Nuclear Energy Costs the Earth

Why NOT NUCLEAR

An Introduction to the Pebble Bed Modular Reactor

“Our policy must rest on the solid moral foundation of dedication to the primacy of people and their long-term well being. We have to be on guard against temptations of short-term benefits and pressures from powerful forces at the expense of the long-term interests of all. We cannot afford to bargain away the birthright of future generations.”

— Extracts from Nelson Mandela’s speech at the opening of the fifth Session of the World Commission on the Ocean, Issued by: Office of the President. Cape Town, 11 November 1997

“The relatively limited public participation in the PBMR debate cannot be blamed entirely on the lack of an integrated energy plan. It is a fact that the DME was never involved at the inception of the PBMR project. We were presented with a fait accompli.”

— Themba Mdlalosa, Chief Director of the Nuclear and Renewable Energy Directorate in the Department of Minerals and Energy, to the parliamentary portfolio committee, on 10 March 2000

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An Introduction to the Pebble Bed Modular Reactor (PBMR)

Earthlife Africa Johannesburg
December 2000

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Earthlife Africa is an association of voluntary environmental and social justice activists, a civil society organisation founded in 1988, that currently has five branches in South Africa and one in Namibia. The founding principles and other guiding documents, as well as membership forms, are posted on our website and available from branches.

Contents

Foreword

This paper has been produced by Earthlife Africa Johannesburg branch, drawing on many sources, including material produced by the Cape Town branch. It is one in a series of papers being produced under the auspices of the *Nuclear Energy Costs the Earth* campaign, which includes examination of the prospects and benefits of renewable energy.

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There is a great deal of supporting documentation that can be accessed through Earthlife Africa, particularly on alternatives to nuclear development, the track record of the nuclear industry and current evaluations of health risks posed by exposure to ionising radiation. Our website includes a general introduction to energy issues, as part of the GreenHouse Project section, and a paper on nuclear power that focuses on the track record of the type of technology used in the Pebble Bed Modular Reactor programme. (See back page for website and contact details.)

So many misleading and/or unsubstantiated claims are made by lobbyists for the nuclear industry that they cannot all be addressed in a popular paper. In the interest of providing a short and accessible introduction to the issues relating to the Pebble Bed Modular Reactor programme, some issues are treated superficially and some ‘prevailing wisdom’, as touted by the industry, is left unchallenged. In particular the figures for costs and projected benefits are not analysed in detail since the developers themselves have informally admitted that they do not stand up to detailed scrutiny and have initiated study and analysis that is due to produce a new set of figures in about March 2001.

— Richard Worthington - December 2000

Introduction

Earthlife Africa (ELA) has, as part of a wide range of activities, campaigned against nuclear power and weapons since being founded over ten years ago. Recently we have focused on the squandering of public money on development of a 'new' generation of reactors. The Pebble Bed Modular Reactor programme (PBMR) within Eskom not only enjoys the benefits of a history of intensive state subsidy for nuclear power, as part of the apartheid government's weapons programme, but also of continuing disproportionate funding allocations, a lack of coherent energy policy and questionable application of law.

The solar and wind energy resources available in South Africa are sufficient to provide for all our energy needs many times over. The development of new nuclear power plants is unjustifiable on any terms, but particularly when judged as an energy strategy for South Africa, rather than solely as a speculative investment opportunity.

The PBMR programme is designed to capitalise on previous subsidisation and an energy industry that continues to ignore full social and environmental costs of energy generation, such as impacts on human health and the environment. Proponents also misrepresent the possible role of nuclear power in climate change mitigation.

Eskom chooses to talk publicly only of the initial "reference module", yet the projected foreign exchange and employment benefits that have been used to gain political support are based on the production of at least 216 reactors, including at least 11 for local use, " by the year 2016." [1]

(Possibly 30 more export units in that year have also been factored in. In an earlier article programme manager David Nicholls in *Nuclear Engineering International* suggested a third of all units would be for local use.)

While even the World Bank (known for favouring centralised, capital-intensive projects) has described new investment in nuclear power projects as a white elephant, the ANC, or at least a significant element of the leadership, by directing the lion's share of public resources for energy development to the nuclear industry, is reneging on previous policy commitments against nuclear power. [2]

Eskom's characterisation of the nuclear technology proposed is done by way of comparison with some of the most polluting energy technology in the world, their own coal-fired power stations. Justifications focus on things that are avoided without fully exploring what is actually involved: the impacts of the entire nuclear fuel chain. Cost comparisons with renewable energy use outdated figures that do not reflect the current market, particularly with regard to wind development on a similar scale.

The poor track record of the nuclear industry is indisputable. In the words of German government spokesperson Michael Schroeren (1999): "Nuclear power plants make inefficient use of energy, are economically non-competitive and prevent the shift to an energy policy based on efficiency and renewable energies."

We are unconvinced by claims that this time things will be totally different, that local improvements of a reactor type, the development of which was abandoned by the leading nuclear powers after billions of dollars of investment, will achieve remarkable new records on all levels including performance, safety, reliability, costs and marketability.

This document explains why Earthlife Africa is calling for termination of the project and the reallocation of all public funds from the programme to social spending, including the development of renewable energy.

Cabinet will decide at some point in 2001 whether the current 'feasibility study' may extend to the construction of the first reactor; we believe that a well-informed decision based on the public interest would conclude that it should not. As awareness of the project grows, so does resistance.

We encourage everybody who is concerned about this issue to register as an Interested & Affected Party in the Environmental Impact Assessment (EIA) process (see final section), so as to be fully informed and afforded an opportunity to express your views.

Contact Afrosearch: Box 13540, Hatfield, 0082; fax: (012) 362 2463; e-mail: sybert@afrosearch.co.za

1 Official letter from Eskom PBMR programme, to ELA, August 1999.

2 In 1994 the ANC Environment Desk issued a statement (printed in The Nuclear Debate, jointly published by the Environmental monitoring Group and the Western Cape ANC Science and Technology Group) that included the declaration: "The nuclear industry should be phased out in the shortest possible time."

The annual COSATU congress 2000 adopted a resolution resolving:

1. To re-affirm the OAU stance that Africa should remain a nuclear free zone.
2. The nuclear expansion programme through the PBMR project be stopped with immediate effect.
3. Resources targeted to PBMR are redirected to alternative energy technologies like hydro, biomass, solar, wind etc.
4. The current nuclear waste from Koeberg Power Station be stored in a safe and sufficient protected area and not be sold to other poorer countries in the continent.
5. Department of Minerals and Energy be forced to take overall accountability for unacceptable radiation levels within both the mining and energy sectors.

Context

We all need energy for survival and to fuel productive activities. From cooking to providing emergency services, from manufacturing to information services, energy plays a critical role in sustainable human development. Electricity is convenient and clean at the point of use but provision of electricity requires generation by utilising a primary source.

Primary sources are generally characterised as the following 'carriers':

* fossil fuels – what was once biomass (vegetation), transformed over time into coal, oil and gas;
* nuclear – involving release of the energy within atoms (the energy that holds all matter together);
* renewable sources, which include ocean power (wave and tidal), geothermal and those derived from the sun; the latter includes:
  - wind – the latest individual 'windmills' drive turbines with a generating capacity of 1.5MW or more;
  - solar – either electro-chemical harvesting with solar cells in Photovoltaic panels (PV) or direct capture of heat, known as solar thermal.
  - biomass – the use of plant matter as fuel or, through decomposition, to produce gas;
  - hydro – using the potential energy of the natural water cycle.

The term Renewable Energy (RE) is used by Earthlife Africa and a growing number of organisations to refer only to sustainable use of renewable sources, thus excluding large dams with their devastating social and environmental impacts (more than 10MW capacity) and biomass that is not sustainably harvested.

Fossil fuels represent about 74% of total global energy consumption. In 1998 world primary energy consumption was sourced as follows: 32.7% from oil; 21.4% from coal; 19.5% from natural gas; 11.6% from biomass; 6.7% from hydro; 6.1% from nuclear; 2% from 'new' renewables (RE). South Africa's economy is energy intensive, highly reliant on fossil fuels and sees economic growth based on energy intensive industries as a key means to development. In addition to direct use of fossil fuels in transport and industry there is extensive domestic use and almost 90% of our electricity generation is coal-fired. Moreover we operate some of the most inefficient plants in the world and burn some of the dirtiest coal; the implications are explored further in another document in this series: *Renewable Energy – the obvious choice for energy development in South Africa*.

Energy demand in South Africa will continue to grow into the foreseeable future. Traditional approaches to the provision of energy services are often inappropriate and highly inefficient. At some of our power stations as little as 35% of the energy released is captured as electricity, much of which is lost through long transmission distances. While electricity is widely perceived as the best form of energy, direct approaches to providing for energy/heat needs, from solar cookers and water heaters to passive building designs and air 'conditioning' systems, are not only more efficient and environmentally friendly but also more cost-effective.

Estimation of future electricity demand is an uncertain and subjective affair, entailing a wide range of assumptions that tend to favour business-as-usual. Eskom's predictions of when demand will exceed supply have been revised over recent years, from 2005

to 2008 and possibly beyond. South Africa's present generation capacity is almost 40 000 MW, yet the highest peak demand to date was 29 146MW. While the rate of economic growth is a significant variable, the nature of that growth will also be decisive and the actual timing of a need for greater generation capacity will depend largely on the extent to which current wasteful practices are perpetuated.

Internationally, the nuclear industry, particularly lobbyists working the circuit of conferences and conventions, are paying close attention to the PBMR, eagerly heralding every development as they grasp for any opportunity to perpetuate a discredited technology.

Proponents of nuclear power desperately need something to back up their denial that their business, unable to live up to any of the claims originally made for it, is on the way out. It is to be expected that Eskom receives encouragement from interest groups within the major nuclear powers, even from those developed countries that have themselves either explicitly, e.g. Germany, or de facto, e.g. the USA, abandoned this technology.

The decision of the South Africa government to pursue nuclear power has far-reaching consequences both domestically and internationally. It is inconsistent with our national policies of sustainable development and intergenerational equity. As noted in the resolution against the PBMR adopted by COSATU at the 2000 national congress, it is also inconsistent with the OAU stance that Africa should be a nuclear free zone.

