6 Energy for the poor? The Clean Development Mechanism

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Introduction

Just over forty years ago in Africa, a man of vision announced his solution for the problems of poor black people. Noting that an ancient African culture was being degraded by an aggressive Western one, and that graceful traditions were being perverted by the trash and glitter of Western consumerism, this man proposed a grand scheme to preserve the old and simple ways of Africa. He wanted Africans to live close to nature in small communities, self-reliant in their modest needs. He wanted them to be protected from the corrupting influences of Western technology and Western avarice. He put his scheme into practice.

The man was former prime minister Dr Hendrik Verwoerd, the country was South Africa and the vision was called 'apartheid'. It resulted in repression, humiliation and mass poverty for millions of black people, and degradation of the environment.

A central theme of Verwoerd and the supporters of apartheid was that 'modern technology and wealth is fine for us whites but it will corrupt those poor blacks.' White supporters of apartheid told me, 'Your native doesn't want what you want. All he wants is a mud hut, three fat wives, a patch of mielies (maize) and a few cows.' Motor cars, air travel, electricity, flushing lavatories discharging into central sewers, brick houses with clean running water – we whites all have these things but those blacks should not have them.

Economist Robert H. Nelson of the University of Maryland has argued that 'The greatest current efforts to "save" Africa are associated with contemporary environmentalism. The results have not been as devastating as the experience of slavery, yet they have often served

Western interests and goals much more than the interests of ordinary Africans.'[1]

This chapter argues that the ideas of today's environmental groups have an astonishing and frightening similarity to those of Verwoerd and his followers, with negative implications for development in Africa. The spectre of global warming is used to encourage poor countries to sign up to agreements which will limit their energy consumption and perpetuate poverty – some of these sentiments are reflected in the UN's Clean Development Mechanism. But poor people do not want a new eco-imperialism: they want to grow wealthy, and energy is fundamental to wealth creation.

Resource sustainability

I attended a discussion on climate change at the University of Cape Town where somebody asked: 'Do you think everybody in the world could have the same living standards as the people in California now?' There was a frisson of horror from the green audience. The speaker replied with great embarrassment that it would not be possible with existing technology. Others have said that there are not enough resources. Both are quite wrong.

The same technology that has made Californians wealthy is available to anybody who wants to use it, and technology will improve, as it always does. The world has vastly more than enough resources to give everyone the same wealth as Californians and to sustain it indefinitely.[2] Almost every commodity needed in a modern economy is becoming cheaper and cheaper, more and more plentiful, and this trend will continue indefinitely.

A more crucial question, indeed the most crucial question in debate about man and the environment, is this: 'Do you think everybody in the world should have the same living standards as the people in California now?' It is necessary for the happiness of mankind and the health of our planet to answer 'yes'.

Poverty is bad for man and it is the greatest threat to the environment. Poor people breed more than rich, pollute rivers and local water supplies because they lack proper sanitation, cut down trees for firewood because they lack modern energy sources, plough down indigenous forest to practise primitive, low-yield agriculture, and overgraze and cause erosion with inefficient herding. Rich people lead lives

which are more environmentally benign. They can afford cleaner and more efficient technologies, they produce more food on less land (and even produce too much food because of subsidies) and are secure enough in their everyday needs to worry about other priorities – caring for nature and regarding wildlife as a splendour rather than as a threat or a meal.

Lions once roamed through the whole of Europe. There are NO wild lions in Europe now. They were wiped out by desperately poor hunter-gatherers and primitive farmers in ancient times. Today their rich descendants pay a fortune to fly to Africa and take photographs of lions – and by so doing are helping to preserve them. But to save all of Africa's wildlife, our priority should be people, and specifically, to make African people wealthy as soon as possible.

Energy consumption is a fundamental requirement in all economies, and is essential to the development of poor countries. ('Poor countries' are sometimes condescendingly called the 'developing countries' or worse, 'the Third World', or worse still 'the Global South'.) Climate change now looms over all official considerations of energy use at both international and national levels, and it is casting a shadow over the energy policies of poor countries, who are being encouraged to buy into agreements which will ultimately limit their energy consumption.

Africans and other people with dark skins will simply be the victims of the decisions of rich white people on climate change, and the question 'Is climate change a real danger?' is not one they will be allowed to answer. But let me briefly address it.

