unusable foreign-owned plutonium and uranium being held at Sellafield at taxpayers' expense. Continued reprocessing of spent nuclear fuel from British and foreign reactors will only make this situation worse. It will create ever larger stockpiles of plutonium and uranium for which there is no use or planned disposal route. The Royal Society in its 2007 report on the problem said continuing to stockpile very dangerous material was not a long term option. "Failure to develop and implement a strategy for the management of separated plutonium could result in significant avoidable costs and security risks."

A TALE OF TWO REPROCESSING PLANTS – MAGNOX

Reprocessing of spent fuel is designed to recover the plutonium and uranium from fuel which has already been used in a reactor. It is presented to the public as a recycling technology, which was the original intention, but it has not turned out like that.

The original Magnox reprocessing works was opened in 1964 to extract plutonium from spent fuel. The extracted plutonium could, in theory, be used for Britain's nuclear weapons arsenal and for use in fast breeder reactors, a technology then thought a practical possibility for large-scale electricity production. The Magnox plant, which employs 830 people, is still in operation and is set to remain open until all the fuel from the UK's older Magnox reactors is reprocessed. The industry says that reprocessing is the best disposal route for this fuel because it cannot be stored for long, as it deteriorates. The deterioration is due to the fact that the means of removing the fuel from the reactor core, the means of transporting it and of storing it all involve the fuel's immersion in water, which corrodes the magnesium cans in which it is stored. The existing Magnox power stations were due to close by 2010 so that the reprocessing works could complete its work by 2012; but this closure has been postponed until 2016 "at least", according to the NDA. The plant was originally designed to reprocess 1,500 tonnes of spent fuel a year and unlike Sellafield's more modern nuclear facilities worked close to its design capacity for many years, altogether reprocessing more than 20,000 tonnes of spent fuel. It is the workhorse that has produced most of Sellafield's unused stockpile of 103 tonnes of plutonium and more than 30,000 tonnes of uranium.

Recently, despite refurbishment, the deterioration through age of the facilities has reduced throughput, according to the NDA. After processing 1,008 tonnes in the year to April 2005 the figure dropped to 243 tonnes and 594 tonnes in the following years. In the first 10 months of 2007/08 401 tonnes of Magnox fuel had been reprocessed.

1995:
Government decides to make a second attempt to privatise AGRs and still-to-be-completed Sizewell B. Announcing plans to privatise Nuclear Electric the Government reduces the clean-up liabilities from £10.5 billion to £7.2 billion without explanation.

1996, MAY:
"The privatisation of part of the nuclear power industry, set out in a white paper on 9 May, looks likely to be a particularly creative example of the well-honed technique of bribing voters with their own money. In this case, the bribe may be financed not just by selling assets that taxpayers have already paid for once, but by money borrowed from future tax payers too." (The Economist magazine)

1996, JULY:
Sell-off of the newer nuclear stations goes ahead. Government receives £1.9 billion, less than the cost of building Sizewell B pressurised water reactor with all seven AGR stations thrown in for nothing.

Comparing this performance with the NDA's three-year work plan of 2005 shows how targets have been missed. The NDA target was 2,520 tonnes, but the Magnox works have only managed 1,238 tonnes throughput so far, less than 50 per cent. This reduction of output has not been due to the ageing of the Magnox facility but, as Sellafield Limited now admits, to the failure of the evaporators and the vitrification plant downstream, which has meant reprocessing being slowed. This has led to the closure of the Magnox reprocessing works being postponed for at least four years. In summary, Magnox still has to reprocess a backlog of spent fuel because large parts of the nuclear waste disposal chain have failed.

These setbacks mean the UK may be unable to meet its commitment made in 1998 under the OSPAR Convention to progressively reduce the concentration of radioactive substances in the marine environment. By 2020 levels of radioactivity from reprocessing in the Irish Sea are supposed to be "close to zero". This agreement meant the Magnox reprocessing works had to close by 2012 so that it could be cleaned and so that debris could be removed to bring measured radioactivity levels down markedly by the 2020 deadline. This commitment has been abandoned because of the backlog of Magnox fuel and the closure put back to 2016 "or later", by the NDA.

A TALE OF TWO REPROCESSING PLANTS –THORP

By the time a second reprocessing facility, the Thermal Oxide Reprocessing Works (Thorp), was discussed in the 1970s and built 20 years later much had changed in the nuclear industry. Thorp was designed to deal with spent fuel from Britain's second generation of AGRs, currently run by British Energy. Plutonium was no longer being recovered for nuclear weapons, but in the 1970s the dream was still to use it for fast-breeder reactors. Thorp would also deal with spent fuel from pressurised and light-water reactors being operated elsewhere in the world. However, by the time Thorp was built in the 1990s the fast-breeder reactor programme had been abandoned as economically unviable. Despite this the Government gave the go-ahead for the plant. The reasoning was mainly that the nuclear industry had signed foreign contracts to reprocess spent fuel; it claimed the £2.3 billion plant would make a £500 million profit for the UK economy by reprocessing 7,000 tonnes of fuel in the first 10 years of operation.

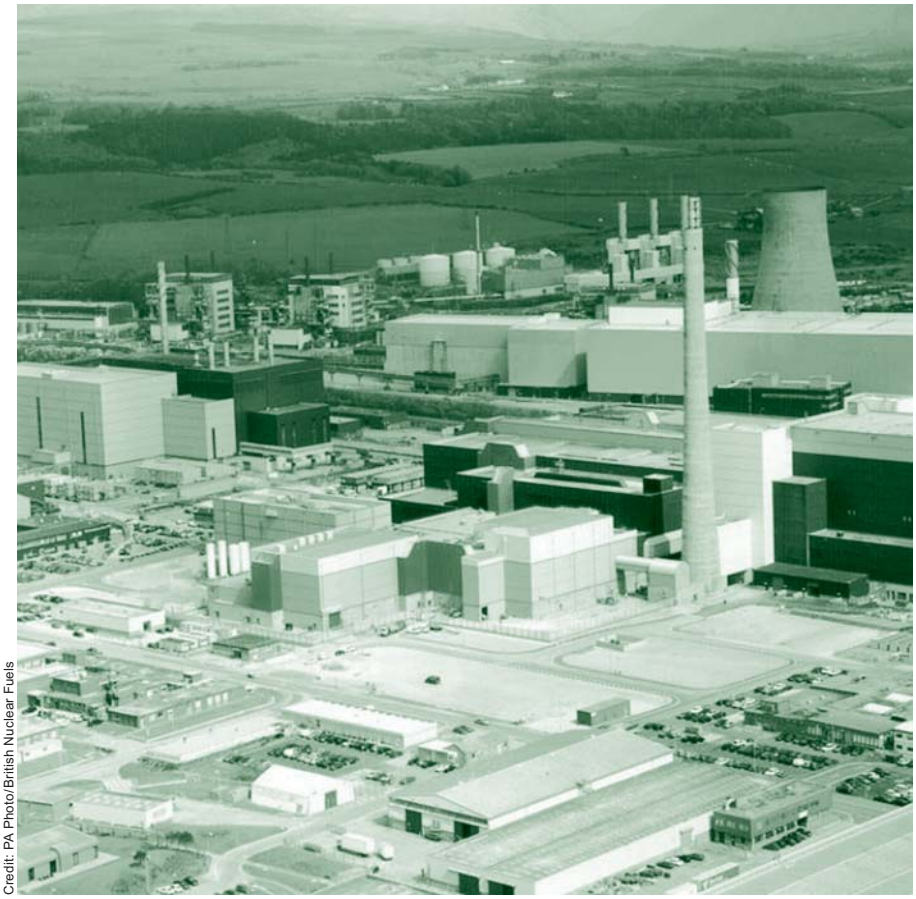
At the time the plant had a full order book for the first 10 years and most of the second decade of the plant's planned lifetime. The optimism that more new orders would be forthcoming was misplaced, however: some were subsequently cancelled and there have been no new ones.