Eskom is already the fifth largest utility in the world and has big ambitions for penetrating African markets but there seems to be no sensitivity to what is locally desired or appropriate.

The PBMR programme is clearly in the apartheid tradition of keeping prices down by externalising the true costs of generation, regardless of consequences for local communities and the natural resources that future generations will depend upon. In the eyes of many international observers and organisations the programme renders SA unsuitable as the host for Earth Summit III (Rio + 10) meeting, expected to attract 40 – 50 000 delegates in 2002.

If the South African bid were accepted it would generate significant foreign exchange and positive exposure; it would also lead to international scrutiny of our environmental practice and track record.

Resources for energy development are limited and nuclear development is happening directly at the expense of other options.

By directing the majority of energy sector investment into nuclear – at least twice as much as goes to all renewable energy technologies combined - we are sacrificing enormous job creation potential and the many positive results of diversification and localised, modestly-scaled sustainable development opportunities.

If an African Renaissance is to be about more than just growth as measured in GDP, it requires an immediate change to the existing energy strategy and the allocation of public resources.

What is the Pebble Bed Modular Reactor programme?

This depends on who is asked and who is asking, variously: a study; a reckless gamble; the most promising avenue, internationally, for the nuclear industry to retain a stake in the energy market; a major obstacle to sustainable development; a bid by special interests to achieve job security . . .

In March 2000 Dr Themba Mdlalose, Chief Director of Nuclear and Renewable Energy at DME (Department of Minerals and Energy) told the parliamentary portfolio committee:

"This reactor is being developed by an Eskom research group at a cost of a few billion rands. The PBMR is based on technology which was originally developed in Germany but later abandoned, after which the associated intellectual property rights were sold to Eskom."

The first stage of the proposed development is to design and build a single nuclear reactor (see below) at Koeberg, as a 'reference module', develop a nuclear fuel production plant at Pelindaba and, since no enrichment takes place in South Africa, import 3 500 kg of enriched uranium via Durban. All this falls within the so-called Feasibility Study. The actual development that is assumed will follow, where the benefits are supposed to appear, is the production of thirty reactors (modules) per year, for at least 10 years, with Eskom committed to buying at least eleven.

The programme was initiated in 1993 and by mid-2000 over R120 million had been spent directly by the programme, which has also required significant time allocation within DME. (It is not clear whether this figure includes all research and development costs

or only costs incurred since PBMR achieved project status). The programme is in the process of becoming an independent company: PBMR (Pty) Ltd, which is wholly owned by Eskom Enterprises, the unregulated component of Eskom created by restructuring in 1999.

Anticipated commercial structure of PBMR:[3]
"Four separate companies are in the process of being formed, as follows: PBMR Holding Company, which will be a holding company for the following three additional companies

* PBMR TechCo, the company creating the plant designs;
* PBMR FuelCo, the company manufacturing the PBMR fuel;
* PBMR PlantCo, the company erecting the plant in accordance with TechCo's designs;

with the real internal rate of return for the respective companies being as follows: PBMR TechCo: 15 %; PBMR FuelCo: 37 %; PBMR PlantCo: 29 %."

According to Eskom's PBMR website: "A fuel development project is currently under way as a joint venture between the PBMR project team and the South African Nuclear Energy Corporation" – Pelindaba facilities are part of NECSA, which is the proponent in the Environmental Impact Assessment (EIA) process for the fuel production.

Despite having a dedicated website, which provides responses to many issues raised by critics, the proponents continue to avoid a direct account of anticipated costs. The most frequently quoted figure is: "The total projected funding for the development project of the PBMR and the fuel plant is R432 million" (PBMR Website).

The total cost of starting the first 'reference module' reactor will be in excess of R 1 300 million. It was described by the proponents in 1999 as including:
"Future total cost estimates...:
Total Development Cost: R 442,5 Million; [plus]
Fuel Plant Capital: R87,4 Million; [plus]
Power Plant Capital: R 688,0 Million.

Please note that the precise allocation of costs to development versus capital, as shown above, is still to some extent under debate within our organisation. Also please note that the above expenditures and estimates are based on 1999 Rands and do not include for CPA (future inflation), Interest During Construction, cost of Forex Cover (mandatory) and possible PBMR Company overheads during construction of the Reference Module."[4] It appears that the costs of procuring and transporting enriched uranium are not included in the above.

Eskom hope that the relative simplicity of the design and the modularity of the system will allow for the realisation of the economies of mass production. For units following the reference module, under mass production conditions, Eskom's own estimations of costs per kilowatt hour vary from 1.7 to 2.43 US cents. Analysts at Massachusetts Institute of Technology's Nuclear Engineering Department estimate the cost to be 4.27 US cents,[5] using the same assumed capacity factor and annual capital charge or 'discount rate' by which the programme effectively borrows at, and is only expected to give a return of 6%.

According to the MIT study Eskom is targeting a capital cost of $1000/kW for a 10 module plant, which would translate into $100 million per reactor unit – this target, equivalent to over R700 million, is at odds with the figure of R400 million used by Eskom in past presentations. Recent press coverage has suggested a cost of $110 – 120 million per reactor.

Eskom has secured "commitments" from investors to "take a share in the Feasibility Study", which would (informal conversations have suggested) translate into the same share of ownership of PBMR (Ltd). Eskom retains a 30% share; the IDC (Industrial Development Corporation – a 'parastatal' institution answerable to government) has committed to 20%; 10% has been set aside for "a black empowerment company." The notorious British Nuclear Fuels Limited (BNFL) will take "an estimated 20% of the scheme at about R100million" and the American utility Peco Energy is making an investment which "officials said could be in the order of British Nuclear Fuels' investment."[6] Later reports put the Peco commitment at $7.5million for a share of about 10%.

It has not been possible to get any details of the nature of these commitments from either Eskom or the IDC, such as when and under what conditions any payments will be made. Exactly what such parties are taking a share in has not been clearly reported but the figures strongly suggest that it is only the reactor design element of the Feasibility Study.

Thus all of this loudly hailed foreign interest in the project has done very little to share the risk being borne by the South African public: even BNFL, the most motivated investor, has committed to invest less than 8% of the full costs of the feasibility study –

3 and 4 Official letter from Eskom PBMR programme, to ELA, August 1999.
5 A. C. Kadak, *The Politically Correct Reactor*, Nuclear Engineering Dept. MIT, 1999
6 R.Chalmers, *Business Day*, 30 August 2000

clearly it's more a matter of wanting a foot in the door than of making a meaningful commitment.

Timing estimates for the programme have varied since the programme was initiated in 1993 but the most recent estimate on record appears to be: "Building of the plant is planned to start in 2001 while cold and hot operation of the plant is planned for 2003 and 2004." [7] (Cold operation will start without radioactive fuel; hot operation is when the nuclear reaction reaches the level at which electricity supply may start).

It is misleading to refer to the current activities or first phase as a "Feasibility Study" since the resources involved are such that proceeding to the end of the "Study" will be a significant development in itself and due to the level of commitment of resources, would make further commercialisation almost inevitable.

South Africa's apparent commitment to the project is already influencing resource allocations elsewhere (e.g. USA). There is a clear intention to use this phase to try to improve the viability and competitive standing of nuclear power generally and this technology in particular. The first fuel production line, to be built as part of the "Study", would be able to provide fuel for seven modules.

The proponents have made no secret of their efforts to secure customers for reactors, which presuppose a positive outcome from a supposedly objective process to determine the desirability of pursuing this contested option. It is not clear how the various international sales / promotion activities are financed.

Eskom's posturing unmasked by unholy alliance

Extract from an Earthlife Africa Johanessburg Press Release

The announcement that the infamous British Nuclear Fuels Ltd. (BNFL) have bought into the Pebble Bed Modular Reactor programme (PBMR) gives the lie to Eskom's claim that their project signals a break with the nuclear industry's damning past record.

"This clearly confirms our contention that the PBMR is just another cynical attempt to prolong the life of a failing, uncompetitive and unsustainable industry; foisting technology on developing countries that has been rejected by 'First World' OECD countries," said Richard Worthington of Earthlife Africa Johannesburg.

"This project is smothered in inaccuracies, deliberately misleading statements and far-fetched benefit projections, clearly following the nuclear tradition of duplicity that gave us the apartheid regime's weapons programme."

British Nuclear Fuels Ltd (BNFL), have admitted to falsification of data in manifests for shipments of the most dangerous substances known to humanity. The British Energy Minister has postponed plans for partial privatisation to beyond 2002 because the company needed to improve its safety and commercial performance.

BNFL Chairman Hugh Collum has acknowledged that the company will not meet the six key performance targets set by government, including environmental and safety standards, and may have to abandon its core business – reprocessing spent fuel. [8]

In response to a BNFL statement in March trying to downplay the consequences of safety data falsification (regarding fuel that subsequently had to be removed from a reactor), the German environment ministry said: "BNFL's press release is as reliable as its forged test results."

In the United States a coalition of 46 environment groups handed over a petition to the Department of Energy to bar BNFL from all US contracts; one contract has already been cancelled. Japanese politicians say they intend to veto any more business with BNFL unless a shipment of flawed fuel pellets delivered nine months ago is returned to Britain. (This would take years to organise and, like the original cargo, would require an escort of warships.)

Having poisoned the Irish Sea and created a well-documented legacy of leukemia more locally, BNFL's Sellafield plant is under increasing pressure to shut down. The Japanese, Germans and Swiss have also withdrawn proposed custom from the MOX plant that remains unlicensed until it can be justified economically.

"After years, a series of unsubstantiated claims of foreign interest and millions of Rands of public money having gone into Eskom's international marketing efforts, this is the best they have come up with," says Worthington.

"The last time BNFL were openly active in South Africa they were showing off one of their nuclear cargo ships and denied that they had any interest in the PBMR project. They have also denied any interest in developing an international radioactive waste dump in southern Africa."

7 Tony Stott at a meeting with Cape Metropolitan Council, 15/11/99

8 wise News Communique #527; http://www.antenna.nl/wise

What is a Pebble Bed Modular Reactor?

The PBMR is a new design for a reactor that falls in the category of High Temperature Gas-cooled Reactor (HTGR), using technology under license from a German consortium.

