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The Chernobyl nuclear disaster –

20th anniversary commemoration

Time for a new orientation of energy policy?

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The text which follows is a discussion paper
from the Study area on Peace and Sustainable Development
of the Protestant Institute for Interdisciplinary Research
of Heidelberg, Germany
Schmeilweg 5
DE -69118 Heidelberg
Tel. +0049 6221-9122-0
www.fest-heidelberg.de
E-mail: hans.diefenbacher@fest-heidelberg.de

The authors of this text are
Hans Diefenbacher,
Constanze Eisenbart
and Ulrich Ratsch,

in collaboration with
Klaus Breyer, Iserlohn

and Gerhard Monninger, Munich

The Chernobyl nuclear disaster – 20th anniversary commemoration
Time for a new orientation of energy policy?

The Protestant Institute for Interdisciplinary Research (FEST) published, in the autumn of 1986, a position paper on energy policy [in Germany] since Chernobyl.[1] *The years 1986 and 1987 saw numerous "post-Chernobyl" resolutions and expressions of opinion on energy policy by the EKD [Evangelical Church in Germany], the Landeskirchen, church groups and others involved in the church.*[2] *Twenty years on, it is time to see whether our assessments and policy recommendations written shortly after the disaster are still valid, and what conclusions can be drawn from them for the direction of energy policy today.*

(1) For the peaceful use of nuclear energy, the Chernobyl nuclear disaster signified that a new age had begun. This new age was beginning to emerge in the months immediately following the event, and 20 years later it has been confirmed. The accident at Chernobyl brought into view what is hidden behind the concept of "element of risk", and the scale of human suffering and environmental destruction that this technology can cause. The overwhelming amount of media and political attention that this event received in 1986 s hard for us to imagine today. Twenty years later, however, for many people, the kind of disaster it was and its extent are largely unknown.

(2) What happened in 1986? In the years since the disaster, the accident's sequence of events has been reconstructed with some precision. During the night from 25 to 26 April, Block 4 of the Chernobyl nuclear power station exploded. "The unbelievable had happened, an event occurred which, according to the then known safety studies, had only the extremely small probability of happening once in ten million years."[3] The catastrophe took place because, in the course of a technical testing programme, during a phase in which, according to plan, the plant was powered down for inspection, certain safety features of the plant were to be tested and certified as operative. The objective was to see whether, if the supply of steam to the reactor's turbines were cut off, they would retain enough momentum to continue covering the plant's own electrical power needs for a short time.

Afterwards it was clear that the testing programme was inadequate, that unexpected circumstances arose while it was being carried out, and that plant personnel interfered

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[1] Research Centre of the Protestant Institute for Interdisciplinary Research (ed.), *Tschernobyl – Folgen und Folgerungen [Chernobyl: Consequences and Conclusions]*. Heidelberg: FEST, 1986.

[2] See Hans Diefenbacher, Ulrich Ratsch and Hans-Richard Reuter: "Energiepolitik und Gefahren der Kernenergie – Kirchliche Stellungnahmen [Energy Policy and Dangers of Nuclear Power – Church Positions]", *Kirchliches Jahrbuch 1986*, Lieferung 2 (1988), 133-312.

[3] Paragraph (2) is largely based on Leopold Barleon, "Tschernobyl, 10 Jahre danach – Versuch einer Bewertung [Chernobyl 10 Years on – an attempt at evaluation]", in *VDW info*, No. 1/1996, 1; see also Gesellschaft für Anlagen- und Reaktorsicherheit (ed.), *Tschernobyl – Zehn Jahre danach. Der Unfall und die Sicherheit der RBMK-Anlagen [Chernobyl – Ten Years on. The Accident and the Safety of RBMK Plants]*. Cologne: GRS, 1996. [Translator's reference: World Nuclear Association, Information and Issue Briefs, Chernobyl Accident, March 2006; www.world-nuclear.org/info/chernobyl/inf07.htm – Tr.]

in ways which were not according to plan. Thus, the reactor entered into a state which no one had anticipated. It reached a so-called “critical” point, which caused a strong surge in the reactor’s power production in a very short period of time. The fuel became extremely hot. This heating of the fuel until it turned to liquid and then to steam, and the expansion, due to fission, of gases locked inside the fuel rods, led to a build up of pressure followed by fragmentation. Pieces of hot fuel came into contact with the surrounding cooling water, producing steam.

All this happened in about a tenth of a second. The explosive release of energy tore off the stoppers at the top of the pressure tubes. So much steam pressure built up under the 1000-tonne cover plates over the reactor core that they were torn loose from their fixings and stood up vertically. Pressure tubes and fuel channels were broken off and the control rods were pulled out together with the plates. In a second violent explosion the upper part of the building was blown off. The 200-tonne refuelling mechanism for the fuel rods was torn from its moorings on the ceiling and fell into the shaft housing the nuclear reactor core. The cement covering of the reactor core had now been destroyed, along with the steel reactor container.