Yet before the plant opened consultants Touche Ross produced

1996:
Despite calls for its cancellation because of delays and cost overruns Sizewell B opens. The cost of the station is £2.3 billion. Power generation cost is not the 3.02 pence per kilowatt hour predicted at the public inquiry but 6.25 pence, more than double the cost of coal and gas.

1997:
John Gummer, with his last act as Environment Secretary refuses permission for a pilot deep repository for nuclear waste under Sellafield partly because of the industry's faulty scientific case, despite spending £200 million on site investigations. The plan to get the depository built by 2015 is abandoned.

1997, OCTOBER:
It is announced that two nuclear waste stores are to be built at Sellafield to take intermediate-level waste for the next 50 years. Another 10 planned for the future.



Credit: PA Photo/British Nuclear Fuels

The Sellafield MOX plant in the foreground with the Thorp reprocessing plant behind. Both plants have failed to work as designed.

a report that supported claims that the plant would be profitable. The report was published with most financial figures expunged by civil servants. Outside the industry and Government few thought the report was reliable, and so it turned out to be – partly because the Thorp plant has never worked as designed either. In the first 11 years of operation it reprocessed 5,729 tonnes of fuel – well short of the 7,000 tonnes needed to make it profitable.

In the plant's twelfth year only a further 51 tonnes of spent fuel had been reprocessed when a disastrous leak, unnoticed by staff for nine months until its discovery in April 2005, forced Thorp to close. It remained closed for two years while investigations and repairs were undertaken; the company was fined £500,000 for negligence, and had £2 million deducted by the NDA for failing to meet safety standards. Subsequently the staff underwent new safety training. The leak could not be repaired but because it can

1998:
Deputy Prime Minister John Prescott signs OSPAR agreement to progressively reduce concentrations of radioactive substances in the marine environment as a result of emissions from Sellafield so that by 2020 they add "close to zero" to historic levels. He says: "I was ashamed of Britain's record in the past but now we have shed the tag of the Dirty Old Man of Europe and have joined the family of nations."

1998:
Chancellor Gordon Brown announces plan to privatise British Nuclear Fuels (BNFL), a plan later abandoned and twice resurrected. It has never happened.

1998:
The Royal Society says stocks of plutonium are "unacceptably high, posing an environmental threat and creating fear that some may be stolen for use in illicit nuclear weapons."

1999:
House of Lords Science and Technology Committee says ministers should abandon policy of regarding plutonium as a valuable resource and reclassify it as waste.

1999:
The first shipment of MOX fuel to Japan (made in the small MOX Demonstration Facility) takes place amid furious protests from Caribbean countries about the dangers.

be by-passed the plant was given permission to test-run in 2007. Although this was judged a success the plant did not re-start.

The failure of the evaporators and the slow throughput of the vitrification plant meant that, like the Magnox reprocessing plant, Thorp's waste could not be dealt with. The NDA said in November 2007 that the only problem holding back the restart of Thorp was the lack of evaporation capacity. By early 2008, possibly because of the problems that prolonged closure of Thorp was causing to upstream storage capacity (see below), Sellafield Limited planned to restart the plant. Because of the restriction caused by the lack of evaporator capacity until 2011 the plan was to put a maximum of 200 tonnes of fuel a year into Thorp for three years to try to fulfil its foreign contracts. Yet another technical failure struck immediately, when the lifting mechanism to get the fuel from the storage ponds into the reprocessing works broke down. This meant the fuel slipped back down into the ponds. It took until the end of March 2008 to fix the problem, when 100 tonnes of foreign fuel were moved into the plant for the first stage of reprocessing.

By then Thorp had, in effect, been closed for 36 months and will never again operate at more than a fraction of its design capacity. Before Thorp opened British Nuclear Fuels, the Government-owned company that then ran the plant, estimated that the weekly cost of keeping it closed would be £2 million – so a three-year closure is very costly for the taxpayer. The 890 staff still have to be paid. One of the effects of this prolonged shutdown is that the contracts to reprocess foreign and domestic spent fuel, claimed still to be worth £2.5 billion, still cannot be completed. The NDA also said the inability to complete the contracts means the 2010 closure date for the plant, proposed in the company's business plan, and reported in evidence to the Royal Society in 2007, has now also been postponed. Even by the most optimistic calculations Thorp will have to remain open until 2015 to fulfil contracts that were due to be completed in 2003.

STORAGE RUNNING OUT

Another problem that Thorp's prolonged closure has caused is lack of storage space for spent fuel that continues to be delivered from Britain's seven AGRs. In May 2007, when the Government signalled its decision to sell a further tranche of British Energy shares, the company warned potential buyers that if Sellafield was unable to continue to take spent fuel from its reactors for storage the company would be unable to reload them with new fuel. These reactors, responsible for around 14 per cent of the UK's electricity supply, would have to be gradually shut down, the company said.

In October 2007 some deliveries of spent Magnox fuel to Sellafield were also suspended. Both types of fuel

1999:
Japan orders investigation after BNFL admits forging quality control data for MOX fuel.

2000:
Japan refuses MOX fuel and is paid £20 million in compensation. The whole episode, which involves sending armed boats to bring the fuel back to UK, costs £113 million.

2000:
Government postpones plan to sell off Sellafield until 2002 "after the election" according to the Department of Trade and Industry

2000:
BNFL announces closure dates for the eight Magnox stations – the last being Wylfa on Anglesey in 2010, so the Magnox reprocessing plant can deal with all 12,000 tonnes of spent fuel remaining and close in 2012.