It differs from the Koeberg-type Pressurised Water Reactor (PWR) by having helium rather than water pass through the core. The proposed capacity of the reactor is 110 MW nominal capacity, which should furnish 100 MW of generating capacity; this is slightly over one tenth of the capacity of one of Koeberg's two reactors, which together generate about 5% of South Africa's electricity.

It is anticipated that power stations will consist of clusters of 5 to 10 reactors – hence the term 'modular'. The fuel is uranium oxide, enriched up to 10%, contained in graphite balls that would circulate through the reactor core in a so-called 'pebble-bed' system.

The Eskom PBMR website provides the following description:

"A PBMR is a high-temperature helium-cooled reactor using a direct cycle gas turbine. The nuclear fuel is contained in balls with a 60 mm diameter. About 400 000 of these fuel balls will lie within a graphite-lined silo that will be 10 m high and 3,5 m in diameter.

Helium at a temperature of about 500 °C is introduced into the top of the reactor. After the gas passes between the fuel balls, it leaves at the bottom at a temperature of about 900 °C. This gas passes through three turbines, the first two drive compressors and the third the generator, from where the power emerges.

The Helium, then at about 600 °C, goes into a recuperator where it loses excess energy and leaves at about 140 °C. A water-cooled precooler takes it down further to about 30 °C. The gas is then repressurised in a turbo-compressor before moving back to the regenerator heat-exchanger, where it picks up the residual energy and goes back into the reactor.

Spent fuel balls are passed pneumatically to large storage tanks at the base of the plant where there is enough storage capacity to store all spent fuel throughout the life of the plant. The tanks are also designed to hold the spent fuel for 40 to 50 years after shutdown. About 2,5-million fuel balls will be required over the 40-year life of a 100 MW reactor.

The small size is the key to claims that the reactor will be "walk-away" safe. What this means is that a core melt-down such as occurred at Chernobyl should not be possible because the unit should radiate heat, without external cooling systems, quickly enough that it won't reach temperatures at which fuel damage would occur.

"This limits the size of the plant but avoids the need for highly reliable, diverse and redundant safety systems that are used to ensure adequate safety on current reactor designs." Eskom still uses the term "intrinsically safe" to describe the PBMR while developers of such designs in Europe and America have recognised the illegitimacy of such a claim and now speak of "passive safety."

There are a variety of other safety issues that are not addressed by the proponents' claims. An account of the history of HTGRs and why the USA, the UK and the Germans, from whom Eskom procured designs, abandoned attempted applications, has been written by S. Thomas of Sussex University (see ELA website). In relation to the last operational reactor of this type in Germany he writes:

"The plant remained closed on the orders of the safety regulator because of concerns about safety and the unwillingness of the various owners of the plant, including the federal government, to continue to provide subsidies to operate the plant. In 1990, the plant was permanently closed and is being decommissioned."

Science and Technology (June 1995) carried an excerpt from a USA Department of Energy document written by Terry Lash, Director of Office of Nuclear Energy: "The Department does not support continued funding for the Gas Turbine Modual Helium Reactor. There are significant questions about the viability of this reactor type, including whether the fuel will retain fissile products to the extent necessary for safety. There is little utility interest in this technology....Gas-cooled reactor technology has been under development by the Federal Government for approximately thirty years without tangible benefit."

The reporter Stefaans Brummer provides the following of the technology transfer: In May 1999, Eskom signed a deal with the German firm HTR, giving the South Africans "full access" to earlier work done in the field. ABB and Siemens concluded a licensing and cooperation agreement, via their joint venture company, Frankfurt based HTR GmbH

Gesellschaft für Hochtemperaturreaktoren, with the South African utility ESKOM, Johannesburg, for the transfer of high-temperature reactor (HTR) technology. ABB and Siemens each have a 50% stake in HTR GmbH, which was founded in 1988. With this licensing agreement Eskom gains non-exclusive rights for the use of HTR know-how in the construction of high temperature reactors, and in the fabrication and sale of HTR fuel. The South African and German governments ratified the deal.[9]

The sales pitch

The extravagant claims of possible national benefits of job-creation and in foreign exchange, usually quoted as R18 billion, are based on a desk-top input-output analysis of a base case scenario, in the absence of meaningful socio-economic analysis. The projected benefits assume both that more reactors will be bought per year than have been ordered, worldwide, over the last five years and that other companies involved will move their manufacturing facilities to South Africa (increasing local content from about 50% to 70%). The whole project continues to assume higher growth rates than we are achieving. Acknowledging that nuclear power is a lot less labour-intensive than renewable energy, proponents use multipliers to suggest massive employment benefits through a trickle-down effect, not achieved anywhere else in our economy. All other arguments put forward to justify the nuclear industry are backward-looking, of the less-bad-than-before variety, that deny the full range of options available and avoid comparison with the obvious attractions of renewable energy. Many of these attractions are so simple and untechnical (e.g. wind and sunlight are free) that many 'experts' and technocrats manage to ignore them. This is compounded by current subsidies, investment and pricing practices that result in many of the advantages of renewably sourced energy not translating into capital return on investment.

The emissions from coal-fired power stations and resulting impacts are appalling, the impacts on worker health in the mines is unacceptable, the enormous transmission distances of the South African grid are undesirable; but no litany of the problems of present practice, that nuclear apologists so readily produce, can of itself justify the use of nuclear power or support for this programme. The same applies to advances in reactor safety and efficiency over previous reactors, even if all the claims are borne out. That a project promises to have advantages over previous practice does not mean that it is the best choice for the future.

The proponents are playing on government's stated desire to capitalise on past investment (as noted in the White Paper) [10] to justify throwing good money after bad but there is in fact very little left to show for that investment and even less that is relevant to this project. Over the last ten years all fuel production and uranium enrichment programmes have been terminated and a great deal of the hardware has been sold off, for example, to China. As the proponents have made very clear, the technology of the PBMR is significantly different to any previously used in South Africa; it is thus not going to derive significant value from previous investment.

Considerable resources have been directed to transforming national institutions required to oversee the nuclear industry, yet in six years they have not even managed to produce an inventory of the wastes already in existence, much less devise a means of dealing with it. Such institutions are needed with or without the PBMR programme, which will only increase the load on an already stretched system.

Another argument put forward is that these nuclear reactors could be located close to where the energy is needed, particularly in coastal areas such as Koega, as opposed to coal-fired stations which need to be close to coal fields to avoid massive coal transport costs. This ignores the cost and impact of importing and transporting enriched uranium to Pelindaba, then fuel to the station. Furthermore, no matter how far into the future they defer responsibility for spent fuel, it will eventually need to be transported to a national facility. It also ignores the fact that coastal areas have particularly good wind resources and could also draw on biomass and ocean energy. Such renewable energy development would not only yield social and environmental benefits but would avoid the costs and uncertainties associated with licensing requirements of nuclear facilities. The suggestion that the 100MW capacity of one reactor lends itself to less centralised and large-scale development is off-set by the long-term plan for power-stations made up of 5-10 reactors to minimise such licensing burdens.

9 Stefans Brummer
10 White Paper on Energy Policy for RSA (www.gov.za)

Nuclear power and climate change

A relatively recent strategy of the nuclear industry is to try to sell itself as "clean" energy on the grounds that it compares favourably with fossil fuels in terms of the release of greenhouse gasses, particularly Carbon Dioxide (CO2), that are causing potentially catastrophic global climate change. Not only is this again a backwards-looking argument but the reasoning is not sound, since we must do better than addressing one problem— climate change—while introducing or increasing another: the release of radioactivity and the creation of dangerous wastes. The greenhouse effect, whereby particular gasses accumulate in the upper atmosphere and form a layer that traps radiant energy reflected off the earth's surface, like the glass of a hothouse, is causing changes in climate on a global scale. While there is not complete scientific agreement on the exact nature and scale of these changes, even the big petroleum companies have acknowledged that we have a major problem. Since 1751 human activity, notably the consumption of fossil fuels and the production of cement, has released over 265 billion tons of carbon into the atmosphere, half of this since the mid 1970s. International efforts to address the problem have led to the United Nations Framework Convention on Climate Change and the development of undertakings contained in the Kyoto Protocol. (This issue is covered in detail in other ELA documents.)

South Africa is ranked between the fifteenth and twentieth largest emitter of greenhouse gases in the world. South Africa has experienced a 4.9-fold increase in fossil-fuel CO2 emissions since 1950, with 80-90% of emissions from coal. Per capita emissions are more than six times the African average, close to levels of the EU and Japan. The emission rate per person in South Africa (10.1 tons of carbon dioxide equivalent per person per year) is above the global average (about 7 tons per person per year), but considerably below that of countries such as the United States of America (over 20 tons per person per year). Furthermore the economy is carbon intensive, producing only 259 US dollar per ton of carbon dioxide emitted as compared to 1 131 US dollar for South Korea, 484 US dollar for Mexico and 418 US dollar for Brazil (DME).

At its source of electricity production, i.e. the reactor, nuclear power does not produce any CO2 — by far the most significant greenhouse gas. However nuclear power does release CO2 in its whole fuel cycle, during mining, fuel enrichment and transport and plant construction. Uranium enrichment is one of the most CO2 intensive industrial operations.

According to calculations by the Öko-Institute, 34 grams of CO2 are emitted per generated kWh in Germany. The results from other international research studies show much higher figures - up to 60 grams of CO2 per kWh. In total, a nuclear power station of standard size (1,250MW operating at 6,500 hours/annum) indirectly emits between 376 billion tonnes (Germany) and 1 300 billion tonnes (other countries) of CO2 per year. In comparison to renewable energy, nuclear power releases 4-5 times more CO2 per unit of energy produced, taking account of the whole fuel cycle. (Friends of the Earth, Scotland).