Thirty years ago, the big scare was global cooling. We were urged by environmentalists to be terrified of a coming ice age. Nigel Calder, former editor of the *New Scientist*, wrote in *International Wildlife* in July 1975: 'The facts have emerged, in recent years and months, from research into past ice ages. They imply that the threat of a new ice age must now stand alongside nuclear war as a likely source of wholesale death and misery for mankind.'[3]

Other scientists and green commentators joined in, warning about plunging temperatures. As recently as January 1994, the supreme authority on matters environmental, *Time Magazine*, wrote:

> The ice age cometh? Last week's big chill was a reminder that the Earth's climate can change at any time … The last one [ice age]

> ended 10,000 years ago; the next one – for there will be a next one – could start tens of thousands of years from now. Or tens of years. Or it may have already started … Temperatures in dozens of US cities dropped to all-time lows … Chicago schools closed because of cold weather for the first time in history … the city's lows were below -23°C for a record 10 straight days.[4]

And the fact is that alarmism sells magazines: we were all going to freeze. Now we are all going to fry. All you need to do to convert from one scare to another is to replace 'unprecedented cooling' with 'unprecedented warming'.

The facts are these. Carbon dioxide is a greenhouse gas (which traps heat); carbon dioxide has been increasing in the atmosphere and the levels are higher now than they have been in at least 400,000 years; and the increase is because of man.[5]

The rest is guesswork. We do not understand the Earth's climate system. We can draw no conclusions from temperature records (temperatures in northern Europe were much higher a thousand years ago than they are now, and this led to a boom in agriculture).[6] Above all, we do not know what causes ice ages, which have occurred in 100,000-year cycles over the last 2 million years but not before. A new ice age, for which we are due, would be an unmitigated disaster. Ice ages happen when carbon dioxide concentrations in the atmosphere are low, but whether this is a cause or an effect is unknown.

In the face of this lack of understanding, how should we apply the precautionary principle, which suggests that we act to eliminate all potential threats? As the greatest danger seems to be an imminent ice age, should we release as much carbon dioxide as we can, giving power stations and industry tax breaks for every ton they release? Should we pretend that ice ages do not happen, and reduce carbon dioxide as much as we can, based on some speculation about global warming? Or should we be honest about our ignorance and do nothing at all?

'Clean' development

In practice the science does not matter since those with the power and the influence have decreed that global warming is occurring, its effects will be bad, it is caused by man's reliance on hydrocarbon fuels, and

it must be resisted and halted by cutting greenhouse gases. Europeans bemusedly watched the workings of African superstitions. Africans bemusedly watched while Europeans feuded first over their Christian factions and then over their Cold War ideologies. But African beliefs hardly touched Europe, whereas European beliefs rocked Africa. And now the white missionary has a new religion – climate change – and is offering his dark-skinned flock a new rite – the Clean Development Mechanism (CDM).

The 1997 Kyoto Protocol has legally binding targets for rich countries (termed Annex 1 countries) to reduce their greenhouse emissions in total by at least 5% below 1990 levels during the period 2008 to 2012. The poor countries (termed Non-Annex 1 countries) have no obligations – thank goodness. But to encourage them to reduce greenhouse gas emissions, a mechanism is being proposed to allow for the rich to pay the poor to reduce emissions.

The CDM will allow rich countries to meet their own emissions cuts by reducing emissions in a poor country. If a rich country pays a poor country to reduce its carbon dioxide emissions by one ton, the rich country can claim that ton as credit towards meeting its own Kyoto targets.

One of the premises of CDM is that it is easier to reduce greenhouse emissions with the primitive technologies of the poor countries than with the advanced technologies of wealthy countries. This is perfectly valid: a dollar spent improving the efficiency of an efficient machine will yield less return than a dollar spent improving the efficiency of an inefficient one. It is much easier to reduce the carbon dioxide released when an African woman in a township cooks her evening meal over a coal fire than when a Parisian woman cooks hers over an electric stove powered by a nuclear station.

The CDM pledges that if poor countries adopt 'clean technologies' ('clean' according to this definition means technologies which reduce greenhouse gas emissions) they will be paid by the rich countries. This will happen in a complicated scheme of 'carbon trading' and 'Certified Emission Reductions' backed by a huge bureaucracy which will 'authorise, validate and register' projects, establish 'baselines' and do a lot of 'monitoring' to measure 'avoided emissions'. There is talk of a 'carbon economy', some of whose present instruments are 'The World Bank Prototype Carbon Fund', 'The Dutch Carbon Credits Purchase' and the 'UK Emissions Trading Scheme'.[7]

The idea of selling the pollution is probably a good one – it will probably achieve environmental protection more efficiently and with better results than penalties or regulated limits for pollution. Carbon dioxide is not a pollutant in the strict sense, but the same arguments hold for it. So, a market in permits to emit carbon dioxide, which could operate within and between countries, has merits.