2001:
Government conducts another energy review. BNFL proposes six new nuclear stations mostly on the sites of Magnox stations that are closed or due to close.

are received at the same handling facilities. There is now a backlog of fuel at Sellafield to be stored and reprocessed. However, the NDA will not be drawn on how much storage space for spent fuel remains, nor how soon it will run out, stating that the main reason for the suspension of shipments was a change of priorities ordered by the Authority in the nuclear clean-up programme, not a shortage of space. The NDA says the existing storage ponds have been reorganised to squeeze as much fuel in as possible. Sellafield Limited said it was reorganising storage facilities and there was "ample room for increasing the capacity of the storage pond". The company said the NDA was re-examining all the options as far as dealing with spent Magnox fuel and would be making an announcement soon.

However, these answers do not alter that fact that when Thorp first closed in 2005 the official line was that there was a year's storage space available at Sellafield – by which time it was expected that Thorp would have opened again. Papers obtained a year later under the Freedom of Information Act, although heavily censored, detailed a series of measures to relieve the pressure. This included ordering a number of new storage flasks and reorganising existing storage ponds.

In the meantime an average of 300 tonnes of spent AGR fuel has continued to be delivered to Sellafield each year and none has been cleared through reprocessing. In order to free storage space for these continued deliveries some of the fuel already in ponds has to be removed for reprocessing. The whole complex was designed for a constant throughput of fuel into Thorp.

From the information already in the public domain it is clear that Sellafield's waste stream is not running as planned and that there is an increasing backlog of both spent fuel and all forms of waste. As a result the future of Thorp remains parlous and it may have a knock-on effect on British Energy's ability to produce electricity from its advanced gas cooled reactors.

When the NDA came into existence in April 2005 to deal with the country's nuclear legacy, it said it would review with the Government whether Thorp should be closed and the remaining reprocessing contracts cancelled. The NDA confirmed in November 2007 that this review was ongoing, but in February 2008 the Department of Business, Enterprise and Regulatory Reform (BERR) denied closure was on the agenda. The Government's policy was that Thorp should remain open until all the contracts had been completed. Closure would cause serious political difficulties – partly because it would be an admission that past Government policies to continue reprocessing and to sanction the MOX plant were serious mistakes on technical and financial grounds.

2001, OCTOBER:
Review reports that onshore wind farms will provide energy at 1.5 to 2.5 pence per kilowatt hour, offshore wind 2 to 4 pence and nuclear power 3 to 4.5 pence. The nuclear power price was said to be comparable to wave power, long derided as too expensive by the Department of Trade and Industry.

2001, OCTOBER:
Government gives permission to operate the new large Sellafield MOX Plant – nine years after British Nuclear Fuels' original planning application and after five public consultations.

2001, NOVEMBER:
BNFL reports to the Government, its sole shareholder, that it has a "net asset deficit" – in other words, it is bankrupt. Under the 1985 Companies Act for the directors to continue trading without informing shareholders it was bankrupt would be a criminal offence. Trade and Industry Secretary Patricia Hewitt decides to create a public body, the Nuclear Decommissioning Authority (NDA), to take on the debts and assets of BNFL.

Credit: Don McPhee/Guardian Newspapers

Spent nuclear fuel being stored underwater at Sellafield to prevent overheating and await reprocessing.

2002, FEBRUARY:

Government decides to keep a new nuclear building option open but to not give public subsidy. BNFL and British Energy announce collaboration to build nine plants at a cost of £9 billion – but nothing else happens.

2002, JULY:

Government admits nuclear clean-up bill now £48 billion – or the equivalent of a 1p rise in income tax for everyone for 20 years. Energy Minister Brian Wilson insists there are no plans to revive the nuclear industry by building new stations.

2002, AUGUST:

British Energy faces bankruptcy because the Government's competition regime causes electricity prices to fall below the cost of producing electricity from nuclear power. Government bails out company and taxpayer foots the bill until 2086 for spent fuel management.

At the time of writing it is not known when Thorp will be able to fully reprocess fuel again. The NDA's worst-case scenario was that it would stay partly closed until the new evaporator was completed in 2011. Equally embarrassing is the NDA's statement: "If Thorp was closed permanently the NDA would consider sending the spent fuel to France for reprocessing or retaining the foreign spent fuel in the UK."

If this happened the NDA promised there would be a public consultation. This would raise questions such as: should the fuel be returned to the country of origin or kept in Britain? Who will pay for its storage and disposal or shipment home? Is it politically acceptable to retain this fuel in Britain when there is nowhere to dispose of it – particularly when there have been repeated pledges by the Government that the UK would not become "the world's nuclear dustbin?". There are many more questions on these lines, all of them difficult to answer.

Credit: Don McPhee/Guardian Newspapers

Reprocessing spent fuel at the Thorp plant Sellafield.

2003, FEBRUARY:

Government's Energy White Paper does not close the door on new nuclear build but does not encourage it either. It describes new nuclear power stations as an "unattractive option" and says that before any decision is made to build more there would be the fullest public consultation.

2003, MARCH:

Calder Hall at Sellafield, the world's oldest nuclear power plant, closes.

2003:

Government appoints Committee on Radioactive Waste Management to review potential options for dealing with the problem. It is required to work in an open manner that will inspire public confidence in recommendations.

2003, AUGUST:

BNFL says Thorp reprocessing plant will close in 2010. Brian Watson, director of the Sellafield site says vitrification plant cannot work fast enough to allow Thorp to work at full production.

2004, MAY:

It is revealed that two years after plutonium is introduced into the Sellafield MOX Plant it has still failed to produce any fuel for overseas buyers and is having to subcontract the work to Belgian and French MOX plants.

2004, JULY:

Tony Blair tells MPs that if climate change is to be tackled nuclear power must be back on the agenda.

The Government makes light of the fact the UK has nowhere to put the high-level waste – apart from constructing a store for the glass blocks. It also has nowhere to put increasing quantities of intermediate-level waste either. It is estimated that it will be at least 2045 before a depository for this still very dangerous waste is open. Meanwhile the UK is running out of space to store fuel from its own nuclear stations – let alone that imported from reactors across the world.

Cleaning up operations at Sellafield will cost the taxpayer the best part of £8 billion in the next three years, according to the NDA's business plan, although this figure has already increased because of further plant malfunctions. After that the budget will escalate if Britain is going to keep in control of its nuclear stockpiles. There are more than 100 tonnes of plutonium, a quarter of which belongs to foreign utilities, and 30,000 tonnes of depleted uranium stockpiled at Sellafield as a result of reprocessing activities.

The Nuclear Installations Inspectorate, the Government's safety watchdog, says that repeated delays and technical failures are causing serious problems across the site. And if Sellafield's services are not operating properly the entire nuclear industry in the UK cannot function efficiently. As well as a logjam of spent fuel from British plants that cannot be dealt with, long-running foreign contracts cannot be fulfilled. Foreign waste due to be sent back to overseas customers remains at Sellafield even though successive governments have guaranteed it would be repatriated. None of the countries that are due to have waste returned after their spent fuel has been reprocessed has places to dispose of it, and highly radioactive material would cause political difficulties if it was returned to any country with no facilities to receive it.