Oxygen from the air outside now had unhindered access to the overheated reactor core. The graphite block was set on fire. The fierce blaze was strengthened by the drawing effect of the reactor’s open roof. As in a chimney, radioactive particles were sucked up in the stream of hot air from the graphite fire to a height of more than 1200 metres and carried away by air currents. The massive release of radioactive materials continued for ten days. In the following five days the upward draft lessened, but materials were still being released at heights of 200 to 400 metres.

The proportion of nuclear fuel found afterwards to have escaped from the reactor was calculated at three to four per cent of the total mass of nuclear fuel. Almost all of the noble gases krypton and xenon escaped, and a more recent calculation of caesium and iodine isotopes yielded a value of either 33 per cent or 50 per cent of the nuclear inventory. For the heavy radionuclides, which have a very long half life, the proportion released was estimated to be four per cent for strontium 90 and three per cent for plutonium.[4]

(3) Nobody was prepared for a catastrophe on this scale – just as today, nobody would be prepared. For example, the nearby town of Pripyat, population 50,000, was not informed until 27 April. The first official announcement of the disaster was made more than two days after it took place.[5] Even some of those most immediately affected were not informed until days afterward. For example, on Saturday, 26 April there was no warning not to let children play outdoors, and all the schools kept to their full

[4] GRS (ed.) (1996), *op.cit.*, 58. The half life of caesium 137 is about 30.1 years; of strontium 90, about 27.9 years; of plutonium 240, about 6.575 years; and of plutonium 239, about 24.383 years.

[5] The Council of Ministers of the USSR announced: “There has been an accident at the Chernobyl nuclear power station, in which one of the reactors was damaged. Measures have been taken to eliminate the consequences of the accident. Help is being provided to those affected. A government commission has been appointed.” See also Yury Scherbak, *Protokolle einer Katastrophe [The Record of a Catastrophe]*. Frankfurt/Main: Athenäum, 1988.

timetables that day. The evacuation of the 30,000 inhabitants of Chernobyl did not take place until 4 May, and many of those evacuated had very little time to prepare. There are many indications that, in the first two or three days, many of the authorities still thought it best to let people carry on their normal lives, even in the 30-km zone around the disaster site, to avoid worrying them unduly. As in all large-scale disasters – and not only in Russia – there were serious problems of communication and coordination between the various levels of government.

(4) Radioactive clouds reached Germany from 30 April onwards. Here too, the population was not appropriately informed in time for the holiday [observed throughout Europe] on the first of May, nor on 2 May. It was raining, in amounts that varied widely over different areas, so that the radioactive pollution was extremely unevenly distributed in Germany, with significant differences even at very local levels. For quite awhile official announcements were completely contradictory, especially with regard to recommendations about how to behave. People's reactions varied from indifference, to concern, to hysteria. However, brochures with introductions to the dangers of radioactivity and recommended behaviour, in a language which could be understood by the general public, were eventually printed in very large quantities in Germany.[6]

The first comments from industrial circles emphasised especially the dependability of German nuclear reactors, which were built differently, and demanded shutting down reactors of the Chernobyl type as quickly as possible. Russian nuclear reactors are very different from those in European and North American nuclear power plants. The unique combination of materials used in these reactors – graphite, metal, water, steam from water, uranium – and the necessity for human intervention in critical situations make them very susceptible to serious accidents. But do the better designs of western nuclear reactors really allow us to go back so quickly to the philosophy of risk which was already highly dubious in 1986? Can we return to business as usual – as we did following the accident at Harrisburg [Three Mile Island] and other western nuclear accidents? Can we compare the number of those who "died instantly" at Chernobyl with those in other accidents, or with traffic accident statistics, and defend the assessment that Chernobyl "wasn't such an outstanding event in the history of technology?"[7]

(5) The number of fatalities as given at the time of the accident and shortly thereafter varies from 40 to 50. There is no really reliable information on the extent of later casualties. Ten years ago the conclusion had already been drawn that a precise record of the

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[6] For example, Holger Strohm, *Was Sie nach der Reaktorkatastrophe wissen müssen [What you need to know following the nuclear reactor disaster]*. Frankfurt: 2001 Verlag, 1986, print run by June 1986 over 110,000; see also IFEU (ed.), *Die Folgen von Tschernobyl [Consequences of Chernobyl]*. Heidelberg, privately printed, 1986; BUND (ed.), *Der Supergau von Tschernobyl [The Chernobyl Super-Disaster]*. Freiburg: Dreisam Verlag, 1986.