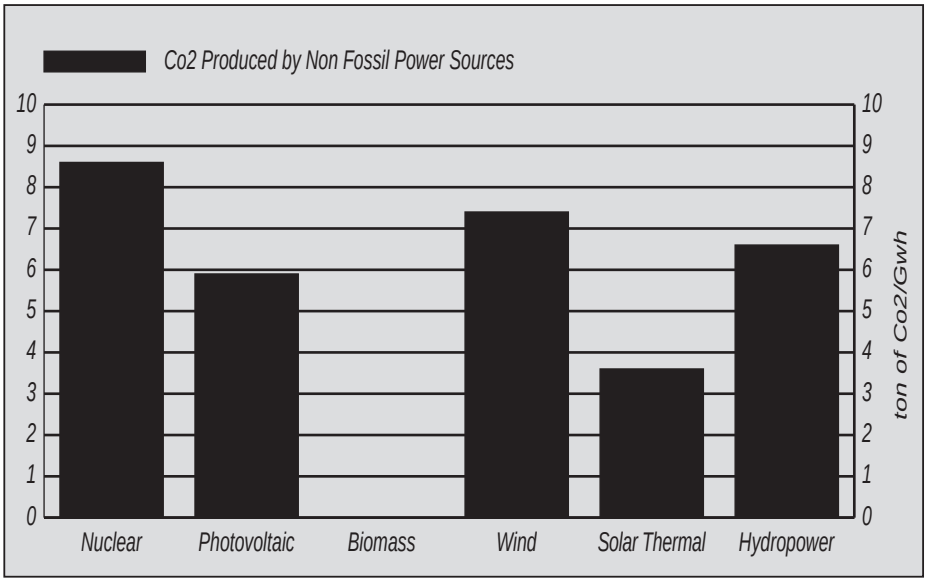
In comparison to renewable energy, nuclear power releases 4-5 times more CO2 per unit of energy produced, taking account of the whole fuel cycle. —(Friends of the Earth, Scotland).

Even conservative institutions recognise the poor standing of nuclear power in this regard.

The graph from the UK Royal Institute for International Affairs shows that nuclear energy produces more CO2 than with renewable energy sources. (*Renewable Energy Strategies for Europe, Volume II, electricity systems and primary electricity sources,* RIIA and Earthscan, London, 1997, Michael Grubb and Roberto Vigotti.)

Furthermore: "The difference in CO2 production between nuclear and renewable energy sources is likely to increase. If nuclear were to be considered as a serious option for reducing CO2 emissions then there would need to be a massive construction program for nuclear. This would result in an increasing rate of consumption of high-grade uranium ore. Consequently, lower grade uranium would have to be used, which would require significantly more energy to produce and enrich, which will increase the overall CO2 being produced by the nuclear fuel cycle. Estimates for the International Panel on Climate Change suggest that within the European Continent, 1000 reactors would need to be operational in 2100, six times the current level. This would require the construction of around 2000 reactors in the next century, i.e. the completion of 20 reactors per year. It is therefore impossible to imagine that nuclear power

will ever play a significant role in reducing human impact on the world's climate."(Antony Froggatt, *Nuclear Power – The End of the Road*).



In his paper, *Profiting from a Nuclear-Free Third Millennium*, Amory B. Lovins of the Rocky Mountain Institute makes a similar point in relation to energy efficiency measures: "Nuclear advocates' last hope is that climate concerns will revitalise their option. Alas, they've overlooked opportunity cost—the impossibility of spending the same money on two different things at the same time. If saving a kW-h cost (pessimistically) as much as three cents, and delivering a kWh of new nuclear electricity cost (optimistically) as little as six cents, then the six cents spent for each new nuclear kWh could instead have bought two kW-h worth of efficiency. The nuclear purchase therefore displaced one less kWh of coal-fired electricity … That's why the order of economic priority must also be the order of environmental priority; why it's irrelevant whether nuclear power can beat coal power as long as any other option costs still less; and why nuclear power makes global warming worse."

Supporters of nuclear power, ignoring such realities, are advocating that nuclear be accepted within the Clean Development Mechanism (CDM) of the Kyoto Protocol, which is supposed to support only sustainable development.

The CDM is one of the 'flexible mechanisms' that is supposed to facilitate action to reduce greenhouse gas emissions by allowing developed countries to off-set their continuing emissions against emissions avoided in developing countries by investing in more climate-friendly technology or initiatives than would take place without their investment. This would effectively provide a massive new subsidy for nuclear power development in the south so that the north can continue with their business as usual.

The nuclear power industry

Note: While nuclear energy generation has a history inseparable from nuclear weapons development and has both been used as a channel to fund the development of nuclear weapons and benefited from enthusiasm for and secrecy surrounding their development, there is not space in this paper to do this issue justice.

The claims made regarding the viability, safety and competitiveness of the PBMR are made by people who have a vested personal interest in seeing the project reach commercial application. Most of these people also have a history within the industry and its tradition of secrecy and misrepresentation, extending in many cases to outright dishonesty (see BNFL box). The common tactic of denial is even applied to the April 1986 Chernobyl disaster in what is now Ukraine — the largest man-made catastrophe outside war.

Promotional presentations by PBMR staff parrot the IAEA's insistence that only 32 people have died as a result of the explosion of the Chernobyl power station: those who died in the radiation ward of Hospital 6 in Moscow soon afterwards. All other deaths related to the disaster and its aftermath —10 000 in Ukraine alone according to the Minister of Health —are ignored. The IAEA reports nothing from Belarus, which had the highest fallout. An organisation of former 'liquidators', workers sent in to clean up the site after the explosion, reported that by 1995, 13 000 of their members had died (20% suicides) and 70 000 members were estimated permanently disabled. The ongoing legacy of cancers, immunological damage, birth defects, child developmental problems and loss of land, livelihoods and homes are simply dismissed.

Less direct costs to society and damage to ecosystems

from Chernobyl are already filling many volumes so an example will have to suffice: In Norway, where radioactive particles were absorbed by lichens eaten by reindeer, official radiation tolerance levels per kg of reindeer meat were increased 20-fold (from 300 to 6 000 units) between May and November 1986. Nevertheless in 1988 alone 545 tonnes of reindeer carcass had to be disposed of as toxic waste.

Another mantra of the nuclear industry is reassurance that: "It couldn't happen here."

Tokaimura - Japan September 30 1999. An accident occurred at a nuclear fuel reprocessing plant releasing massive amounts of radiation into Tokaimura. The administrative vice minister of the Science and Technology Agency, Mr Toshio Okazaki, said that as much as 4 000 times the normal amount of radiation was recorded on the borders of the plant compound after the accident. The accident was due to a human error which the government protocols assumed was impossible. At an emergency Cabinet meeting later in the day, Science and Technology Agency chief Akito Arima said that: "The accident was unimaginable."

According to an article on the Tokaimura disaster in the Wall Street Journal, it was the crushing pressure to remain competitive in the face of financial threats that arose in the new era of deregulation that led the middle management of the company, with the almost certain tacit approval of the president, to revise the standard procedures so as to cut costs. At least two of the exposed workers have since died.

When something does go wrong — keep it quiet: In August 1998, the Cape Times uncovered a technical accident at the Koeberg Power Station in Cape Town the previous year which had left 3 men contaminated with a high dose of radiation. The incident remained under wraps until uncovered by the press as the people concerned were bound by their contracts to remain silent. "Within 2 minutes, experts say, they were exposed to the same level of radiation they would have normally been exposed to over eight to ten years at the plant" (Cape Times).

It is important to contextualise the misrepresentations of those who advocate nuclear power but it does not take an accident to cause radiation exposure. While they may be quick to point out that routine exposure to radiation occurs in South African coal mines – an issue that the mining industry is working hard to keep out of the purview of the National Nuclear Regulator (NNR, previously the CNS) – that is hardly a justification for increasing such impacts by continuing nuclear development. One of the central fictions of the industry has been the claim that there is such a thing as a 'safe' dose of man-made radiation.

Radiation and human health

The nuclear industry is damaging to human health and the environment. Ionising radiation can be fatal in large doses and even in minute amounts is known to cause a range of cancers, particularly leukaemia; genetic damage, particularly to an embryo or foetus and damage to the immune and nervous systems. There are different types of radiation, different pathways for human contamination, with inhalation/ingestion of particles of radioactive material leading to long-term damage that may take many years to appear, different parts of the body more susceptible to damage by particular isotopes and different synergistic effects that can occur in conjunction with chemicals.

Some ionising radiation (hereafter: radiation) is naturally occurring, most commonly radon, which can be detrimental to health if there is a build-up as can occur in the basements of houses near a mine dump. The radioisotopes (substances that give off radiation) used in nuclear reactors and in medicine are human produced.Most medical radioisotopes have short half-lives, meaning that the rate at which they emit radiation decreases fairly quickly. For example a half-life of 8 days means that the amount of radioactivity released is halved every 8 days, so it is down to a quarter after 16 days and just over 10% of original emission after 64 days. Such substances are a lot easier to manage than those used in reactors. Plutonium is produced in reactors and has a half-life of 24 000 years.

In 1995 the National Radiological Protection Board in Britain conceded that: "There is no basis for the assumption that there is likely to be a dose threshold below which the risk of tumour induction would be zero." [11] Assertions by the nuclear industry regarding what may be considered a safe level of exposure to

11 *Risk of radiation induced cancer at low dose and low dose rate for radiation protection purposes*, Documents of the RPB 6/1 chilton; (1995).

man-made radiation have been based not on evidence but on lack of evidence and denial of the significance of evidence. As evidence has been accumulated by concerned physicians the industry has been forced to revise such levels downwards.

This is reflected by the safety levels set by the International Commission on Radiological Protection (IPRC), an institution regarded by many as a vehicle to legitimise the industry and protect it from compensation claims:

The International Atomic Energy Association (IAEA), often presented by the industry as an independent authority, was established by the United Nations in the late 1950s with two (contradictory) objectives: to prevent the spread of nuclear weapons and to promote the peaceful use of atomic energy.

It has had far more success with promoting nuclear energy than preventing weapons proliferation and a major means to this end has been the underrating of the ill-health caused by nuclear power. The main way this has been achieved is through exclusionary definition of what qualifies as a radiation-caused illness statistic.

To give just a few examples of the IAEA's criteria:

* If a radiation-caused cancer is not fatal it is not counted;
* If an auto-immune disease or other non-cancer is caused by radiation it is not counted;
* Radiation-damaged embryos or foetuses which result in miscarriage or still-birth do not count;
* Even if radiation causes a fatal cancer or serious genetic disease in a live-born infant, it is discounted if the estimated radiation dose is below 100 mSv (a measurement of exposure equivalent to about 100 X-rays);
* Wherever there is a possibility of another cause, such as smoking, radiation is not blamed.[12]

The Radiation and Public Health Project in America has produced many studies that track the impacts of radiation in small doses. Such evidence helped to bring an end to atmospheric testing of nuclear weapons, of which the full impacts are still being traced but seldom reported. The following two extracts from recent studies are from the abstracts (executive summary) of detailed papers available at: www.radiation.org.