The current crop of Sellafield's technical failures is long-term and critical. In the context of a massive new nuclear building programme they are not merely an embarrassment but show how expensive mistakes can be. The optimism of the nuclear industry has repeatedly proved unfounded and Sellafield shows how the nuclear dreams of the last 50 years have turned sour. This vast complex is going to continue to be a very expensive operation to run. According to the National Audit Office in 2008 it is creating an "apparently ever escalating bill" for the taxpayer.

2004, AUGUST:

Despite repeated promises that all nuclear waste should be returned to its country of origin the Department of Trade and Industry reveals that 10,000 cubic metres of foreign waste has been buried at Drigg in Cumbria. In December it becomes official government policy to keep bulky foreign wastes in the UK and return smaller quantities of high-level waste to the country of origin. Income from burying foreign waste, put at £680 million, would be used for Britain's nuclear clean-up.

2005, MARCH:

As UK's carbon dioxide emissions continue to rise a Downing Street spokesman says nuclear power must be reconsidered.

2005, MAY:

Sir David King, Government chief scientific advisor, rules out a rapid return to nuclear power. The Committee on Radioactive Waste Management warns that Government failure to deal with nuclear waste has made people reluctant to support new nuclear power.

2005, MAY:

Irish Environment Minister Dick Roche criticises management systems at the Sellafield nuclear plant, describing them as "something you'd expect from Homer Simpson", after it emerges that liquid high-level waste was escaping from a pipe at the Thorp nuclear reprocessing plant for far longer than first believed.

PART 2:

BRITISH ENERGY – SUBSIDIES, LIABILITIES AND DEFICITS

In March at a UK/French summit the two countries agreed cooperation on nuclear development but gave no details. British ministers again pledged there would be no government subsidies involved.

But everyone inside the industry, and people who have studied its economics, know that without subsidy no new nuclear power station has ever been constructed. Commercial reactors without Government underwriting and financial guarantees cannot get the backing they need from investors.

The UK's record is particularly bad in this area. Attempts to privatise Britain's nuclear industry by Margaret Thatcher in the 1980s were abandoned, and only went ahead in 1996 because the selling price was so low – less than the cost to the taxpayer of building any one of the eight privatised stations. Even so, within six years, this new company, British Energy, faced bankruptcy and had to be bailed out by the taxpayer.

British Energy was rescued because to shut nuclear stations down would have meant power shortages. The privatised nuclear industry got such a good deal it is now in the happy position where the shareholders get the profits but, if anything goes wrong a second time, the taxpayer picks up the bill. Or as Sir John Bourn, head of the National Audit Office put it in March 2006 when launching the NAO report into the rescue: "The Department of Trade and Industry intervened when British Energy could no longer meet its debts. As a result the taxpayer is responsible for underwriting a large and uncertain liability. The scale of the net liability to be borne by the public purse will depend crucially on British Energy's performance in future years. It is therefore vital that the Department keeps close scrutiny to ensure the taxpayer's position is safeguarded."

Despite the nuclear industry's dire record, detailed in this report, the Government has decided that more nuclear power is essential to the UK's energy mix. It is claimed that a third generation of nuclear power plants is needed to provide security of supply and combat climate change. Whether this is true is disputed by many people – particularly since there are many alternatives to nuclear power. What is certain is that plumping for nuclear is not going to help the UK meet its carbon emissions targets by 2020, or provide inexpensive power.

Although there is much evidence to the contrary, the Government has accepted the claims of the nuclear industry that it can build larger nuclear stations, cheaper than ever before, at a far quicker pace. As a result, the Government calculates that the electricity these reactors produce will be comparable in price to that of gas-fired power stations. This is true only if the price of gas stays high and under an emissions trading scheme there is, according to Department of Trade and Industry assessments, a "reasonable

2005, JULY:
Government reveals to the European Union that it paid British Energy £184 million in 2004 to deal with spent fuel from British reactors. The payments, which would be variable, would continue for another 80 years.

2005, AUGUST:
Britain's bill for getting rid of its own nuclear waste rises to £56 billion, according to Sir Anthony Cleaver, chairman of the Nuclear Decommissioning Authority.

2005:
British Energy announces 10-year extension of Dungeness B AGR to 2018. This life extension means instead of the waste and decommissioning costs becoming a liability on British Energy's books and pushing the company close to bankruptcy, the station is counted as a continuing asset.

2006, JANUARY:
Government launches new energy review, and in July publishes "The Energy Challenge" which says "new nuclear power stations would make a significant contribution to our energy policy goals".

2006, JULY:
Committee on Radioactive Waste Management says repository for medium-level nuclear waste unlikely to be ready until 2045.

credit" of more than £25 given to the nuclear industry for every tonne of carbon saved through nuclear generation.

Currently the nuclear industry does not get a financial credit for carbon saved through generating electricity. Opponents say it should not receive this credit because nuclear power is not a sustainable industry as it has not solved its waste problem. As a result of opposition from non-nuclear states, exports of nuclear technology to Eastern Europe and developing countries were refused carbon credits under the Kyoto Protocol. The Government is, however, counting on nuclear power being awarded substantial carbon credits in the next round of the European Union's carbon trading scheme. This is essential if the Government is to make nuclear power seem financially viable and competitive with renewable energy, which unlike nuclear power is steadily getting cheaper.

WHAT TYPE OF REACTOR TO BUILD?

The most likely third generation nuclear plant to be built in Britain is the Evolutionary Pressurised Water Reactor (EPR). There is one under construction in Finland, which was due to be generating electricity in 2009, in time to allow the country to meet its carbon dioxide reduction targets under the Kyoto Protocol. It will be the largest reactor ever built, at 1,600 megawatts. Delays have dogged its construction from the outset and its completion date has repeatedly been put back. In December 2007 completion was again delayed to summer 2011 – two years late. The company constructing the plant, Areva-Siemens, said: "The delay of the project will cost additional work and costs" – without saying how much, but it is believed to be around £1 billion.

An investigation into the delay by the Finnish Radiation and Nuclear Safety Authority (STUK), published in December 2007, blamed the problem partly on the failure of everyone concerned to appreciate the time and resources needed for detailed design of the reactor.

Another failure was the lack of safety culture and the use of inexperienced subcontractors given insufficient guidance, according to the STUK. Some had no experience in constructing nuclear power plants. The UK's Nuclear Installations Inspectorate has repeatedly warned the Government that there are skills shortages throughout the British nuclear industry, which would seriously hamper a new nuclear building programme. This kind of warning carries in-built delays judging by the Finnish and previous British experience. This makes the Minister's public optimism that the first new plant in the UK would be up and running by 2017 dubious – particularly when the Department of Business Enterprise and Regulatory Reform paper on the economics of the issue put the likely date of first electricity generation at 2021. As

2006:
UK's Sustainable Development Commission, in an eight volume assessment of the potential for a new nuclear building programme, concludes: "there is no justification for a new nuclear programme at this time, and that any such proposal would be incompatible with the Government's own sustainable strategy".