[7] Joachim Grawe, "Zukünftige Energieversorgung – Überlegungen zu der Möglichkeit eines nuklear-regenerativen Energiesystems [Future Energy Supplies – Thoughts on the Possibility of a Nuclear Regenerative System]", in *Energiewirtschaftliche Tagesfragen [Questions for Today on Energy and Economy]*, Vol. 10, 1988; see also Helmut Körber, *Energie für morgen: Fragen, Argumente, Meinungen [Energy for Tomorrow: Questions, Arguments, Opinions]*. Stuttgart/Munich/Landsberg: Verlag Bonn aktuell, 1991, 119.

consequences would not be possible, due to the wretched state of administration following the collapse of the Soviet Union. Long-term and systematic accounting for the damage was never undertaken and probably is still not a sought-after objective. Ten years after the disaster, many of those who were evacuated too late had fallen ill with cancer, or had already died of it, but they do not appear in any statistics, because no health authorities kept records on them.[8]

As of 1990 there were 86 officially recognised fatalities, and there were unofficial reports that, of the soldiers who were ordered to build the "sarcophagus" around the melted-down reactor, 300 died. In 1990, some three and a half to four million people were still living in areas of radioactive pollution in Belarus, Ukraine and Russia. A World Health Organisation (WHO) conference in November 1995 noted a drastic rise in thyroid cancer among children. Psychological illnesses such as severe depression were also mentioned in the WHO report as common delayed consequences of the accident and the necessary forced relocations of over 116,000 people. The [German chapter of the] International Physicians for the Prevention of Nuclear War (IPPNW) estimates that as many as 70,000 people died immediately or later from the consequences of the nuclear disaster.[9]

(6) However, ten years further on, in the autumn of 2005, the WHO announced an astonishing change in its views. It had since taken part in a joint study with the International Atomic Energy Association (IAEA) and the United Nations Development Programme (UNDP).[10] This study, and even more so the shorter and simplified versions given in statements made about it at press conferences, which was all the wider public heard about it, downplayed the consequences of the disaster in a way that is incomprehensible to many experts in the field. It is as though these big, respected UN organisations, above all the IAEA, had decided to end discussion on this topic once and for all. The authors claimed to "settle the outstanding questions" and to have arrived at a "sound consensus" in their assessment of the accident. This study gives the number of fatalities which are attributed directly to radiation from the accident, up to mid-2005, as "under 50". Altogether, according to the study, up to 4000 people may have died from the radiation. Due to the "high survival rate" of children and youth with thyroid cancer, these problems are not considered dramatic. Thus "the sum total of the Chernobyl Forum is a reassuring message," according to Dr Michael Repacholi, Manager of WHO's Radiation Program, at the press conference announcing publication of the study.[11] What the study does not conceal, but evidently does not consider very significant, is the fact that a 30 km zone around the nuclear plant is uninhabitable and

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[8] Cf. Barleon, *op.cit.*, 3.

[9] International Physicians for the Prevention of Nuclear War (IPPNW) [German chapter], "Atomstrom adé [Goodbye to Nukes]", on its Website, <www.ippnw.de>. [Not available in English, according to the IPPNW's English-speaking (US) Website – see its list of publications at www.ippnw.org/NukePubs.html – Tr.]

[10] UN Chernobyl Forum, *Consequences of the Chernobyl Accident and Their Remediation – Twenty Years of Experience.* Geneva: IAEA/WHO/UNDP, 2005. [Not mentioned by title on the Websites of the UN Chernobyl Forum, IAEA, WHO or UNDP, nor in the press release, see note 11 – Tr.]

[11] IAEA/WHO/UNDP (eds.), "Chernobyl: the true scale of the accident". Press release of 5 September 2005.

closed off.[12]

Many scientists have strongly criticised the above-mentioned study since its publication. For example, Keith Baverstock, also a WHO staff member, who has spent many years investigating the rise in thyroid cancer in Belarus:[13] "My main criticism is that the study claims to be conclusive. But only twenty years have passed since Chernobyl. That's much too short a period in which to draw final conclusions. Twenty years after the atom bombs were dropped on Japan, we knew only that leukemia was one of the consequences of the radiation. After 24 years we observed a rise in other cancers, and after 45 years a rise in non-cancerous illnesses. Furthermore, these authors assert that 99 per cent of thyroid cancers can be cured. That's not the point, because we don't know today whether more deadly forms of thyroid cancer may yet emerge. Today we are already seeing changing patterns, in histology and in types of cancer. We are seeing all sorts of latent conditions, each of which can signify a different illness. Furthermore, being sick with thyroid cancer is no trivial matter, the way it is made to seem in this study. For a child it is a heavy burden on his or her childhood years. The harm it causes is being completely underestimated. It's far too soon to close the file on Chernobyl."