ICRP safety levels for people exposed to occupational radiation					
1931	1936	1948	1954	1977	1990
73 rem	50 rem	25 rem	15 rem	5 rem	2 rem

Strontium-90 in baby teeth as a factor in early childhood cancer

Jay M. Gould, Ernest J. Sternglass, Janette D. Sherman, Jerry Brown, William McDonnell, Joseph J.Mangano International Journal of Health Services, Volume 30, Number 3, Pages 515-539, 2000.

Strontium-90 (a long-lived radionuclide that tends to accumulate in the body, making it measurable) concentrations in baby teeth of 515 children born mainly after the end of world-wide atmospheric nuclear bomb tests in 1980 are found to equal the level in children born during atmospheric tests in the late 1950s.

Recent concentrations in the New York-New Jersey-Long Island Metropolitan area have exceeded the expected downward trend seen in both baby teeth and adult bone after the 1963 ban on atmospheric testing.

Sharp rises and declines are also seen in Miami, Florida. In Suffolk County, Long Island, Strontium-90 concentrations in baby teeth were significantly correlated with cancer incidence for children 0 to 4 years of age.A similar correlation of childhood malignancies with the rise and decline of Strontium-90 in deciduous teeth occurred during the peak years of fallout in the 1950s and 1960s. These results strongly support a major role of nuclear reactor releases in the recent increase of cancer and other immune system related disorders in young American children since the early 1980s.

12 Adapted from an article in *The Ecologist* Vol.9 No.7 by Rosalie Bertell, PhD, GNSH, (President of the International Institute of Concern for Public Health and Editor in Chief of International Perspectives in Public Health).

Improvements in local infant health after nuclear reactor closing

By Joseph J. Mangano, *Environmental Epidemiology and Toxicology* (2000) 2, 32-36.

Between 1987 and 1998, operations ceased at 12 US nuclear power stations. One of these, Rancho Seco, is located in a densely populated area.After the reactor closed down in 1989, decreases in infant mortality (all causes and from congenital anomalies) and cancer incidence were observed for foetuses, infants and small children. These trends contrast with a worsening of infant health status since the plant opening in 1974. The data suggests that a relationship between nuclear emissions and adverse health effects exists, especially since foetuses and newborns are most sensitive to radiation.

Because Rancho Seco released low levels of radionuclides into the local environment, the issue of health effects of prolonged low-level radiation exposure is raised. The issue becomes increasingly important as operators of several dozen ageing US reactors must soon decide whether to extend their operating licenses.

Workers' health is put at risk at every stage of the fuel chain and workers are routinely exposed to very small doses of radioactivity even though there is extensive evidence that the is no such thing as a 'safe dose'. The full impact on workers is often obscured by averaging exposure over a period of years and in South African mines existing standards are not adequately enforced.Public health is put at risk by operating nuclear reactors, transport of radioactive materials and waste storage.

Nuclear waste and decommissioning

Nuclear wastes are divided into three categories but the criteria are not standardised internationally. Classification as low-level waste does not always mean that only low-level or short-lived radionuclides are present, or indeed that risks involved in dealing with such materials is low and there are dozens of cases of serious groundwater and downstream contamination from "low-level" waste dumps.

The most intractable problems are associated with spent fuel, which is classified as high-level waste and which remains very dangerous for tens of thousands of years. There is no explicit policy or accepted method, world-wide, for the disposal of high-level waste.

The holy grail of the nuclear industry is a means to dispose of plutonium and other long-lived nuclear wastes, to put these lethal substances into the public domain. Since deep-sea dumping was banned in terms of an international convention, deep burial, a 'geological repository,' is the next choice. This is attractive to the nuclear industry principally for the opportunity it offers of devolving responsibility for its wastes.

The USA have been trying for decades and at enormous expense to identify and develop deep burial sites. The Waste Isolation Pilot Project that started operating in New Mexico in March 2000 (first authorized 20 years ago), while 2 150 feet underground, has not qualified and is not allowed to accept high-level radioactive waste.

The French, British and Japanese have developed a ridiculously expensive and energy intensive industry to reprocess spent fuel to recover and reuse some of the radionuclides in spent fuel – itself a highly polluting process.

This has provoked international protest against the programme: producing mixed oxide fuel (MOX), and the practice of shipping these materials around the world, including local action by South African civil society organisations.

South Africa does not have a good history of dealing with any level of radioactive wastes, from the airborne dispersal of radioactive materials by some medical waste incinerators to 'incidents' during the latest re-racking of spent fuel in the 'cooling ponds' at the Koeberg power station to make space for more capacity.

Workers at Radiation Hill at the Pelindaba site were not wearing protective clothing when they exposed and handled radioactive wastes (of undisclosed level) in an area not approved or recorded for such material. An illegal release of wastes reportedly including plutonium, of undisclosed rate and duration, at levels exceeding total annual allowances (already an

unacceptable public risk and environmental impact), took place in 1999 but only came to light a year later. Such an event should have been reported within hours and one must hope that it was not at times when there were children playing downstream.

Vaalputs, a facility in the Northern Cape, is South Africa's dedicated radioactive waste dump and numerous problems and failures have come to light over recent years pictures and stories of cracked and leaking drums were met with assurances that "it's not as bad as it sounds" and that off-site consequences were negligible or trivial.

It has lost its license to receive high-level waste from Koeberg, which is now stored on site in Cape Town.Development of a policy for dealing with high-level waste is identified in the Energy White Paper as an urgent priority for the DME.

Recently the scientific thinking used to justify the burial approach has been called into question by research reported in *Science Magazine*, by chemists Haschke, Allen, and Morales (Vol 287 # 5451,14 January 2000), which found that plutonium reacts differently than previously assumed when exposed to air and water, and becomes very soluble in water. This means that plutonium can, over time, transition to a chemical form that will rapidly move into the biosphere.

A commentary in the same issue of the magazine, entitled *Towards the End of PuO2's Supremacy?* discusses implications for long-term storage of plutonium dioxide:

"It has ... been assumed for more than 50 years that PuO2 is the highest plutonium oxide which can be prepared. This oxide ... was believed to be stable over a wide temperature range.... For both civilian and military applications, the stability of PuO2 was a key factor underlying the industrial strategy ... The new results ... have great consequences for the underground disposal of plutonium wastes. Until now, it was assumed that plutonium would not be very mobile in the underground geological environment because of the insolubility of Pu(IV) compounds. But Haschke et al. demonstrate that water can oxide PuO2 into PuO2+x in which more than 25% of the plutonium ions exist as Pu(VI), an ion that is far more water soluble."

Plutonium would be a by-product in the spent fuel of a PBMR and it would be possible to extract it and use it to produce weapons from the 5% or more of Plutonium 238 that the high burn-up rate would produce but this would require a complicated, costly and large-scale process.

In light of the existing global stocks of weapons-grade material and the failing infrastructure in former Soviet countries for safeguarding some of those stocks, the issue of weapons proliferation risks is unlikely to carry weight in the evaluation of the PBMR. Nevertheless any new nuclear development has a negative impact on efforts to stop the proliferation of nuclear weapons.

The PBMR programme proposal does not address the issue of the long-term fate of spent fuel, deferring such challenges to future generations.

The plan is to build large vessels within the reactor building, similar to the reactor vessel, and store the spent fuel there for 40 to 50 years; after that it will presumably become a government responsibility. Furthermore international precedent indicates that South Africa, as the source of fuel, will be responsible for and required to take back all spent fuel from all exported PBMRs.

While high-level waste is the most widely known and discussed legacy of the industry and one which clearly disqualifies it from consideration as sustainable development, the whole nuclear fuel chain involves pollution: uranium mining leaves huge volumes of radioactive tailings that are just dumped, not even handled as hazardous waste; uranium processing and enrichment and fuel production produce toxic as well as radioactive wastes; the whole process, including handling and transport of materials, involves radioactive releases officially regarded as 'insignificant'; and then there is decomissioning – dealing with all the facilities and equipment that has become contaminated throughout the process, most notably the power plant.

The costs of decommissioning (taking apart and disposing of) a nuclear power plant is one of the great economic uncertainties of the industry and there are very few precedents of complete decommissioning. The only certainty is that it is expensive, always more so than anticipated, generally at least half the original cost but in some cases exceeding the original cost of the plant.

The Background Information Document put out by the PBMR programme does not describe any provisions made in this regard and actually equates decommissioning with simply shutting down the plant They are understood to have estimated the costs to be only 15% of the cost of establishing the plant, making this another area where they are projecting a massive improvement on past performance in the industry, and where costs, as well as potential impacts, are passed on to future generations.

Radioactive renaissance: will SA host an atomic dump?

Business Day letters column August 2000

In the flurry of publicity for its reactor programme, Eskom is leaving out some dubious details, writes Richard Worthington.

Is the development of Africa, or any seducible developing nation, to provide a last but lucrative gasp for an industry that is no longer acceptable in the so-called first world?

Developed countries are, almost unanimously, cutting their losses and renouncing nuclear energy. Even the World Bank, notorious for putting the interests of investors first, says that in developing countries "nuclear plants in the power sector would not be economic; they are large white elephants."

Nevertheless, it appears the SA nuclear industry still enjoys the special status in senior circles of government that it developed under apartheid with its nuclear weapons programme.

If Eskom's pebble bed nuclear reactor programme does get some kind of high-level political blessing, as recent presentations to cabinet (exclusively by the proponents) were intended to elicit, will this also pave the way for SA to develop an international dump for radioactive waste?

While those promoting the pebble bed project avoid public consideration of the dirty details of nuclear fuel production, the speculative national benefits central to their sales pitch depend on SA also producing the fuel for the minimum of 216 reactors required by their figures.

There is already precedent to suggest that producing countries will be required to take back exported nuclear fuel once it is "spent". This is long-life, potentially lethal waste.

A letter from Gordon Sibiya on radioactive waste (Business Day, November 30 1999) appeared at the time to be somewhat out of the blue. It made no reference to the pebble bed programme. Controversy over the Koeberg operation to increase short-term capacity for storing spent fuel had passed, unresolved, from media attention.