However, the complexity of the CDM mechanism looks daunting and the prospect of a vast international army of inspectors and monitors is not appealing to most. The most ominous feature of the system, though, is the possibility of choosing entirely unsuitable CDM projects based more on the interests and ideology of the wealthy supplier than of the poor recipient.

Africa is littered with relics of the white man's folly. The Tanganyika Groundnuts Scheme, Nyerere's Ujaama socialist farms heavily financed by the West, solar power installations that never worked, and myriad other projects and schemes that crumbled the moment they were implemented all bear testimony to an arrogant stupidity from the white sponsors. Of course, corrupt black leaders built lavish conference halls, grand palaces and huge international airports while their economies collapsed. They are also to blame, but most of their extravaganzas would not have been possible without Western aid or loan money.

There are two keys to the success of any project in Africa. The first is to understand what African people want rather than what African leaders or white donors want. The second is to have objective measures of cost and benefit.

It is no surprise, contrary to the ideas of Verwoerd and his supporters, that black people nearly always want the same things as white people. To begin with, most would prefer to live in cities and suburbs than in the countryside.

Urbanisation is a universal trend around the world. According to people who have experienced both, a slum in the city is better than a village in the hills. So, in Asia, Latin America and Africa, they pour into town. This horrifies green ideologues in exactly the same way that it horrified Dr Verwoerd. Indeed, the single greatest battle of apartheid, fought with the utmost brutality and complete failure, was to stop rural black people coming into the 'white' cities.

But urbanisation is almost wholly good. It is much easier to improve access to services which improve human well-being – such as

running water, sewerage, electricity, waste collection, transport, communications and education – to people in urban areas than in rural areas. It is urban areas which present more economic opportunities than the countryside.

And urbanisation, despite myths promoted by environmental groups, is beneficial for the environment. The greatest threat to African wildlife is the encroachment of poor farmers and the predations of poachers in the countryside. If people move to cities, it will be easier to preserve wild places, and the animals of Africa, a wonder of the world, will be left free and secure, visited only by game rangers, local enthusiasts and paying tourists from abroad. The best possible solution for Africa is a great area of wilderness filled with our planet's most magnificent fauna, an area of commercial farms feeding the continent efficiently and most of the human population living in cities and suburbs, which is just what they want to do.

As a start, there should be no CDM projects that try to force people to stay in the countryside. The CDM's projects should encourage urbanisation and help to make urban life safer, cleaner, healthier and more prosperous.

It is extremely important to have objective measurements of the costs and benefits of different energy options. Right now, such judgements seem to be based on emotion. For example, there is excessive anxiety about industrial pollution and very little on household pollution. But in South Africa, and no doubt in the rest of Africa, Latin America and Asia, the health hazards of fuels used for home cooking and lighting are much larger than those posed by big power stations or industry.

If you drive past the townships of South Africa on a still winter day, you will see an evil smog lying over them like the sheet over a dead man. This comes from the burning of wood, coal and paraffin in households, which kills and debilitates on a huge scale. In South Africa, the mortality rate for acute respiratory infections in children is 270 times greater than in western Europe; this is because of indoor air pollution caused by burning wood, coal and paraffin.[8] Electricity from the dirtiest possible power station (coal) provides energy which is hundreds of times cleaner and healthier than that from burning fuel inside a shanty.

The single greatest energy need for an African woman is the energy to cook an evening meal in the middle of winter. In the countryside, she cooks it with wood or dung for fuel. She might spend three hours

collecting the wood and she might chop down trees to get it, adding to Africa's land degradation, which has happened in Dr Verwoerd's model Bantustan, the Transkei. Wood, which is 'renewable', is more likely to suffer depletion through abuse than non-renewable energy such as coal, and can be extremely unhealthy as an energy source. In the townships, a woman cooks with coal, paraffin or LPG. If she is lucky, she will have electricity for cooking. No other energy decision has more effect on life and death than this African woman selecting the fuel for her evening meal.

A colleague prepared a brilliant slide on the comparative perils of energy.[9] The slide is called 'two paraffin accidents'. It is divided into two sides. The right side, with the lesser accident, shows New York's World Trade Center buildings on fire on 11 September 2001. The explosions and fire which caused this tragedy were ignited by jet fuel, which is paraffin. It killed just under 3,000 people.