(7) Six hundred thousand recovery workers, the so-called "liquidators", mostly young men recruited by coercion, preserved humanity from an even greater catastrophe in the months after the nuclear accident. It took them many months to build the protective cement covering and to clear away debris and clean up around the reactor and the surrounding area, the death zone. Can there really have been only 50 deaths after all this? Figures given by the Ukrainian government and the liquidators' associations speak a different language from that of the IAEA and WHO study. Currently 94 per cent of the liquidators are sick, according to the Ukrainian embassy in Paris in April 2005. Professor Alexey Yablokov of the Centre for Russian Environmental Policy reports, on behalf of liquidators' associations, that 50 per cent of the recovery workers are regarded as disabled today. Their average life expectancy is 46.2 years. Who is right here? In November 2005, scientists from Russia, Ukraine and Belarus were invited to a meeting by the Swiss IPPNW. Their conclusion: beyond the initial acute radiation, it was evident that particularly the low doses of radiation which they continue to receive even today, and the permanent load of radioactive contamination of food in the region, is having severe effects on the health of recovery workers and the general population. These scientists warned that there would be an epidemic of cancer in the next ten to twenty years. They reproached the authors of the IAEA and WHO's September 2005 publication with ignoring their studies and keeping quiet about the true extent of the nuclear catastrophe.[14]

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[12] See also [German] Ministry of the Environment (BMU) (ed.), "Tschernobyl – alles nicht so schlimm? [Chernobyl – not so bad after all?]" BMU Press Service No. 236/05, 7 September 2005.

[13] Ute Watermann, Interview with Keith Baverstock, in *IPPNW-Forum* [Germany], No. 96/2006 [not found in English – Tr.]

[14] Ute Watermann, "Der lange Schatten von Tschernobyl [The Long Shadow of Chernobyl]", in *IPPNW-Forum* [Germany], No. 97/2006.

(8) The Chernobyl nuclear disaster showed that there is obviously a problem with the assessment of human error in the risk models – and that large-scale damage cannot be played down by using extremely small probabilities of occurrence. Both doctrines continue to apply today as much as before. The nuclear accident at Chernobyl showed that the deadly risks of nuclear energy cannot, in the end, be controlled with certainty. Even if western philosophies of nuclear reactor safety and western procedures for authorisation are so conceived that people have time for analysis in problematic situations, this does not change the basic difficulty, namely that there is an increased risk inherent in any interface between human beings and machines, and that in the case of "high-tech" dealings with highly radioactive material this risk becomes unacceptable. From an ethical viewpoint, a technology that does not meet the criteria regarding liability to error and the minimising of risk must be rejected. In its final report, the [German parliament's] Commission of Enquiry on "Protection of Humankind and the Environment" formulated five rules of management for sustainable development, of which the fifth says, "Threats and unjustifiable risks to human health from (hu)man-made interventions are to be avoided."[15]

(9) Long before the nuclear disaster at Chernobyl, the nuclear industry began offering a series of "inherently safe reactors" to legitimise continuing the peaceful use of nuclear energy. There has not yet been a nuclear reactor which can stabilise disturbances through processes that work entirely according to the laws of nature, without intervention by personnel. The nuclear power plant at Hamm-Uentrop and the research reactor at Jülich have been shut down. In the 1990s this line of argument lost its credibility even with many supporters of nuclear energy, some of whom thought this goal was a dream, a desire which technology could not achieve, while others feared that even setting it as a goal could cause a "deficiency in safety technology to be suspected, or read between the lines, in the case of the existing nuclear plants".[16] The debate has flickered up again from time to time in recent years, rather half-heartedly. It seems as if, at least in Germany, even energy economists have largely let go of the dream of being able to silence the discussion of risks purely through technical development.

(10) Furthermore, the long-term, widespread use of nuclear energy still implies, as always, moving to a plutonium industry.[17] There is a basic consensus today that this cannot be an option. At today's prices, uranium is a non-renewable resource, and – especially if the peaceful use of nuclear energy were to become much more widespread – also a very scarce one. Its use even in the medium term, without a plutonium industry, would not contribute to increased security of energy supplies. Based on the present level of use and present costs of extraction, world-wide uranium reserves will only last about 40

[15] Commission of Enquiry on "Protection of Humankind and the Environment" (ed.), *Abschlussbericht [Final Report]*. Bonn: Deutscher Bundestag, 1998.

[16] Otto Gremm and Siegfried Jacke, "Entwicklungspotential und Entwicklungsprobleme neuer Reactorkonzepte [Developmental Potential and Development Problems of New Reactor Designs]", in *Atomwirtschaft*, Vol. 1, 1992, 22-27; see also Gerd Rosenkranz, Irene Meichsner and Manfred Kriener, *Die neue Offensive der Atomwirtschaft – Treibhauseffekt, Sicherheitsdiskussion, Markt im Osten [The New Offensive in Nuclear Economics – Greenhouse Effect, Safety Discussions, Markets in the East]*. Munich: C.H. Beck, 1992, 247ff.

[17] See paragraph 16 below.

years.[18] At incomparably higher expense uranium could be extracted from sea water and, at even greater expense, from gneiss rock. However, there is no comparison between such expenses and that of a world-wide breeder reactor technology. This is why a system to supply the world with energy which relies extensively on nuclear energy would be obliged to go to a plutonium industry. It would have to produce plutonium, in breeder reactors and reprocessing plants, as the new "fuel". The fact that even the breakdown of uranium at present is often a problem and entails great dangers for the environment and for the health of the people involved, is not often taken into account.