However, speculation about the motivation for a call to develop a "deep burial repository", by a consultant who was previously a senior official at the minerals and energy department, has been fuelled by international developments.

Ann MacLachlan wrote in the January 24 issue of Nuclear Fuel: "Spurned by state and federal politicians in Australia, the Pangea consortium is now turning its attention to other potential host regions for the international nuclear waste repository it sees as inevitable. Pangea's Charles McCombie said the group (would) be concentrating on 10 countries of the southern hemisphere … encompassing parts of … South America, SA and Namibia, which are considered to have geology favourable to a nuclear waste repository."

Sibiya's proposal is consistent with the views of a majority of players in the nuclear industry. Deep disposal is attractive to the industry for the opportunity it offers of passing responsibility for their wastes to the state and because it can be presented as a permanent solution - out of sight and out of mind.

In reality it places the risks beyond our control, which is why monitored containment in retrievable storage is a more responsible strategy. The literal meanings of disposal include "distribution" and "right to bestow" - precisely what we do not want those who profit from the industry to do with wastes that remain highly radioactive for many thousands of years.

The US has been trying for decades and at great expense to identify and develop deep burial sites. The waste isolation pilot project that started operating in New Mexico this month, 20 years after it was first authorised, has not qualified for and is not allowed to accept high-level radioactive waste.

….Surely the African renaissance would be better informed and inspired by the full meaning of the slogan: “renewable energy for people's power.” This includes the social and economic benefits of wind farms that directly create eight to 12 times as many jobs as equal investments in nuclear plants, which rely on trickle-down benefits; the empowerment of rural communities that is being demonstrated in small projects around the region; decentralised ownership of the means of production and distribution of electricity; and the robust nature of diverse energy strategies that harvest the freely available resources of sun, wind and water flows without massive pollution, degradation or inundation of agricultural land, or displacement of people.

Economics of nuclear power — a failing industry

According to economists at the World Bank, "nuclear power cannot compete with fossil fuels once the costs of decommissioning old reactors and dealing with spent fuel are included." (*The Economist*, 1995)

The World Bank 's Environmental Assessment Source Book is unambiguous about nuclear's problems: "Nuclear plants are thus uneconomic because at present and projected costs they are unlikely to be the least-cost alternative. There is also evidence that the cost figures usually cited by suppliers are substantially underestimated and often fail to take adequately into account waste disposal, decommissioning, and other environmental costs."

According to a 1996 Worldwatch report, *Bad Credit at the World Bank*:

Despite decades of IAEA and nuclear vendor promotion, the Third World accounted for only 23 000 megawatts of nuclear power in operation at the start of 1996, less than 7 percent of the world total. Many of these plants have run far over budget or behind schedule, and have been plagued by technical and waste disposal problems. One result is that the World Bank, despite its established partiality to grandiose development projects, has taken an active role in slowing the spread of nuclear power to developing countries, most recently Thailand and Indonesia. As an investment, the Bank says, nuclear power is both too costly and too risky.

The Worldwatch report further noted:

* It has been 26 years since a US reactor order was placed that was not subsequently cancelled. In fact, more nuclear capacity has been cancelled in the USA in the last 30 years than the total capacity that existed in the country in 1996.
* A 1996 poll of utility executives found that only 2 percent would even consider ordering a new nuclear reactor.
* In the UK, as the books were opened on the nuclear industry in preparation for privatisation, it became clear that the government had lied to itself as well as to the British public, generation costs turned out to be about double what the government had claimed.
* The last reactor built in the United Kingdom, was completed in 1995 at a cost of some $3 000 per kilowatt of capacity - nearly 10 times more than it costs to build a gas-fired plant.

For 40 years, governments have heavily promoted and subsidised nuclear power - a trend that has slowed but not changed to this day. Indeed, governments belonging to the OECD's International Energy Agency spent almost $4,8 billion dollars on nuclear research in 1994, nearly 55 percent of their total energy research and development budgets of $8.7 billion. In Japan, in 1993, the government squandered 95% of its energy research and development budget on nuclear energy.

In South Africa the nuclear industry received massive support at public expense under the apartheid government and, although full details of total spending since 1994 and in support of current activities are not available, this practice continues.

In South Africa the nuclear industry received massive support at public expense under the apartheid government and, although full details of total spending since 1994 and in support of current activities are not available, this practice continues.

While fuel manufacturing equipment has been sold off we continue to pay heavily for decommissioning of plant for previous activities – R109.5 million budgeted for the three years 1998 – 2000 for closure of the BEVA plant alone.

With most successful new technologies, people confidently expect that successive designs become cheaper and offer better performance. This has not been the experience with nuclear power: costs have consistently gone up in real terms and processes which were expected to prove easy to master continue to throw up technical difficulties. The economics of nuclear power remain a subject of such fierce controversy that detailed consideration will not be attempted here; many of the issues are covered in the paper written by S. Thomas of Sussex University that is posted on the Earthlife Africa website and is also available in hard copy on request.

The following table is taken from a report of the EDRC at UCT.[13] Figures were taken from parliamentary records.

Dept – refers to the government ministry: pre-1984 the Department of Mines, thereafter the Department of Mineral and Energy Affairs (the last word has since been dropped, giving us the DME).
AEC – Atomic Energy Corporation, established in 1982 as the controlling body of the Atomic Energy Board (AEB) and Ucor. By 1974 the AEB's brief had been expanded into supplying military technology, when the Prime Ministers ad hoc committee had decided to construct nuclear weapons.
UCOR – Uranium Enrichment Corporation, was amalgamated into AEC in 1985.
CNS – Council for Nuclear Safety, established in 1982, became independent of the AEC in 1988.

Figures in millions of rands (current, i.e. not adjusted for inflation)

Year	AEC	UCOR	CNS	TOTAL	% of Dept Budget
1971/2	6.390			6.390	16
1972/3	6.709			6.709	17
1973/4	8.762			8.762	20
1974/5	15.978			15.978	19
1975/6	17.174	51.000		68.174	55
1976/7	18.603	50.000		68.603	43
1977/8	19.987	43.000		62.987	37
1978/9	22.925	67.481		90.406	47
1979/80	32.400	99.895		132.295	33
1980/1	57.060	142.300		199.360	46
1981/2	76.835	173.400		250.235	65
1982/3	114.958	200.600		315.558	66
1983/4	352.921		0.075	352.996	66
1984/5	370.000		0.075	370.075	66
1985/6	525.878		0.123	526.001	84
1986/7	775.504		0.179	775.683	89
1987/8	671.146		0.183	671.329	87
1988/9	619.018		0.180	619.198	83
1989/90	640.000		5.200	645.200	82
1990/1	712.700		6.653	719.353	63
1992/3	451.958		5.089	457.047	67
1993/4	469.096		5.398	474.494	67
TOTAL	6671.002	827.676	29.699	7528.799	

On average the AEB/AEC budget differed from parliamentary allocations by less than 1% (a factor of 1.006). Most of the operations provided services at many times market prices, for example over the period 1988-1992 Eskom, through its nuclear fuel procurement, subsidised the AEC to a value of more than R220 million. In 1993 the EDRC report concluded: "On the macro-level, the situation at present is that the NFP (Nuclear Fuel Production) division is being subsidised by the state to the tune of almost R300m/yr, while generating about R10m income from export contracts, and about R80m/yr from contracts with Eskom." A 1998 government review of the AEC reported that the AEC still accounted for 59% of the DME budget; even though: "The AEC itself has abandoned its forecasts of a nuclear future for South Africa." 'Review of the Atomic Energy Corporation' commissioned by the Department of Arts, Science, Culture and Technology, Baruth-Ram, Eberhard, Myers, Sellschop, Webster (1998).

The review also notes: "The AEC's ambitions of becoming a fully integrated (one-stop) supplier of nuclear fuels and waste management have evaporated with the closure of its uneconomic Y and Z enrichment and BEVA fuel fabrication plants, and the announcement that its conversion plant will also be closed. Koeberg sources its fuel from international markets… the decision to close its MLIS programme effectively means that the AEC is now out of the nuclear fuels business."

13 *The South African nuclear fuel industry: History and prospects,* Thomas Auf Der Hyde (1993); a report of the Energy and Development Research Centre at the University of Cape Town.

Export potential?

Critical to the motivation and success of the programme is a market for the export units but while proponents claim that "… interest is already being shown by a number of countries including the U.K., China, Indonesia, Morocco, Egypt and Tunisia…"[14] there are no committed customers.

Furthermore one can safely assume that if they can persuade any party to sign a letter of intent to purchase, it will contain preconditions relating to the projections of proponents being borne out in practice. This includes the expectation that the construction costs per MW of the PBMR will be only 20% of that of the most recent British nuclear power plant. In the USA no new plants have been built for over 20 years and 41 existing orders have been cancelled since 1974.

Japan has developed its own design of HTR (high temperature reactor) and completed a prototype in 1998, some 3 years later than scheduled, and the country has recently lost much enthusiasm for nuclear power, not least due to a number of accidents.

In Europe: Italy closed its three plants after a referendum; Austria closed its plant without operating it, after a referendum; Sweden is committed to closing its plant; the Spanish government ordered work to stop on several unfinished reactors in the 1980s; Germany has committed to phasing out nuclear power and there are strong indications that Switzerland and the Netherlands are likely to follow suit.

France has spent such vast amounts on developing its own nuclear industry that it is far more interested in selling than buying.

For a South African designed nuclear plant to be sold on the world market the design would have to be approved by safety authorities in one or more of the countries with high technical credibility in nuclear regulation.

The only developed country identified by proponents as a possible customer is the UK, where BNFL has purchased a share in the project. It is unlikely that public opinion would allow a company, particularly one with such a poor track record (see Box – extract of press release), to invest public money to gain safety clearance for a design of plant that would not be made locally.

China has been mentioned as a prospective client but is itself in the business of reactor design and manufacture and also has a license to develop the German technology. China has indicated that it will only pursue nuclear power if it can be subsidised through mechanisms under the United Nations Framework Convention on Climate Change, i.e. if the rules determining what technologies will be accepted as sustainable development and be included in the Clean Development Mechanism of the Kyoto Protocol allow for nuclear projects to earn carbon credits.

Such a provision would severely undermine the effectiveness and credibility of the protocol and is thus opposed by a majority of countries; it is only the unjust weight of the US vote that is preventing its exclusion.