2006:
Construction of Finland's 1,600 megawatt Evolutionary Power Reactor begins. It is the first of the third generation nuclear power plants (and the one most likely to be built in Britain). It is designed to be completed in 2009 at a cost of 3 billion Euros.

2006:
NDA's lifetime plan says an end to reprocessing in 2012 will enable Sellafield to reduce discharges to "near to zero by 2020" as envisaged by the OSPAR agreement of 1998.

2006:
Committee on Radioactive Waste Management recommends the development of partnerships between the nuclear industry and willing communities to find nuclear waste disposal facilities. Deep geological disposal is recommended but only after proper research into uncertainties about storage, disposal and security issues.

in Finland there is the additional problem that the nuclear stations would be unable to contribute to meet the UK's 20 per cent carbon dioxide reduction target by 2020. Neither will the UK's new nuclear build timetable fill the Department of Trade and Industry's predicted "energy gap" of 2015 caused by old generating plant closing. So Britain's environmental targets will be missed and its reputation will suffer.

A second EPR began construction in France in December 2007 where there should be no shortage of expertise. Here construction is supposed to take 54 months. This is described as a demonstration EPR. France has announced plans to build 40 to replace its existing 58 ageing reactors. However, a decision will not be made until 2015 when experience has been gained to see if the EPR works as intended. Ominously for the UK the French have already modified the design being used for the Finnish reactor under construction. This is a point of interest to the UK where the constantly changing design of the advanced gas-cooled reactors is said to be the main reason why they have been liable to breakdown and poor performance. The next generation was supposed to be of standard design, thus reducing costs because design and parts could be replicated. The EPR design is clearly still evolving, so these savings might not be available as claimed by the British Government.

It may be that the EPR is not the reactor type that gets built in Britain. There are other candidates, but all of them are untried prototypes – a recipe on past and present experience for even longer delays and costly overruns.

WHERE TO BUILD NEW REACTORS?

The next question is where these stations are going to be built and by whom. The proposed sites (see p33) all contain existing nuclear stations. British Energy has signed agreements for grid connections for new stations at Sizewell in Suffolk, Bradwell in Essex, Dungeness in Kent and Hinkley Point, Somerset. These agreements become operative in 2015, well before any stations are likely to be built, but indicate confidence that this is where four giant EPRs will be built. This also anticipates British Energy having a serious financial interest in the new build – it owns eight sites that are the most likely contenders for nuclear new build of any type.

BRITISH ENERGY'S LIABILITIES

The financial viability of British Energy over a period long enough to construct new nuclear power stations is questionable. The Government has a nuclear liabilities fund which stood at £6.9 billion on 1 June 2007 and to which British Energy contributes each year from profits. Liabilities are put at £4.3 billion. These figures provided by the Government show that in 2008 the book value of the fund exceeds its liabilities by £2.6 billion. However British Energy's actual liabilities are

2006, NOVEMBER:
Unlike Magnox and AGR fuel, the spent fuel from Sizewell B reactor is stored on site in special ponds. This vulnerable coastal site is a potential target for terrorists but the security arrangements and evacuation plans for local people are pronounced secret by British Energy, even though 300 tonnes of spent fuel is kept there.

2007, FEBRUARY:
High Court rules that the Government's nuclear consultation on its Energy Review of the previous year was seriously flawed and procedurally unfair. The information on nuclear waste was not merely inadequate but misleading. Prime Minister Tony Blair says the ruling "will not affect policy at all".

2007, APRIL:
A cost benefit analysis by the Department for Business, Enterprise and Regulatory Reform (BERR) concludes that nuclear power is likely to cost 3.8 pence per kilowatt hour to produce, provided all future nuclear waste costs are discounted. It also concludes that the first plant would be built around 2021. This would involve an eight-year pre-development period and six years for construction. Adding four new 1,600 megawatt nuclear stations of similar design to the one in Finland would reduce total forecast gas consumption by 7 per cent – and carbon dioxide emissions by just 4 per cent.

Credit: The Guardian

Sizewell B, in Suffolk, Britain's newest nuclear station, and the UK's only pressurised water reactor. It was built with the levy on electricity bills which was supposed to be spent on nuclear clean-up.

much higher because of the cost of decommissioning the ageing nuclear power stations it owns and the share of costs it must bear for the dismantling of the Thorp reprocessing plant it uses. There is a time delay before this money is needed so these gross liabilities are discounted at a rate of 3 per cent a year until the planned closure date of decommissioning. At that point the full cost of decommissioning has to be shown as a liability on the books. In 2007 British Energy's undiscounted liabilities were given as £14.5 billion – more than double the amount in the liabilities fund.

The nuclear liabilities fund is designed to pay for all decommissioning costs when they arise. The money is invested in a supposedly ring-fenced fund – like a pension fund for nuclear facilities. But in the past (see time line) these funds have been raided by the nuclear industry to build new nuclear facilities, such as Sizewell B, and the money has evaporated.

2007, JUNE:

Nuclear Decommissioning Authority (NDA) reveals there are 30,000 tonnes of uranium and 100 tonnes of plutonium in store, but no policy for managing this material in the long term.

2007, JUNE:

Government sells £2.3 billion worth of shares in British Energy. Money goes to the Nuclear Liabilities Fund to pay for spent fuel reprocessing.

2007, JUNE:

The original idea of Thorp was to reprocess foreign spent fuel so the plutonium and uranium it contained could be returned to its country of origin for re-use as fuel. The shutdown of the plant means no plutonium is being produced to make into MOX fuel for foreign contracts. A condition of the MOX plant licence was that only plutonium from foreign fuel could be used. To avoid having to shut the MOX plant as well as Thorp, the NDA proposes changing the licence so allowing the use of British plutonium from stores to make up foreign fuel until Thorp can restart. There is a short public consultation on the issue.

2007, AUGUST:

Finland's Olkiluoto 1,600 megawatt third generation reactor is revealed to be two years late and over budget. It was originally due to be completed in 2009; now estimated to be completed 2011 at a cost of 4 billion Euros (£1 billion over budget). The project was supposed to require no public subsidies but is supported by export credit guarantees from French and Swedish Governments.

The Government has pledged this will not happen again and the discount rate of 3 per cent is based on the assumption that the liabilities fund will grow at the rate of 3 per cent. The theory is that by the time decommissioning is necessary the fund will neatly pay for everything. This is the view of British Energy and BERR.