(11) The greatest danger arising from nuclear technology, however, is the continued spread of nuclear weapons, so-called "proliferation". Plutonium is basically for use in weapons. It is an unavoidable by-product of today's nuclear technology. As long as nuclear plants continue to operate, stocks of plutonium will continue to grow. Even thorium cycles cannot entirely avoid producing plutonium. Theoretically a nuclear technology would be possible in which plutonium is consumed and none is produced anew. But to establish an alternative nuclear energy technology on a world-wide scale would take decades, be highly expensive and presuppose a change in the total global politics of nuclear energy. However, if the present forms of nuclear energy production are retained world-wide and even expanded, then the growing inventories of plutonium raise the risk of proliferation considerably.

(12) The transition from civilian to military use of nuclear fission can be made more difficult, but cannot be prevented. It is not possible to safeguard completely any nuclear cycle from being passed on to other countries or even to terrorist organisations.

An international "regime" of treaties and institutions is supposed to prevent nuclear proliferation. Since 1968 its main pillar has been the largest world-wide arms control agreement, the Nuclear Non-Proliferation Treaty (NPT). It allows only five states the right to possess nuclear weapons: the USA, Russia, China, France and Great Britain. Three countries which did not sign the treaty have since become "unofficial" nuclear states: Israel, India and Pakistan. At the moment, international attention is concentrated on North Korea and Iran. North Korea has resigned its membership of the treaty, and Iran is threatening to do so. There has been no further discussion recently of sanctions against India and Pakistan. They are tacitly recognised as nuclear weapons states, and are needed by the United States as allies in the fight against international terrorism. India will submit part of its civilian nuclear plants to international inspection, and will receive in return modern technologies and nuclear fuel from the Americans. However, it has expressly declined to limit its nuclear weapons programme.

But the non-proliferation regime which was achieved through so much effort is not only being undermined from the outside, but also from within. In 1995 the signatories to the NPT agreed to extend it indefinitely in time, but only on condition that the five nuclear weapons states finally take seriously their obligation to nuclear disarmament under Article VI. Moreover, a comprehensive test ban treaty was to block access to the most

[18] Öko-Institut e.V. (ed.), *Risiko Kernenergie – Es gibt Alternativen [The Risk of Nuclear Energy – There Are Alternatives]*. Freiburg: privately printed, 2005, 24; see also www.oeko.de/dokumente/kernenergie.pdf

important condition for further development of nuclear weapons. Since then, Russia and the USA have reduced their strategic nuclear weapons systems, but have not agreed on what is to be done with the warheads and the delivery systems. In this way the irreversibility of nuclear disarmament has been nullified. Meanwhile the Americans especially, but also the other four official nuclear states, are continuing to develop new nuclear weapons, against the spirit and the letter of the NPT. The estimated "overkill factor" has been reduced from 10-12 to four since 1990, but this is not "nuclear disarmament" in the sense intended by the NPT. As long as these weapons still exist, there is no guarantee against them being stolen, or against sabotage or an accident. There is no guarantee that the nuclear taboo which has prevented any new use of nuclear weapons since 1945 will not be broken.

(13) Nor has the problem of final disposal of highly radioactive waste yet been solved. The last federal government [in Germany] did not take its responsibility seriously, and kept putting off implementing the recommendations of the Working Group on Selecting Final Disposal Locations (AkEnd), which it had set up in 1999. Right until the end of the "red-green" coalition [Social Democrat and Green parties] – and on into the months afterward – it did not come any closer to an appropriate political solution to this problem. The problem of final disposal shows in a very basic way that the use of nuclear energy has irreversible consequences and that it does not satisfy the ethical "criterion of reversibility", which says that the consequences of any technological decision should be reversible.

The debate on suitable technologies and above all on acceptable locations for the final disposal of radioactive wastes has been accompanying discussions on nuclear power in Germany for 30 years now. Ninety-nine per cent of the radioactivity found in all rubbish is contained in these heat-producing wastes, which consist largely of radionuclides with a long half life and which constitute overall less than 10 per cent of all wastes. By 2040 there will be 24,000 cubic metres of such wastes; by the end of 2000 there were already 8400 cubic metres of them in Germany.[19]

The dispute over Gorleben as a potential location is also continuing, in particular because the criteria for choosing it as a location could not be made comprehensible to the local people affected.[20] The AkEnd recommended that at least two other locations of equal status be investigated, taking into account both geological and social criteria. The geological criteria may be summarised in passing as demanding that no scientific insights or data should exist which arouse doubts that the minimum requirements with regard to permeability of the rock, and to the mass and extent of the area within the rock intended to enclose the planned final disposal site, can be preserved for a million years (!). Ten years are allowed for the search for underground locations. The process of authorisation which is to follow is expected to take at least five more years, even if no further reconnaissance or investigation is needed. Construction of the final disposal

[19] AkEnd (ed.), *Zum Auswahlverfahren für Endlagerstandorte – Empfehlungsentwurf des AkEnd [On Selection of Final Disposal Locations – Draft Recommendations by AkEnd]*, Berlin, September 2005, 5.