The prospects of sales to countries in North Africa are compromised by the Organisation for African Unity (OAU)'s long-standing anti-nuclear stance.

Any interest that has been generated appears to be a product of speculative linking of the project with proposals for desalination of sea water, itself an energy –intensive activity that some arid countries are considering for the future. Egypt is a particularly unlikely prospect as it has recently committed to a large-scale wind development programme.

The International Atomic Energy Agency (IAEA), in a publication reviewing the financing of nuclear power plants in developing countries, warned: "Experience in various countries has shown that construction of a (nuclear) plant can be faced by many uncertainties which could lead to longer than expected construction times and, as a consequence, to large cost overruns and thus higher, protracted, financing requirements, as well as large debt servicing payments." [15]

As there is little activity and a lot of competition in existing nuclear energy markets the level of exports assumed possible by the PBMR programme would require making new converts to the nuclear cause. As the history of cost and lead-time over-runs, the full extent of impacts on human and ecological health, the inadequacy of regulations, safety procedures and risk

14 Official letter from Eskom PBMR programme, to ELA, August 1999.

15 Greenpeace International, Ben Pearson, *Nuclear power in developing countries: radioactive waste, proliferation and debt*

assessments and the impossibility of determining a 'safe' level of radiation exposure are becoming more widely recognised, the market for new nuclear power is unlikely to improve.

Eskom commissioned a study undertaken by Pricewaterhouse Coopers on the commercial risk of the project which found that Eskom has underestimated the cost and time requirements of the PBMR programme.

Prospective customers are likely to pay more attention to the findings themselves than Eskom's attempts to trivialise them. Even the World Bank, well known for putting the interests of investors first, says that in developing countries: "Nuclear plants in the power sector would not be economic; they are large white elephants."

A history of failure in developing Countries

Greenpeace International, Ben Pearson, *Nuclear power in developing countries: radioactive waste, proliferation and debt.*

The following case studies provide graphic examples of how nuclear power is an uneconomic and financially risky option for developing countries.

India: In India, the cost of the two Kaiga reactors has increased dramatically, largely because of an accident at the first unit in 1994 that has so far delayed construction by over two years. The original cost estimate for the two units was about 7.31 billion rupees (US$ 169.93 million), but the project is now expected to cost around Rs 28.96 billion — an increase of nearly 400%.

Thailand: In 1993 a World Bank study on Thailand estimated that nuclear was not competitive compared to gas, lignite, coal or fuel-oil fired generation, even after the investment and operating costs of pollution mitigating technology such as flue-gas desulphurization units on lignite and coal-fired power plants were considered. As a result of this report, nuclear power was taken out of the Thai Government's 1994 energy plan.

The Philippines: The cancelled Bataan nuclear plant in the Philippines is a symbol of the folly of nuclear power. Delayed and finally killed by scandals and public opposition, it is responsible for 20% of the Philippines foreign debt. Yet it has never generated a single watt of electricity, nor brought in one dollar of revenue.

Trade-related issues

Governments and consumers, particularly in developed countries of the north, are becoming increasingly sensitive to the hidden costs and environmental implications of energy use and trade-related mechanisms are being considered to compensate for state support for energy-intensive industries and to penalise dirty practice.

As international mechanisms are implemented to support sustainable development there are increasing opportunities for financial and technological support for such projects in developing countries. In future there will be competitive advantages, at least in some markets, for products made using renewable energy.

While there has been no public statement of intent to produce the fuel to run exported reactors it is clearly implicit in the programme that South Africa will be the source; certainly no other plan has been suggested and the Pelindaba facility would be the first of its kind.

The implications of such an undertaking are probably the reason for the vagueness: the international trend, reflected in existing agreements, is for the country producing nuclear fuel to be required to take it back once it is spent.While PBMR Ltd would no doubt resist any such suggestions it is a possible eventuality of such enormous consequence that it must considered.

No current need for new generation capacity

Given current energy consumption (highest peak demand to date: 29 146MW) and generation capacity (almost 40 000 MW), South Africa is unlikely to need additional bulk generating capacity before 2010, even without significant improvement in the energy efficiency of our economy.

There are good reasons to develop off-grid generation capacity in remote rural locations but nuclear power would not be considered for such applications. The best way to provide for growing energy service provision and need is to manage the demands placed on existing resources while facilitating and encouraging optimal use.

Even given hoped-for economic growth, energy efficiency programmes could considerably defer the need for new generation capacity. Eskom themselves dropped their energy use by 34% from 1991 to 1997 at their MegaWatt Park headquarters by implementing Demand Side Management (DSM) Daily News June 4, 1999. – i.e. efficiency measures. Extensive overseas precedents show that efficiency measures reducing use by 20 to 35 % can be achieved at negative cost (i.e. also saving money) , particularly in industry. Eskom's DSM initiatives are welcome but completely inadequate: they are directed primarily at domestic consumers and the research budget for the field in 1999 was a paltry R10.7million.

If energy efficiency potential is realised then the economy will benefit while providing for the needs of industry with current capacity. Demand Side Management also includes strategies for levelling electricity use to lower the demand at peak consumption times through a variety of strategies including the use of passive solar water heaters and lower late night tariffs that encourage consumers to put their electric geysers on timers to avoid switch-on during evening peak use periods. Application of DSM strategies will allow plenty of time for further development of existing policy and allow for decisions regarding future electricity generation development to be informed by rigorous planning and market developments over the next few years.

Energy efficiency programmes welcomed

(Extracts from Lani Holtzhausen, *Martin Creamer's Engineering News* Oct 20-26, 2000)

"Initial case-studies into increasing energy efficiency at three prominent South African companies have revealed that local corporations could be saving millions of rands a year by implementing simple energy-saving strategies… Evaluations into potential energy savings at Anglogold's Elandskraal gold-mine near Carletonville, South African Breweries' (SAB) Prospecton brewery in Durban and Sappi's Mandini paper mill showed a total potential return of about R9-million a year on investments totalling just more than R5-million. About 60% of these savings could be made without significant investment in new capital. Moreover, none of the energy-saving projects had an investment payback period of more than a year; the longest payback period being ten months in the case of SAB."

"The three companies, which all have a record of active energy management, volunteered for the energy audits as part of the Energy Efficiency Earnings (3E) strategy, a programme developed specifically for South African corporations. The project is being undertaken by Eskom subsidiary Technical Services International (TSI), the Energy Research Institute at the University of Cape Town, Dutch organisation Novem and UK energy-efficiency agency Etsu. The European Commission is the main sponsor of the programme."

"This programme has proved that even five-star operations have room for improving their energy efficiency," maintains Doug Geddes (SAB Prospecton project engineer). "It has been reported that energy-saving

programmes are in place in all industrialised countries, mainly as a result of legislation, the provision of information and encouragement of energy efficiency practice. However, as a result of the availability of relatively cheap energy in South Africa, energy efficiency has not been a priority for most local companies until now. Continued pressure on the price of local energy, the high price of oil, the quest for global competitiveness and environmental considerations have resulted in energy management receiving increased attention." "DME Minister Phumzile Mlambo-Ngcuka welcomed the programme, adding that South Africa could save between 15% and 20% in energy through such efficiency programmes. This would increase the country's gross domestic product by at least 3%…. 'We need to improve the quality of life of the population on one hand, while on the other we need to develop an efficient and internationally competitive economy. A key challenge, a convergence needs to be sought, and the implementation of sustainable energy efficiency programmes is certainly one way of achieving that balance,' she maintained."

Policy context

"Our policy must rest on the solid moral foundation of dedication to the primacy of people and their long-term well being. We have to be on guard against temptations of short-term benefits and pressures from powerful forces at the expense of the long-term interests of all. We cannot afford to bargain away the birthright of future generations." — Extracts from Nelson Mandela's speech at the opening of the fifth Session of the World Commission on the Ocean, Issued by: Office of the President. Cape Town, 11 November 1997

The White Paper on Minerals and Energy Policy (1998) calls for aggressive development of renewable energy supply while providing only that the nuclear option should not be ruled out, but presidential favour for PBMR appears to be constraining efforts to give effect to this intent.

In the mean time PBMR proponents bolster momentum by any means, including taking advantage of the failing regulatory mechanisms and desperate financial straits of the Russian nuclear industry to conduct engineering tests far removed from South African scrutiny (The Star 26/8/99). It is widely recognised that existing policy is too broad and inclusive and needs further development.

Correspondence from the Department of Minerals and Energy (DME) has explicitly accepted the White Paper position that: "Decisions to construct future nuclear power stations will be taken within the context of an integrated energy planning process with due consideration given to all relevant legislation, and the process will be subject to structured participation and consultation with all stakeholders."

Such an integrated energy planning (IEP) process was initiated early in 2000 but it suffers various limitations. The DME has recognised that the timeframes first proposed were completely unrealistic but no new timeframes have been put forward. Participation in the process, through the Steering Committee and various working committees, is 'voluntary', i.e. only for parties who can pay their own way to meetings in Pretoria.

There is no provision to facilitate stakeholder participation and consequently the process is dominated by big business, particularly parties keen to continue business-as-usual; organised labour is virtually unrepresented.

Verbal presentations at the opening meeting suggest that sending out an invitation is considered to qualify as consultation. The present status of the IEP is not clear since the revised programme promised at the second meeting at the end of August 2000 has not materialised.

Policy within Eskom, and by implication the Department of Public Enterprise, is also sufficiently broad and vague to mean anything to anyone. Renewable Energy initiatives are sufficient to retain a competitive position in the emerging market but not sufficient to drive development of a local industry for bulk supply or to fulfil the mandate of national policy.

Alternatives: renewable energy and socio-economic considerations

It is by now widely recognised that the 'price' of electricity generation – i.e. the cost to Eskom – bears little relation to the actual cost to the nation of producing electricity, both in economic terms, due to direct and indirect subsidies, and in terms of human health and degradation of natural resources. Alternatives to fossil and nuclear fuels have not received the benefits of being developed as strategic industries and have thus taken considerable time to realise the potential that was enthusiastically heralded in the seventies. The following is an extract from the Executive Summary of the Earthlife Africa Johannesburg *Renewable Energy* document:

Renewable energy technologies are some of the fastest growing global industries reflecting annual growth rates between 25% and 40%. The cost of harnessing renewable energy is, in many countries and situations, already competitive with use of fossil fuel and nuclear energy sources, and costs are predicted to continue falling. The current and expected growth in renewable energy technology and supply is so great that even the conservative International Energy Agency says that, "The world is in the early stages of an inevitable transition to a sustainable energy system that will be largely dependent on renewable resources."

