Nuclear Power

An obstacle to rapid development

Climate change threatens the lives of millions and the ecological integrity of our planet. As the reality of rising temperatures continues to outstrip research findings, it is becoming clear that we are approaching a 'tipping point' - the window of opportunity for avoiding runaway climate change and its catastrophic consequences is rapidly and inexorably closing.

As electricity and energy consumption increases in many developing countries, the energy generation choices made over the coming years will have profound consequences for the planet's climate, as well as the lives and livelihoods of billions of people.

This briefing details why nuclear power is neither a necessary nor a beneficial part of a sustainable energy strategy for countries experiencing rapid industrialisation. Specifically:

- Nuclear power is expensive
- Nuclear power takes too long to build
- Nuclear power does not increase national energy independence
- Nuclear power does not provide jobs for the local population
- Nuclear power is incompatible with most grids in developing countries
- Nuclear power is not safe

Developing countries must guard against becoming locked for decades into expensive and unsustainable patterns of energy production, transmission and consumption. The promotion of nuclear power as the answer to climate change is a dangerous diversion from the real solutions: a massive uptake of renewable energy and the adoption of energy efficiency are the only effective ways to combat climate change. They are available now, they are clean, they are cheap, and they have the added benefit of providing energy security.

Nuclear power is expensive

With the global economy in crisis, financial decisions being made today are much more important than they have been for the past decade. The nuclear industry wants us to believe that nuclear energy is relatively cheap to produce. On the contrary, nuclear energy has proven time and again to be an unbearable burden for governments and taxpayers; it is often described as 'the most expensive way to boil water'. Nuclear projects quickly become an economic liability, with their initial investment (or construction) costs increasing two to three times higher than originally forecast.[1]

For instance, in 2008 South Africa had to scrap its nuclear tender, as the state utility was unable to afford the prices offered by either of the two bidders.[2] In January 2009 the sole bidder for Turkey's nuclear power plant bid a record-breaking 21.16 cents per kilowatt hour.[3] Although this is reported to have been revised seven months later to approximately 15 cents with additional conditions[4], it was still very high compared to electricity prices in Turkey.

[1] Mycle Schneider, Steve Thomas, Antony Froggatt, Doug Koplow, 'The World Nuclear Industry Status Report 2009 – with particular emphasis on economic issues', August 2009 http://www.nirs.org/neconomics/weltstatusbericht0908.pdf

[2] Business Times, 'Eskom scraps nuclear tenders', 5 January 2009, http://www.thetimes.co.za/Business/BusinessTimes/Article1.aspx?id=912305

[3] Bloomberg, 19 January 2009, Atomstroyexport Revises Bid for Turkey Nuclear Plant (Update1) http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aWqdvKAyErT0

[4] 'Russian Consortium Cuts Turkey Nuclear Power Price' http://in.reuters.com/article/oilRpt/idINL612809620090806?pageNumber=1&virtualBrandChannel=11584

In Canada, the regional government of Ontario decided to shelve its plans for two nuclear reactors when it became clear that they would cost up to $ 26 billion Canadian dollars, which was the state's budget for all of its nuclear power projects, including refurbishments, for the following 20 years.[5]

In Bulgaria, in August 2009, the new government estimated the cost of the Belene nuclear power plant to have increased to € 10 billion; the original estimate by the previous government had been € 4 billion. Subsequently, the Energy Minister Traicho Traikov admitted that the power plant was not vital to Bulgaria's energy security.[6]

India is one of the countries with the most recent experience of nuclear construction. Completion of the last 10 reactors is, on average, 300% over budget. There are constant massive miscalculations when it comes to the nuclear build.

The substantial risk of accidents with nuclear power plants also means that no insurance company will agree to cover their liability for full damage. A major accident could cost hundreds of billions of euros - the total Chernobyl cost is estimated to be € 358 billion, for example - and this cost becomes the liability of governments, and taxpayers. In addition, decommissioning and the waste management required for many years afterwards are costs largely carried by the state.

So, the rosy picture painted by the nuclear industry continues to fade every day, as various financing and economic institutions list significant risks related to new nuclear investments.[7] Standard & Poor's concluded that for new nuclear construction projects: 'risks remain uncertain but significant'.[8]

With a fairer legal and political framework, green electricity can provide cleaner, safer, and cheaper electricity. Talking about renewable energy projects in Southeast Asia, Ferran Tarrandellas Espuny, spokesman for the EU Energy Commissioner, said: "*You should go for it. It is cheaper than investing in nuclear development*."[9]

Bataan Nuclear Power Plant (Philippines)

The Bataan nuclear power plant was commissioned by then President of the Philippines, Ferdinand Marcos, in response to the oil crises of the 1970s. The intention was to increase the Philippines' energy independence. An agreement was made with Westinghouse to build a 620 MW nuclear reactor.

Construction work started in 1974. Following the Three Mile Island accident in the United States, the construction stopped for safety checks, which revealed over 4,000 defects. It was completed in 1984 after costing the country $ 2.3 billion US dollars – nearly five times the originally proposed cost of $ 500 million. For 20 years, funding Bataan was the Philippines government's largest overseas debt. It was finally paid off in 2007, 32 years after construction began.[10]

Ferdinand Marcos and his associates helped themselves to $ 80 million in kickbacks from the deal. Attempts by subsequent Filipino governments to sue the builders, Westinghouse Electric Company, for corruption and overpricing on the contract were rejected by US courts.