[20] Folker Thamm, "Bewahrt uns vor Fehlentscheidungen [Save Us from Wrong Decisions]", in *AkEnd Forum*, January 2002 edition, October 2002, 7.

site itself will require another five years, so that even now there is not very much leeway, beyond the designated minimum periods, if this project is really to be operational by 2030.

The AkEnd emphasised that in every phase a "fair, just and efficient process, with participation by relevant interest groups and interested members of the public" is indispensable. Only in this way would it be possible to achieve a high degree of legitimacy in the society for the choice of location. The AkEnd intended that the issue of willingness of the inhabitants of affected regions to be involved should itself be a topic of discussion in public gatherings of citizens. However, if there were no region in Germany in which the inhabitants said they were willing to be involved, the AkEnd recommended that the Bundestag itself should undertake the search for a location and the decision, in the form of a "legal plan". Three years have now passed during which the politicians have not begun this process.

The unsolved problem of final disposal is being aggravated by the current legal situation in which temporary disposal sites have to be approved, which will be vulnerable for decades to the dangers of terrorism and natural disasters. Many protests in the affected regions are showing that this is leading to a good deal of popular unrest.

(14) Discussions on energy during the last 25 years in Germany have not regained the high quality that distinguished the German Bundestag's 1980 Commission of Enquiry on "Nuclear Energy Policies for the Future".[21] That was the first time a body of the German parliament showed, by presenting different "energy paths", that there are alternatives which can be negotiated, and that these alternatives in turn have consequences for the consumption of energy. This served to refute arguments that used prognoses of a rapidly rising demand for energy to justify the further expansion of electricity production capacities as the "natural" response to exogenous developments which had already become facts.

The Commission demonstrated their conclusion by presenting four "energy paths":
- Path 1, based on a high availability of energy, aimed at a massive build up of nuclear power, to 165 GWe, of which 84 GWe were to come from fast breeder reactors. To make this amount of energy available, the amount of coal used in 1980 must be doubled by 2030, and significant savings in oil consumption could not be expected. This strategy would ensure that a high rate of economic growth could be maintained.
- Path 2 was based on a lower increase in gross domestic product (GDP). But even here, considerably more nuclear power would be needed, more than 100 additional reactors overall. Lower rates of natural gas, oil and nuclear energy consumption would be due to acceptance of increased efforts at energy conservation.
- Paths 3 and 4 would have made it possible to shut down the nuclear power plants

[21] For more on the work of this Commission of Enquiry, see Hans Diefenbacher and Jeffrey Johnson, "Energy Forecasting in West Germany: Confrontation and Convergence", in Thomas Baumgartner and Atle Midttun (eds.), *The Politics of Energy Forecasting*. Oxford: Oxford University Press, 1987, 61-84; or Jobst Conrad, "Future Nuclear Energy Policy – The West German EnquΛte Commission", in *Energy Policy*, Vol. 10 (3), 1982, 244-249. On paragraph (14) as a whole, see Hans Diefenbacher and Ulrich Ratsch, *Verelendung durch Naturzerstörung [Impoverishment through Destruction of Nature]*. Frankfurt/Main: S. Fischer, 1992.

between 1990 and 2000, but based on the same growth in GDP as in Path 2. The supply of energy could have been secured without nuclear power through more thorough exploitation of the potential for energy savings, and through the use of renewable energy sources to meet a much greater share of energy supply needs. During the last 25 years, the economy would already have undergone a far-reaching structural transformation.[22]

The contrast between Paths 1 and 2 on one hand and Paths 3 and 4 on the other reflects the polarisation of debates on energy, at that time and to some extent still today. The Commission made a compromise which offered a temporary solution: its members agreed on calling for increased energy-saving measures, together with increased efforts to develop renewable energy sources; the research budget for these purposes was definitely to be expanded. However, the decision on peaceful use of nuclear energy was left open. The Enquiry Commission's final report did not even exclude the possibility of building additional nuclear power stations, if the developing demand for energy made this necessary. This compromise on the part of the Commission was only intended for a transitional period, however. In the longer term the Commission did not think it possible to avoid making a decision between the two main energy alternatives.

After the nuclear disaster in Chernobyl, it seemed for awhile as though this incident had fundamentally changed the discussion. In some German *Länder* energy had again become a topic which had to be included in every political declaration of principle. The peaceful use of nuclear power was again being fundamentally questioned. The questions which politicians put to those who could make prognoses were accordingly altered. In the first months "after Chernobyl" there was a focus on considering whether, and at what cost, it might be possible to abandon the use of nuclear power, and when. During this time, scientific articles largely entered into the change in formulation of the issue which had come first from the politicians.[23]

This first generation of studies "since Chernobyl" showed broad agreement on a series of points, which surprised many politicians. The electricity supply seemed technically assured even if nuclear power were abandoned. The additional sources of fossil fuel supplies which would be needed could be obtained on the world market, though to some extent at higher prices, even in case of an "immediate" abandonment of nuclear power. The price of electricity would rise, but the rise seemed likely to be bearable. An immediate abandonment of nuclear power would result in the loss of 50,000 to 100,000 jobs in the short term, but this would be compensated in the medium and long term by a gain of additional jobs, due to increased use of energy-saving technologies.