While the Government is happy with this arrangement the National Audit Office (see above) and the House of Commons Committee on Public accounts in its 2006/07 report concluded "the taxpayer is still exposed".

The exposure will become critical when liabilities exceed assets. This may happen as in 2001 when the price of electricity dropped below the cost of producing it from nuclear power – although this seems unlikely in the foreseeable future because the price for wholesale electricity has more than doubled. Yet costs could rise sufficiently to make some of the current AGR power stations' profits marginal. For example, the cost of uranium is rising, and although the Government is confident this will not substantially alter the long-term cost figures for nuclear generation, some mining experts say good quality supplies of uranium are finite. Over the planned life of existing and new nuclear reactors, a shortage of suitable uranium could do to nuclear fuel prices what the price of oil has done to the cost of running the family car. British Energy said that in January 2008 the uranium price had gone up to US$95 a pound. This was compared with $85 in March 2007. This would drive up nuclear fuel costs by £146 million a year if British Energy had not advance-purchased uranium at the old price.

A more likely immediate danger to British Energy arises if any of the ageing AGR power stations have to close because of safety faults, for example distortion of graphite blocks or corrosion, both of which have already been identified as life-limiting problems. The closure of Thorp could add billions of pounds to the liabilities. Both British Energy and Sellafield Limited refuse to disclose the company's liabilities for Thorp; but about 40 per cent of the throughput at Thorp has been from the AGR stations owned by British Energy. The clean-up cost of Sellafield is more than £31 billion, but only a small part of that is for Thorp.

So far the company and the Government are avoiding both these eventualities by extending the life of Thorp to at least 2015, along with extensions for the three AGRs which were due to be closed soon. Despite boiler cracks, Hinkley Point in Somerset and Hunterston on the Ayrshire coast, due to close in 2011, had their lives extended to 2016 in December. Because of safety fears they were operating at an uneconomic 60 per cent of capacity at the beginning of 2008 but the company hoped to raise this to 70 per cent and get them back in the

2007, SEPTEMBER:
Royal Society reveals that the Sellafield MOX Plant will never work to design capacity of 120 tonnes of MOX fuel a year and 40 tonnes is maximum production target.

2007, SEPTEMBER:
Greenpeace, Friends of the Earth, WWF, and Green Alliance pull out of latest Government consultation on nuclear power describing it as "a sham".

2007, OCTOBER:
Cost of nuclear clean-up rises to £73 billion according to the NDA – 16 per cent more than estimated only a year before.

2007, NOVEMBER:
Government approves swapping British plutonium for foreign plutonium so MOX production can continue while Thorp remains closed.

2007, NOVEMBER:
Because of breakdowns and poor performance at Sellafield the NDA abandons plans to close the Magnox reprocessing plant in 2012 and puts it back to 2016 at least. Thorp closure is also left open ended.

black. Dungeness B in Kent, due to close in 2008, has already had its life extended to 2018. Next in line for extensions are Hartlepool on Teeside, and Heysham 1 in Lancashire, both due to close in 2014.

It is only the lifetime extensions to these stations and Thorp that are preventing British Energy having to turn to the taxpayer to underwrite its liabilities, which would exceed the assets in the liability fund. In response to detailed questions both British Energy and BERR express confidence that the fund will always manage to keep ahead of liabilities. On the figures available, with the size of the known undiscounted liabilities rising, it may need a remarkable juggling act and a great deal of the nuclear industry's voodoo economics to keep the company afloat while a new generation of nuclear power plants is built. But British Energy notes that if the juggling act fails "There is provision within the restructuring agreements for the Government to exercise an option to acquire a BE station on closure to either decommission or continue to operate it." In other words, if bankruptcy looms the industry or any failing part of it will be nationalised.

Credit: Guardian Newspapers

The first advanced gas cooled nuclear power station at Dungeness Nuclear in Kent which took 18 years to construct and has never worked as designed.

GET-OUTS AND PERKS

To avoid the new nuclear building programme being too closely associated with existing costs at Sellafield and future problems for British Energy it is probable that the

2007, NOVEMBER:

British Energy says it has signed agreements for grid connections for four nuclear sites at Sizewell in Suffolk and Bradwell in Essex, Dungeness, Kent, and Hinkley Point, Somerset. It has also received a report about sea defences on all four sites having to be strengthened to cope with climate change.

2007, DECEMBER:

British Energy to spend £90 million extending the life of Hinkley Point B and Hunterston B Power stations by five years to 2016 although they will only be able to run at 70 per cent of original output. There is no formal closure date for any of the company's stations. Provided they are safe and the company decides they are economically viable they can stay open indefinitely. This means new nuclear build is not needed to replace existing stations because they are unlikely to close when the Government claims they will.

2007:

Builders of Olkiluoto 3, the new nuclear power station in Finland, still hope to open the plant in summer 2011.

2007:

First concrete poured for France's third generation nuclear power plant, similar but modified design to Olkiluoto 3. Expected to be commissioned in 2012.

When the Government recently decided to back a revival of the nuclear industry, two favourite characters from political cartoonist Steve Bell returned. The two-headed radioactive sheep, first seen after the Chernobyl disaster reappeared, alongside a new herd of white elephants.

2008, JANUARY:

Government announces it is favourable towards new nuclear building porgramme but pledges that there will be no public subsidy. Details on how this is to be achieved to be published later. Tim Jackson, economics commissioner at the UK's Sustainable Development Commission denounces the Government's endorsement of nuclear power as "disingenuous nonsense and a blatant failure of moral vision".

2008, JANUARY:

Hopes of restarting Thorp dashed when lift carrying spent fuel into plant fails and sinks back into storage pond.

2008, MARCH:

Energy Minister Malcolm Wicks admits MOX plant produced only 2.6 tonnes of fuel in 2007 and less than 6 tonnes since opening in 2001. Wicks describes it as a "largely unproven technology".

2008, MARCH:

Independent think tank the Economic Research Council releases a report saying that a nuclear build programme is not possible in the UK without the Government speeding up the planning process and giving financial guarantees so the taxpayer covers the risk of cost overruns. It says the Government would have to guarantee to buy all the electricity output of nuclear stations and the taxpayer underwrite any consortium's exposure to cost of spent fuel and waste disposal.

Government and the nuclear industry would like to float another company to own the sites and new stations. In this way the taxpayer would be made to shoulder all the costs and private industry would take all the profits of a new programme. One of the key components of a new programme would be that all the spent fuel would be stored on site – effectively postponing the disposal problem for future generations to deal with. This is contrary to the Government's stated aim of only encouraging sustainable development.

Some of the subsidies the Government will give to the nuclear power industry will become apparent as terms and conditions are negotiated with potential builders. The need for sea defences for the new stations as climate change takes a hold have been mentioned but it is not clear who will pay for them. All the proposed sites are on vulnerable coasts. Will the nuclear industry pay the cost or the taxpayer-funded Environment Agency?