The left side, with the major accident, shows a cheap paraffin stove knocked over and in flames. This sort of cooking stove is used by African people in the townships. In South Africa alone, it causes over twice as many deaths every year as the number caused by September 11. The stoves are badly designed, so that the paraffin in the reservoir is heated to ignition temperature by the burner and, if the stoves are bumped or knocked over, paraffin spills out and explodes.

The result is death and disability on a massive scale. Week after week, fires caused by these explosions rip through the tinder constructions of the shacks in the squatter campers and townships. Thousands of people die every year. Infants who survive the flames are often left with their faces burned off and spend the rest of their lives as monsters. To add to the horror, paraffin is highly toxic but colourless, and usually stored in beverage bottles. Infants often drink it – and die. Paraffin poisoning kills over 4,000 children a year in South Africa.[10] Finally, the emissions from paraffin burning in these stoves are dangerous to health.

A far safer fuel is liquid petroleum gas (LPG). It is stored in gas bottles and so there is no chance of accidental ingestion. It burns cleanly. LPG stoves do not explode if they are knocked over. LPG is two orders of magnitude safer than cheap paraffin stoves.[11] LPG is a product of oil refineries, plentifully available. Unfortunately, LPG stoves, like the ones used for camping, are considerably more expensive than paraffin stoves.

A wonderful CDM project would be to replace cheap paraffin stoves with LPG stoves. Because its ratio of hydrogen to carbon atoms is higher than that of paraffin and because LPG stoves cook more efficiently than cheap paraffin ones, LPG releases less carbon dioxide for every joule of useful energy, and so would probably qualify for CDM. A project financed by a Western donor to design and make a cheaper LPG stove, and to set up an efficient distribution and marketing system for LPG in the rural areas and townships, would do more to save African lives and improve African health than any other energy project.

What would not benefit Africa are daft 'renewable energy' projects. In almost all cases, wind and solar energy is useless for Africa. It is very expensive (relative to other energy sources), unreliable, fragile, difficult to maintain and does not provide energy when you want it – for example, to cook the evening meal in the middle of winter. This means that renewable energy for Africa is usually unsustainable – though there are a few exceptions, such as water heating. For making electricity, solar and wind are extremely costly and so can only be used in poor communities for generating tiny amounts, suitable for lighting and radios (both important) but not for heating or cooking.

There is a simple-minded attraction to the idea that Africa is hot and sunny and therefore solar power is a good thing for it. But even in Africa, sunshine is very dilute and intermittent, and can only be harnessed in useful quantities at great cost and low reliability.

I gained insight into the social consequences of solar electricity when an American worker in 'alternative energy' came to Africa. She told us about a survey she had conducted among African villagers, asking them whether they wanted electricity and what they wanted it for. Everyone wanted it but there was a stark gender difference in what they wanted it for. The women wanted it for cooking and heating. The men wanted it for entertainment (radio, television and CD players). Since solar power can only deliver tiny amounts of electricity at reasonable costs, it was useless for the first but acceptable for the second. She concluded, 'Solar power is a very guy thing.'

As an engineering student, I had to design a solar-powered refrigerator for storing vaccines in remote African clinics. This seemed a rather good idea because refrigeration is most needed when the sun is providing the most energy. I approached a refrigeration contractor who had had decades of experience in solar power in Africa, and

asked him the best way to run a small refrigerator in the heart of the bush. Without hesitation he replied: 'A diesel generator.'

Unfortunately, though, there are European companies who are looking to make a killing by peddling wind turbines and solar power equipment to the poor countries under CDM. More important, wealthy environmental ideologues are besotted with wind and solar. Their experience with such energy is usually limited to recreational experiences – the photovoltaic panel on their yachts, the charming little wind generator in their safari camp in Kenya, and they see no reason why black chappies should not have them all the time. In rich countries with energy intensive economies, such as Denmark, renewable electricity is heavily subsidised as a sort of self-indulgence. If these patronising and entirely wrong sentiments become the driving force for CDM projects on solar and wind electricity generation, Africa will suffer.

South Africa has embarked on the world's most ambitious programme to electrify poor communities.[12] Grid electricity is brought first to those living closest to the existing grid. Those far from it are offered photovoltaic panels, and if they accept, they are less likely to be connected to the grid.