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[22] Friedrich Krause, Hartmut Bossel and Karl-Friedrich Müller-Reißmann, *Energiewende [A New Energy Age]*. Frankfurt: S. Fischer, 1980.

[23] A summary of the contents of the most important studies may be found in FEST, *op.cit.*, 1986, Theses 15-19. See also Thomas Weber-Carstanjen, *Zusammenstellung quantitativer und qualitativer technischer Angaben aus fünf Energiebedarfsprognosen [Compilation of Quantitative and Qualitative Technical Data from Five Prognoses of Demand for Energy]*. Basel: Prognos, 1987; and Ulrich Denkhaus *et al.*, "Ausstieg aus der Kernenergie – Vergleich einiger repräsentativer Studien zum Ausstieg aus der Kernenergie [Getting Off Nuclear Energy – a Comparison of Some Representative Studies]", in *Umweltschutzforum Berlin*, Vol. 89, 1987.

Such a consensus caused something of a sensation in late 1986. One could get the impression that this sort of agreement was not what some of those who commissioned the studies had wanted. Often enough the prognoses on which the work was based were disparaged as “hastily put together”, “produced under time pressure”, and the like. The result was that a year later the consensus on some points began to break down. Once again, the “old” polarisation made itself known, which has only begun to change, finally, in the last few years. Not until these most recent changes has the resolution to abandon nuclear power become at all possible.

(15) Ten years after Chernobyl, the attitude of the German population towards nuclear power in the Federal Republic has not changed. It remained stable until the most recent polls in 2005: the majority of people in Germany want a secure supply of energy without nuclear-generated electricity. By the end of the 1990s it was becoming increasingly apparent that energy policy – as had been shown in the scenarios drawn by the Commission of Enquiry almost twenty years earlier – was standing at a “crossroads between stagnation and transformation”.[24] Until then, the previous energy and economic policies had been carried on without far-reaching changes. Of course, even though economic growth is becoming less and less linked to demand for energy, in the long run such a policy would result in a rising demand for primary energy supplies. The United Nations World Conference on Environment and Development (UNCED) in 1992 had nevertheless made it impressively clear to the world-wide public that in future all supplies of energy must be understood in the context of a fundamentally changed policy, to be discussed from the viewpoint of the environment and social sustainability, if humankind wants to get through the 21st century without ecological disasters and breakdowns in parts of the energy sector.

For Germany to give up nuclear power is a step in the right direction. It would send a signal that extremely risky technologies cannot be part of a society that looks to the future. It would also send a signal that reduction in the availability of energy can be a decisive stimulus to changing course towards conserving energy and towards the decentralised production of power from renewable sources. But in view of the current situation in which this decision has to be made, the abandonment of nuclear power is taking too long. The timetable was set up by a process of negotiation with industries, which was oriented too much towards secondary criteria – such as the economic profits of energy-producing industries (EVUs). These negotiations did have the result that by now almost all EVUs want in principle to stay on course towards abandoning nuclear power. But the economic gain which they could expect from stretching the timetable cannot be weighed against safety considerations. The potential danger is rising as older and even obsolete nuclear power stations continue normal operations. At the same time, the urgently necessary changeover to renewable energy sources and to energy-saving measures is being further delayed.

(16) In developing countries and those on the threshold of rapid economic growth, demand

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See Michael Müller, *Der Ausstieg ist möglich [Getting Out is Possible]*. Bonn: J.H.W. Dietz Nachf., 1998, 135ff.

for energy will rise drastically in the next few years. But in these countries too, nuclear power is not an option for a sustainable supply of energy that will assure their future. If Third World countries expected to provide for their expected and desirable growth in use of electricity through nuclear power, for example, in order to limit greenhouse gas emissions, the number of nuclear reactors which would have to be built world-wide must grow by leaps and bounds. A rough calculation: 16 per cent of the world's electric power comes from nuclear power plants, 65 per cent from fossil fuels. To replace the latter completely, the number of nuclear reactors would have to be raised from the current 443 to about 1770. This would have to be done almost entirely in industrial countries and those on the threshold of joining them – and it would get rid of just 10 per cent of greenhouse gas emissions.

At present, nuclear energy covers about 2.5 per cent of global primary energy consumption. To replace at least 25 per cent of greenhouse gas emissions from fossil fuel sources, the number of nuclear power plants would have to be increased ten times over, to over 4000. In addition, acceptable ways must be found to convert nuclear power into final forms for transport and to heat houses.