Another public subsidy is insurance against accident and the increasing bill for security. Unlimited insurance underwritten by the state is already enshrined in international treaty so the UK taxpayer has no alternative but to foot the bill for these. It is, however, an economic advantage that other forms of electricity generation do not enjoy. The special armed nuclear police are also a public expense.

Hard to quantify as a financial perk is the need for nuclear power to be given priority as a baseload provider, that is to say the power that is needed 24 hours a day outside the times of peak demand. Much is made of the intermittency of wind-generated power but nuclear has the opposite problem: stations cannot be readily turned on and off and they only operate economically at full power, so they have to be given priority to sell their electricity to the grid to the exclusion of other power sources that may be cheaper.

There is one other issue that is not addressed in the figures the Government has put forward and on which they rely to make nuclear power appear competitive: transmission costs. The new breed of nuclear power stations are going to be among the biggest power plants in Britain and distant from where most of their electricity will be used. This will require a large investment in the National Grid, clearly something British Energy is aware of because of the deal it has already struck for four proposed sites. Lack of grid connection has long held back development of renewables in Britain mainly because the Government has failed to force progress. This is one of the many problems that has kept Britain's renewables programme behind the rest of Europe. Only Malta and Luxembourg have a smaller percentage of renewables in their energy supply.

But the transmission problem hides another statistic that makes nuclear

2008, MARCH:
Business Secretary, John Hutton, says he wants the nuclear component of Britain's electricity production to rise beyond 19 per cent with new build and says he wants to sell the Government's remaining 35 per cent stake in British Energy.

2008, MARCH:
British Energy shares rise 20 per cent after announcement that company is in talks with potential partners or might be the subject of a takeover bid. RWE and E.ON in Germany, EDF France and Centrica, owner of British Gas and Scottish and Southern all said to be interested.

2008, MARCH:
The Government says it will be happy if British Energy is owned by a foreign company. Concern is expressed that any successful bidder would have control of all the suitable sites for new nuclear stations in England.

power look less financially attractive. The standard loss of power through long distance transmission from big generating plants is quoted as 9 per cent by the industry. Losses are much smaller for locally based renewables because the energy is used close to source.

THE FRENCH CONNECTION

The March 2008 Anglo-French summit agreement of cooperation on nuclear matters was interpreted by Downing Street officials as meaning that the UK would rely heavily on French expertise to help build its first new nuclear stations.

This makes it more likely that the first choice for Britain's nuclear new build will be the French 1,600 megawatt Evolutionary Power Reactor, the first of which is being built in Finland. It was due to be producing power in 2009 but has been delayed to summer 2011, and is estimated to cost at least double its original 3 billion Euro budget. Lack of skill in the workforce was given as one of the reasons for the delay. This nuclear station was to be built at a fixed price so has had to be heavily subsidised. This is being done by a guarantee by heavy industry to buy the electricity output, and by export credit guarantees by the French and Swedish Governments. The extra costs will therefore fall on French and Swedish taxpayers.

No nuclear station has ever been built in Europe without government subsidy. In France the public pays for the nuclear industry twice, through its electricity bills and again through its taxes. The true cost of nuclear energy in France is a state secret and has never been disclosed.

The biggest problem for potential nuclear investors in Britain is the capital costs of nuclear stations, especially with the credit crunch and high interest rates. It is a virtual certainty, going on past and current experience of nuclear construction, that there will be cost overruns and time delays. This would add dramatically to the cost of borrowing capital in the open market. Without government guarantees to hold down interest rates for new nuclear build, which amounts to a substantial subsidy, it seems impossible to finance the programme. The Government is already committed to bailing out British Energy if it fails financially. Because British Energy owns all the best nuclear sites it is almost certain to be a partner in any new nuclear venture. Because of its guarantees to the company to take on any liabilities the Government will be in a position of having to foot the bill for any shortfall in funds. It is hard to avoid the conclusion that, whatever the Government's assurances to the contrary, nuclear new build will involve heavy government subsidies and unlimited liability for the British taxpayer.

2008, MARCH:

John Hutton, Energy Secretary, says new nuclear build in the UK will create 100,000 jobs, provide £20 billion in new business for UK and likens it to the North Sea Oil bonanza of the 1980s. He wants the UK to be the number one place in the world to do nuclear business, and says there is a critical two year window to achieve this. Promises nuclear waste White Paper for spring 2008 so problem of waste from new stations is solved.

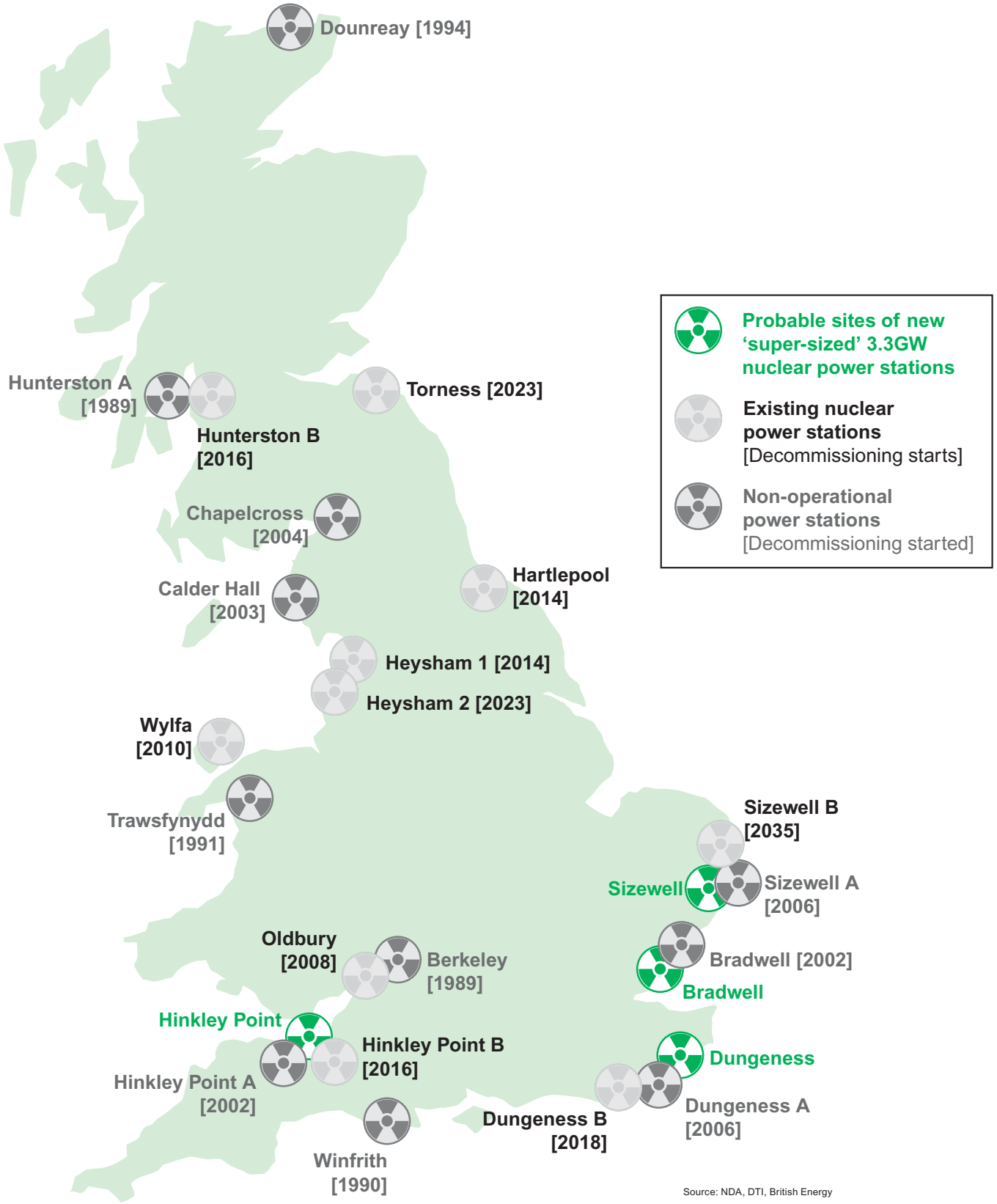
2008, MARCH:

Energy Minister Malcolm Wicks, claims there will be "no subsidies for new nuclear build" and says he is convinced that the UK cannot reduce its carbon dioxide emissions by 60 per cent by 2050 without new nuclear stations.

2008, MARCH:

Prime Minister Gordon Brown and French President Nicolas Sarkozy issue a communiqué promising to jointly "improve the efficiency and effectiveness of nuclear developments". Officials say it means the UK will lean heavily on French nuclear energy skills "at least in the initial stages of expansion".

NEW SITES: THE UK'S PROBABLE, EXISTING AND NON-OPERATIONAL NUCLEAR POWER STATIONS



Source: NDA, DTI, British Energy

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There has been an enormous number of reports, books and papers on the nuclear industry in the past five years, and many more in the decades before. Below are the major ones I have read and drawn on. I have been writing about the industry and talking to and interviewing people interested in it since mid-1980s.

The list is arranged with the most up-to-date books and papers first. However at the end of the list are details of some of the other sources, including some of those interviewed in 2007 and 2008 during the course of my press fellowship at Wolfson College, Cambridge.

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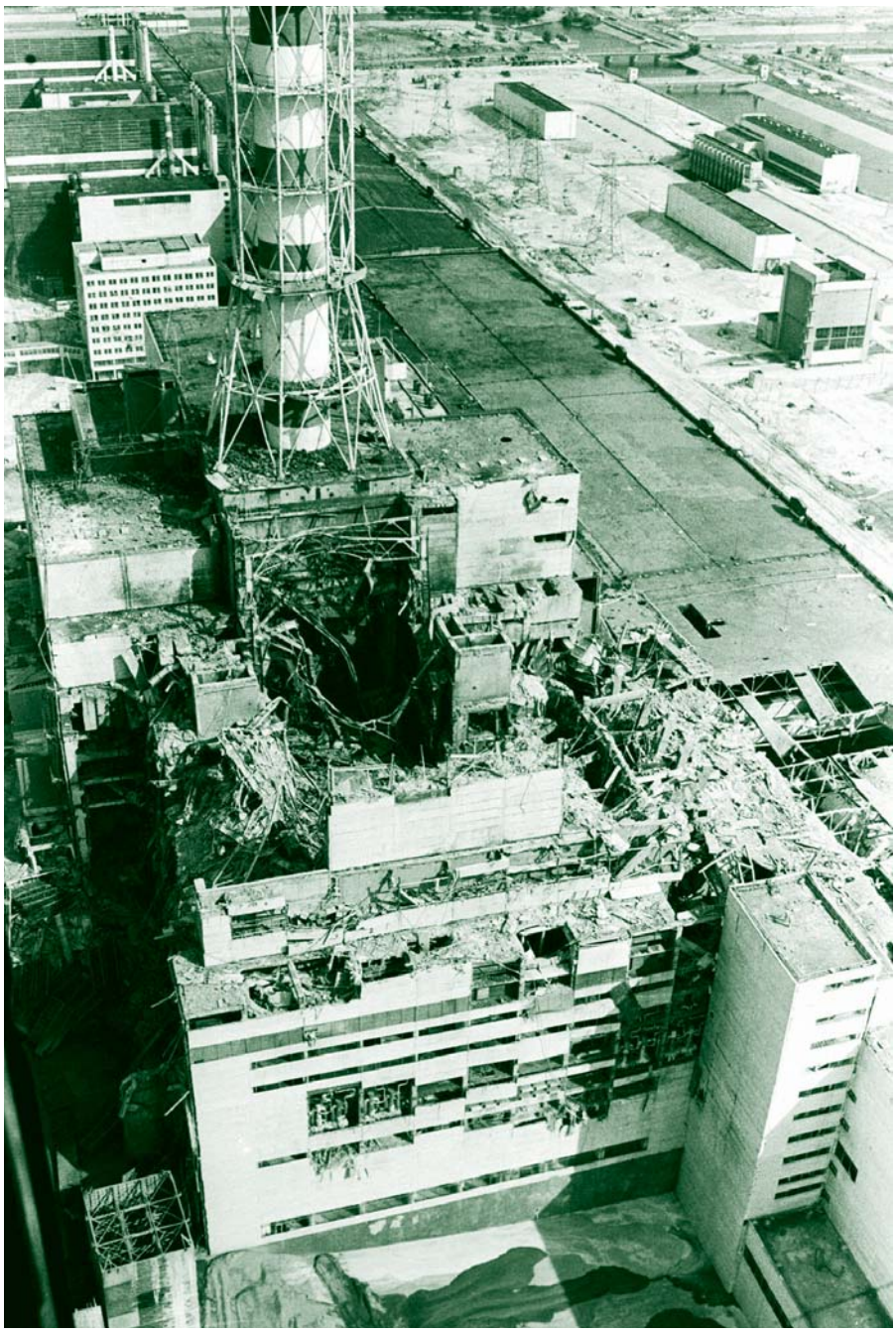

Credit: Reuters

The Chernobyl reactor in 1986 shortly after the world's worst nuclear accident devastated the area.

VOODOO ECONOMICS AND THE DOOMED NUCLEAR RENAISSANCE

This paper exposes how badly the nuclear industry in Britain has performed throughout its entire history.

Fifty years of unfulfilled promises, technical failures and an escalating bill to the taxpayer raise huge questions over the viability of a new nuclear power programme in the UK.

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