These technologies are being promoted, particularly in developed countries, due to their associated environmental and human health benefits. An area that has been less thoroughly explored, but is as important for developing countries, is that of the social benefits. These include the intergenerational equity benefits that come from the relatively light use of finite natural resources, since there is no need to mine and/or produce fuel, and from the avoided degradation of resources and pollution which would have resulted from fossil fuel derived energy.

Furthermore renewable energy technologies are labour intensive, directly producing more jobs than fossil fuel or nuclear development; they are suited to small-scale projects, thus allowing for community investment and ownership; as they are currently underdeveloped they provide an avenue for economic growth, including potential exports.

Global trends in electricity supply are toward smaller scale localised or 'embedded' generators, suitable to renewable energy supply, providing electricity close to where it is required, reducing transmission costs and associated efficiency losses. International environmental obligations and deregulation trends will in future result in electricity supply which uses a diverse mix and range of small scale renewable energy generators. This will result in obvious regional or local benefits such as education, employment and a clean environment as well as less obvious benefits such as improving energy supply security and optimising on global greenhouse gas emissions reduction incentive opportunities.

Initially renewable energy sources can be used for grid flexibility, fitting load and demand growth requirements, and thus displacing future demand for conventional generation.

Renewable energy projects have shorter lead times (2 years) and can thus match grid demands with minimal risk. Research shows that aggregate renewable energy supply, drawing on many modestly-scaled sources, is at least as reliable as conventional supply... Assuming that efficiency measures are implemented, environmental standards are enforced and the unique energy demands of a region are properly matched with the available renewable energy resources, then such resources could potentially supply the vast majority of national and global energy needs. How long this takes will depend on the will and determination of all stakeholders, from consumers to government.

South Africa has excellent renewable energy potential – our wind resources are excellent in many areas but have not been fully assessed and our solar resources are known to be among the best in the world. Achieving a 10 000 MW renewable energy capacity in SA by 2012 could generate 200 000 jobs in the country, most of them potentially being in the areas where they are most needed, without significant displacement of current energy sector jobs. Initially about 5 jobs would be created locally per MW installed; however this could rise to 35 per MW as local content ratios increase.

Although some of the potential of renewable energy is being realised for remote area power supply, there are still many barriers to using renewable energy sources for bulk electricity generation. Perhaps most important is the inability of medium or small

Independent Power Producers (IPPs) to obtain licenses and integrate easily into a region's supply. There is an urgent need to develop awareness of sustainability issues in the energy sector and build capacity at the National Electricity Regulator (NER), the authority responsible for licensing IPPs .

Internationally both solar thermal power, for example, in Sacramento, California; and wind power, most notably in Denmark and Spain, expose the deception of claims by some Eskom staff that renewable energy "...cannot provide for base load" electricity generation (Tony Stott at a meeting with Cape Metropolitan Council, 15/11/99).

Solar technologies are becoming increasingly efficient and cost-effective. "Even in terms of present technology, in sunny climates solar thermal electricity is the world's most flexible and compact source of grid electricity. It is also by far the largest – capable of delivering, from just 4% of South Africa's land surface, the total present world electrical generating capacity." *(Solar Energy in Southern Africa* by Solar Energy Society of South Africa)

Wind power technology is improving rapidly (being directly competitive with fossil fuels in situations where full costs are taken into account) and past problems such as noise and impacts on bird-life have been resolved.

Ten times more jobs are created by investments in Wind Power projects than in nuclear and the leading developers are willing and ready to undertake technology-transfer projects that will allow South Africa to develop the industry locally. Wind farms produce no air pollution and most (95-99%) of the land needed can also be used for farming.

Energy recovery time[16]

The amount of time a plant has to be operational to become a net producer of energy, or to earn back the energy expended in the fuel chain and plant construction, is known as energy recovery time.

For renewable technologies this is decreasing as technology and conversion yields improve while for nuclear it will increase as lower grade ore is utilised. When uranium content is low, the nuclear energy process chain uses more energy than it generates in electricity; uranium content in most of the ore currently extracted is between 1 and 10 percent, yielding an energy recovery time between 18 and 10 years.

Figures for fossil fuel plants only account for electricity, used for construction and processes in the fuel chain, not fossil fuels used. If the energy generated is similarly measured in the form of electricity - not process heat as generated by modern gas-fired stations – the recovery time for gas and oil-fired stations is 0.7 full-load years, effectively 1 calendar year.

Recovery Time:	
wind	*0.62 – 0.9 years*
gas and oil	*1 year*
photovoltaic (PV)	*1.5 – 3 years*
nuclear power station	*10 – 18 years*

Public participation process

The Environmental Impact Assessment (EIA) process for the PBMR programme, as required by the National Environmental Management Act (NEMA) is in progress with two EIAs being conducted in parallel, one for the reactor at Koeberg and the other for the fuel production facility at Pelindaba, separate on the basis that it is undertaken by a different public enterprise, the Nuclear Energy Corporation of South Africa (NECSA), formerly the Atomic Energy Corporation (AEC). A "transport study" is to be conducted for the movement of enriched uranium, fuel and wastes.

This activity occurs in the context of the approval of a cabinet committee for the Feasibility Study to proceed up to the point where a decision will be made as to whether a reference module should be built. This decision will be informed by the results of the EIA and the initial target date was set for October 2001 but is likely to be delayed.

The public participation process has been compromised by a false start to the EIA in April of 1999, when it was announced but 'suspended' after registration of some Interested and Affected Parties. This has afforded proponents the opportunity to try and canvas support outside of a formal and accountable process. Legislation requires consideration of alternative sites as part of the EIA process and three sites were originally identified. Public meetings to consider the suitability of sites were announced and minuted as part of the EIA process when in fact an EIA has no legal standing until an application has been accepted by the relevant authority, in this case the national Department of Environmental Affairs and Tourism (DEAT) and two

16 Adapted from *'coming clean'*, Groenlinks

provincial governments.

The fact that Eskom has decided not to proceed with investigation of two of the three proposed sites for the 'reference module' has been claimed as a victory for public protest but it could be seen as Eskom legitimising a pre-existing decision to use the Koeberg site without following a proper process with scrutiny by the DEAT.

We have yet to see any meaningful consideration of alternative technologies, another requirement of proper process. At the public meeting at Thyspunt Cape Town and Bantamsklip senior representatives of Eskom not only misrepresented the status of the project but also the viability of renewable energy, directly contradicting the White Paper on Energy which recognises the role it can play in base-load supply.

The official commencement of the EIA process was advertised in August 2000 and the consortium of consultants conducting the EIA submitted the application around the same time. Open days were held at Koeberg and Pelindaba a few weeks later and Background Information Documents (BID) were circulated. The BID documents had significant shortcomings, including a pie chart purporting to represent energy resources available in South Africa on which renewables did not even feature.

Afrosearch, the consultants handling the public participation component of the EIA, have committed themselves to following the letter and intent of the law but intentions communicated at the public meetings have not been realised, presumably due to the intransigence of Eskom. Earthlife Africa Johannesburg secured various commitments at a meeting on 30 September 2000, where Eskom, PBMR Ltd and the consultants were well represented, including agreement to expand the proposed public participation activities and to correct the BID. Commitment to make the Plan of Study for Scoping, or a draft, available and to send out amendments to the BIDs have not been fulfilled.

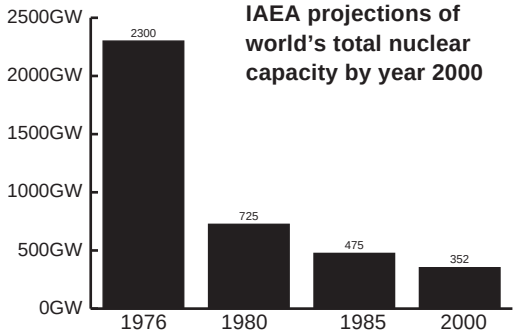
Public capacity-building workshops have been announced for late 2000 in Durban and the Western Cape and early January in Gauteng, to be followed by public meetings. No provision has been made for balanced input at the workshops, or for effective access for (previously) disadvantaged communities. Public meetings, required by law, have also been announced but no agenda or documentation beyond the original superficial BID is available. Public comment either in writing or at public meetings must be reflected in the Scoping Report.

The timeline presented at the open days has already been exceeded and a new one has been promised but there is at present no established plan of the process or timeline. When the Scoping Report has been accepted by authorities an Environmental Impact Report, reflecting further study of issues and alternatives, must be prepared and must be made available to all registered I & APs for comment before being submitted to the DEAT. It is accepted that the August target date for these comments will need to be rolled back and that the decision of whether or not to build a reference model will not be possible before late 2001.

The International Atomic Energy Agency (IAEA) was requested to investigate and advise on the technical and economic feasibility, safety and nuclear proliferation aspects of the PBMR. The report was expected in February 2000 and has reportedly been completed but has not been released. This is anyway not an independent study since the IAEA is an institution whose mission includes promoting the use of atomic energy and it also has a history of manipulating statistics to obscure the health-effects of radiation.

Revised economic studies are expected in about March 2001 but have already been described as proprietary and thus confidential. It will be important to get truly independent peer review of at least the methodology, baseline data and assumptions used to generate the figures, as well as of the Environental Impact Report. If the public participation is to consist of more than going through the motions then civil society needs to interrogate and ensure improvement of the process.

The International Atomic Energy Agency (IAEA) consistently misrepresents both the prospects for the industry, claiming growth when in real terms the industry is in decline, and the number of reactors under construction, by including those where construction may have started but is not actually taking place. The IAEA has for decades overestimated the world's total nuclear capacity by the year 2000 and expectations had to be adjusted downward from 2300GW projected in 1976 to 475GW in 1985; actual capacity for 2000 is estimated at 352GW, as shown in the graph:



“Nuclear Energy Costs the Earth” is one in a series of papers intended to inform the many decisions facing government and society with regard to the provision of energy services.