To provide countries of the South, including China, with a supply of electricity comparable to that available in the North, the nuclear power plants there must increase their current capacity of about 50 gigawatts (GW) to far above 50,000 GW. The number of reactors would thus have to be increased by a factor of 1000, based on a capacity of 1 GW per reactor. This estimate assumes that in these countries the share of nuclear power in production of electricity attains the European average, and that the extent of electrical installations, measured in consumption per person, also approaches the standard current in Europe.

No doubt these assumptions are unrealistic, but no less realistic than the assertion that the use of nuclear power in developing countries will allow the goals of global climate policy to be reached, or global fossil fuel reserves to be spared, for these reasons:
- In view of the present level of electrification in countries of the South, the use of nuclear power is too capital-intensive, for economic reasons, and cannot succeed with the small size of networks and low density of consumption which are present. Decentralised production of electricity is much more suitable in view of present patterns of consumption.
- Only if patterns of consumption approached European conditions would nuclear power be adequate, at least from a technical standpoint.
- Such patterns of consumption are most likely in urban centres. It could be argued that the proportion of populations living in such agglomerations keeps increasing, and that here the technical prerequisites for centralised production of electricity from nuclear power plants would be present. The question then is, whether the supply of electricity should be reserved for industrial plants and areas where the prosperous classes live – an option which must be strictly rejected in terms of development policy – or whether the expansion of electrical installations should be seen in the context of the economic and social development of the entire population. In the latter case, one is led inevitably to the world-wide multiplication of nuclear facilities described above.

We would mention in passing that, even then, nuclear power in all parts of the world would still play "only" the role that it plays in Europe at present; this is the assumption for these calculations. However, nuclear power in Europe has yet to contribute anything either to protection of the climate or to significant replacement of the use of fossil fuels.

Even if the expansion of nuclear power on a global scale were decidedly less than portrayed above, an enormous number of nuclear reactors would be in countries whose political and technical dependability is highly dubious. There would also be doubts about the capacity of the IAEA to inspect such a number of reactors adequately, unless control inspection administration were to grow almost exponentially. In addition, as has already been mentioned, the world would have to go over to a plutonium industry.

(17) The nuclear power industry discovered the topic of climate change for itself early on, and in the autumn of 1990 launched a large advertising campaign [in Germany] in which it called for "the society to re-think on nuclear power",[25] claiming that nuclear power was the only energy source "on a scale worth mentioning" which did not cause CO_2 emissions. A similar debate was begun again at the end of 2005 after the quarrel over gas between Russia and Ukraine. The EU's dependence on energy imports from "politically insecure countries" was used to portray nuclear power as the "alternative which can rescue" and guarantee the security of national energy supplies.

However, nuclear power is not the right strategy for a long-term reduction of carbon dioxide emissions or for a sustainable future. First of all, it is not true that nuclear power is produced by means totally free of CO_2. The building and dismantling of nuclear plants, the extraction and transport of uranium, the building and operation of final disposal sites cause CO_2 emissions in significant quantities. More important, however, is the fact that nuclear power produces electricity only in a steady stream. It is not suited to flexible production of energy, adapted to the demand at any moment; basically it stimulates a high level of energy consumption, nullifying efforts to increase efficiency and sufficiency. The highest priority for a sustainable power supply is the "eco-efficiency revolution" – using the least amount of energy and materials needed to make a particular product or provide a particular transport service.[26] For this reason, the increasing dangers of nuclear power are too great to justify its use on the grounds of climate protection. And, not least of all, Europe is more dependent on its imports of uranium than on any other energy imports.

The minimising of risks through giving up nuclear power must not lead to an increase in risks to the climate. The abandonment of nuclear power must therefore be linked with an obligatory switch to alternative power sources, and with significant increases in efficiency of energy generation and use. So the debates on, and planning for, energy policy must not be confined to what will take the place of the nuclear power plants as they are shut down. It is the complete conversion of Germany's power facilities which we must consider. This only gains importance from the fact that in the next 20 years

[25] Cf. Rosenkranz, Meichsner and Kriener (1992), *op.cit.*, 48.

[26] For a detailed analysis, see among others Amory Lovins and Peter Hennicke, *Voller Energie – die globale Faktor-Vier-Strategie für Klimaschutz und Atomausstieg [Full of Power – the Global Factor-4-Scenario for Climate Protection and Abandoning Nuclear Power]*. Frankfurt/New York: Campus-Verlag, 1999, 29ff.

about 50 per cent of all power plants will have to be replaced due to age. Here it is precisely the abandonment of nuclear power which offers us the chance to build a sustainable power supply system, designed for efficiency in making energy available, efficient energy use, and for the use of renewable energy sources.

(18) Chernobyl today, twenty years after its nuclear disaster, is still a powerful warning that neither our present use of energy nor our present system of power supply is sustainable for the future. The Chernobyl catastrophe represented a deep wound in the lives of a great many people. This anniversary should be dedicated first of all to remembering the human beings who lost their lives, their health or their homes. It is far too soon to "close the file" on Chernobyl.