The experience of the two groups has rapidly been communicated throughout the country. When black people in villages are approached and asked if they would like solar panels for electricity, they always reject them in dismay. They do not want the 'weak' electricity from solar panels, they want the 'strong' electricity from the grid. In some provinces, there are subsidised schemes for private power companies to supply villagers with a combination of photovoltaic units for lighting and radio, and LPG for cooking and heating. This is a sensible compromise, and would also be a good candidate for CDM. But it is only an interim measure until the villagers get grid connection either to the central grid or a local one.

All of humanity is moving towards reliance on electricity as the best form of energy. Electricity is clean, convenient, versatile, superbly ordered and quite safe. Lenin was right about one thing at least: electrification benefits man. With the exception of energy for heat, which may be better provided by other sources, electricity is the optimum energy. All attempts to bring electricity to the poor are motivated by good intentions even though they may fail in practice (mainly because poor people cannot afford to pay their electricity bills). Regardless, to

make the poor countries rich, they must encourage a variety of solutions to energy provision, including large, grid-based electricity.

So which is the best source of electrical energy, which will most reduce greenhouse gases, with the best safety record, and is most environmentally benign? It is on this question that CDM fails worst. By every objective measure of safety, health, economics and the environment, the best source of energy for making electricity is nuclear power.

Nuclear power has an unrivalled safety record. No other source of large-scale energy comes close. Nuclear power currently provides 17% of the world's electricity. The worst ever nuclear power station accident in the West, during over 40 years of experience, was at Three Mile Island in 1979. It killed no one, injured no one and had no ill health effects afterwards. According to the Paul Scherrer Institut, the number of accidents in the energy sector between 1969 and 1996 which killed at least five people was the following: coal – 187, oil – 334, natural gas – 86, LPG – 77, hydropower – 9, nuclear – 1.[13] The single nuclear accident was Chernobyl, whose primary cause was a mad reactor design that would never have been allowed in the West.

There is very little connection between nuclear power and nuclear weapons. Weapons require enrichment over 90%; nuclear power uses enrichment under 10%. From nuclear power reactors that run for more than a month without waste removal – the great majority – their waste is useless for making weapons.[14]

In operation, nuclear power reactors release no greenhouse gases, nor any other air pollution. Over the whole energy cycle, including construction, fuel preparation, operation and decommissioning, nuclear power releases amongst the fewest greenhouse gases of any energy source, including wind and solar power.[15] The radiation from nuclear stations is tiny, less than that from coal power stations and much less than that from large hospitals.

Above all, nuclear power has the least waste problem, producing a tiny amount of radioactive waste which is solid, stable and easy to store so that it presents no danger to man or the environment. By contrast, the waste from coal stations is massively larger, far more dangerous and lasts much longer. Coal waste includes heavy metal toxins such as mercury and arsenic, which remain dangerous forever, and radioactive elements such as thorium, which has a half-life of 14 billion years. This is simply hurled into the air we breathe or dumped on to

ash tips – with never a peep of protest from anti-nuclear groups who fret about the problem of nuclear waste.

But nuclear power is specifically ruled out for CDM, which gives reason to question its intentions and goals. Does the CDM intend to reduce greenhouse gases through clean and safe technologies? Or does it intend to promote an irrational green ideology, which regards nuclear power as sixteenth-century witch-finders regarded witches? Many of the non-Annex 1 countries already have nuclear power stations which run successfully, safely and efficiently. These include India, China, South Korea, Taiwan and South Africa. It is illogical and outrageous that their new nuclear power stations do not qualify for CDM.

South Africa, which has a highly energy-intensive economy, releases about 300 million tons of carbon dioxide equivalent a year, half of which comes from coal-fired power stations.[16] South Africa produces over 90% of its electricity from coal. The coal stations do not have flue gas desulphurisation because the public utility, Eskom, decided that cheaper electricity was a bigger benefit than the slightly cleaner air you would get by paying for expensive desulphurisation equipment. It was right.

By building nuclear stations in the future, South Africa would reduce greenhouse gas emissions more than the whole continent's wind and solar projects put together – probably more than the world's wind and solar projects put together. And it so happens that South Africa is developing a new nuclear reactor, the Pebble Bed Modular Reactor (PBMR), based on a proven German design. Its design philosophy is inherent or passive safety. No matter what human error or equipment failure, it is impossible to have an accident that endangers the public. It is small, simple and cheap. In an honest world, this would be a prime candidate for CDM.

Africa has other potential low-emission energy sources. For instance, it has the world's biggest untapped potential for hydropower. One site on the Congo River alone, at the Inga Falls, could provide up to 100,000 MWe – twice the electricity consumption of the British Isles or twice that of the African continent. And this would generate electricity through the flow of the river, rather than with a dam. But there is an ideological objection to all hydropower from the environmental groups. Hydropower at Inga Falls would not need a dam at all, so it would have almost no environmental consequences. Hydropower should also be a prime target for CDM projects.

Many African countries have failing power stations and electricity grids. Zimbabwe is a good example. It has more than enough generation capacity to meet its needs, but it keeps running out of electricity. The reasons are purely political: competent electricity managers were replaced with incompetent political cronies, and a loss of foreign exchange thanks to President Mugabe's ruinous policies has made it difficult to get equipment to maintain the power stations, coal mines and distribution networks.

If calculations showed that the extra electricity obtained from repairing existing African grids would release less carbon dioxide than the energy it would replace (for example if electricity replaced candles and coal as household fuel), then an excellent CDM project would be simply to refurbish the power stations and distribution systems and get them working again. Of course, political reform is essential but CDM, which is also highly political and bristling with administrative procedures and directives, could actually be useful in working side by side with the African bureaucracies.

In 1900, average human life expectancy in the world was 30 years. In 2000, it was 60.[17] The main reason for the improvement was the big five benefits of the Industrial Revolution: a brick house, clean running water, good sanitation, decent food and electricity. The lesser reason was medicine, especially in combating infectious diseases. The Industrial Revolution was based on the energy from fossil fuels. Development for the poor countries using fossil fuels, as Europe did, is incomparably better than no development at all – better for man and the environment. To achieve the same development using fewer hydrocarbon fuels is possible, because we have substantially better technologies now than in the nineteenth century. But our energy sources should be selected carefully and objectively, based on calculations of cost and benefit.

If representatives of wealthy countries – namely, green NGOs, donor agencies, and international agencies – insist on 'bringing the truth to the natives', this time in the form of the Clean Development Mechanism, they should know what the truth is. Poor countries do not want a new eco-imperialism, or a sequel to Verwoerd's apartheid, in the form of windmills that hardly produce enough electricity to make a piece of toast, solar cookers that can only cook in the middle of the day if there are no clouds, or tanks of fermenting pig waste that need a porcine multitude to supply them. These are hopelessly inap-

propriate, deeply patronising schemes of the wealthy green elite who think that energy comes from electric outlets or gas taps.

If wealthy countries really want to help the poor, the best thing they can do is to trade with them freely, getting rid of the wicked subsidies to wealthy farmers and eliminating protectionism in agriculture, textiles and other industries where the poor countries are highly competitive.

Poor countries are poor because they have not experienced their own Industrial Revolution, which drove wealth creation. People in poor countries want to achieve prosperity, literacy, efficiency, health and well-being – and rich countries achieved this through wealth.

Notes

1 Nelson (2003).
2 This subject is explored in depth by the late economist Simon (1981) and Lomborg (2001).
3 Calder (1975).
4 Lemonick (1994).
5 Isotope analysis shows that the extra carbon has no C-14 and therefore must come from hydrocarbon fuels. The 420,000-year record comes from the Vostok ice core.
6 For example, Keigwin (1996). The increase in temperatures in northern Europe caused a large increase in agricultural production, triggering various historical movements, including the Viking invasions.
7 ERI (2002).
8 Von Schirnding *et al.* (1991).
9 Dr Philip Lloyd, Energy Research Institute, University of Cape Town.
10 Paraffin Safety Association of South Africa (2001).
11 Studies by Dr Philip Lloyd, Energy Research Institute, University of Cape Town. From the National Electricity Regulator.
12 *Ibid.*
13 'Severe Accidents in the Energy Sector'. Paul Scherrer Institut. PSI Bericht Nr 98-.
14 Nuclear reactions make Plutonium 239, which is a fissile material that can be used in bombs. But soon afterwards, they make Plutonium 240, which is not fissile and which contaminates the 239, making it useless for bombs. So the waste fuel must be extracted quickly to make bombs. Most power reactors run for a year or so before re-fuelling, making their waste useless for bombs.
15 'Comparison of energy sources in terms of their full energy chain emission factors of greenhouse gases', Joop F. van de Vate. *Energy Policy*, vol. 25, No 1. Elsevier.
16 In 1995, South Africa emitted 310 million tons of carbon dioxide equivalent, of which 140 million tons came from coal power stations. ERI.
17 UNDP (1998).

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