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5 The Star, 14 July 2009, '$26 Billion Killed Nuclear Bid' http://www.thestar.com/business/article/665644

6 The Sofia Echo, 21 August 2009, 'Energy Minister says Belene Nuke Not Vital for Bulgaria' http://www.sofiaecho.com/2009/08/21/772833_energy-minister-says-belene-nuke-not-vital-for-bulgaria

7 These financial institutions include: Citigroup Global Markets, "Nuclear Energy – State of the Debate, Citi Investment Research, London, 6 June 2008; Fitch Ratings, 'US Nuclear Power: Credit Implications' New York, 2 November 2006 ; Moody's Corporate Finance, 'New Nuclear Generating Capacity: Potential Credit Implications for US Investor Owned Utilities', New York, May 2008

8 Standard & Poor's, Rating Direct, 'Construction Costs To Soar For New US. Nuclear Power Plants', New York, 15 October 2008

9 Bangkok Post, Europe advises ASEAN against nuclear energy, 12 October 2008 http://www.bangkokpost.com/121008_News/12Oct2008_news08.php

10 Inquirer, 'Nuclear Power Plant Loan Finally Paid', http://business.inquirer.net/money/topstories/view/20070613-71098/Nuclear_power_plant_loan_finally_paid

Nuclear takes too long to build.

Despite 50 years of history, and billions of euros being poured into research, the average construction time for nuclear plants is on the rise. In the 1960s and 1970s the completion period of a nuclear power plant was between 60 and 80 months. Between 1985-2000, this period increased to over 100 months.[11] Even in countries with decades of history of nuclear power generation, construction times continue to increase: a clear example is the Temelin nuclear power plant in the Czech Republic where construction delays meant that the plant was only completed 10 years later than actually planned. A current example is provided by the Olkiluoto plant in Finland, supposedly the 'poster child' of the industry: three years into its construction, it is already three years behind schedule.[12]

Many nuclear power plants currently listed as being 'under construction', have now been so for more than 20 years. For example, construction started on the Atucha II reactor in Argentina in 1981 (see below). Even those plants that do eventually get finished sometimes takes decades. Laguna Verde in Mexico is a good example; for the first block the construction started in 1976, and for the second block in 1977; both finishing respectively in 1989 and 1994.

Most developing countries interested in nuclear power have no previous experience with commercially-used nuclear power plants.[13] The very complicated nature of nuclear power calls for a large infrastructure to be prepared; regulations, inspectors, personnel, etc. Ensuring that this infrastructure is in place takes a significant amount of time, and this is always conveniently omitted from the nuclear debate. Increasing construction times also mean increasing costs, whereas developing countries need faster solutions to their rapidly increasing energy demands and a much faster return on their investment.

Mohammed ElBaradei, the Head of International Atomic Energy Agency between 1997-2009, has warned developing countries about these problems: "*It [nuclear power] is not a panacea by itself and many countries will have to understand that it will take 10 to 15 years before they can use nuclear [power]*". [14]

Renewable energy technologies are available much sooner. Construction time for a large wind turbine has fallen to only two weeks, and the associated planning period between one or two years. Solar photovoltaic systems can be installed on buildings such as schools or hospitals within several days.

Atucha 2 (Argentina)

The decision in the late 1970s to build Atucha II, taken by Argentina's ruling military junta of the time, was motivated more by politics than being a question of energy. Siemens was chosen to carry out the construction. The initial contract was signed in May 1980 and ratified by the military junta in a matter of months. Construction began in March 1981 and reached its present stage by 1983.

By the end of 1983 Atucha represented 13% of the country's foreign debt. The cost was originally estimated in 1991 to be $1.5 billion US dollars. By the following year, this had risen to $ 3.1 billion. Today, the cost to complete the work would be around $ 4 billion. However, the possibility of a Chernobyl-type accident was not taken into account during the initial design process, making the completion of Atucha at even this cost an unsuitable option in a post-Chernobyl world.

[11] World Energy Council, Alexandro Clerici, ABB Italy, 'European regional study group, the future role of nuclear energy in Europe'. 13 June 2006.

[12] AFX News Limited, TVO says won't share nuclear reactor cost overruns with Areva. http://www.forbes.com/markets/feeds/afx/2007/09/28/afx4165822.html

[13] Fifteen countries that had expressed an interest in developing nuclear power have no previous experience with commercial or research reactors.

[14] http://www.planetark.com/avantgo/dailynewsstory.cfm?newsid=50783

Nuclear power does not increase national energy independence

Acquiring nuclear technology has become somewhat of a status symbol for developing countries. Lula da Silva, the president of Brazil, expressed this clearly when he said that having uranium enrichment technology would make his country "*more highly valued as a nation*".[15]

Today, energy security is among the biggest concerns for any country. The nuclear industry argues that nuclear energy increases countries' energy independence. However, there are several reasons why nuclear power makes countries less, not more independent.

Uranium resources are the preserve of a handful of countries and subsequently uranium prices are extremely volatile. In addition, the nuclear supply chain from mining to enrichment, the experience and spare components needed to keep plants running, the management of nuclear waste – these are *all* complex issues, and expose the vulnerability of nuclear power.

The nuclear supply chain is very *interdependent*; one small break in the chain can have wide repercussions.

Fuel enrichment capacity and nuclear expertise is strictly controlled for fear of spread of nuclear weapons. It would be very hard for any country to acquire the machinery and expertise required to manufacture nuclear fuel, operate nuclear power plants and deal with nuclear waste without being at the mercy of a handful of developed countries who have the necessary technology and supplies: France, Russia, Canada, US, Japan, South Korea or China.

Far from guaranteeing national energy independence and energy security, a country choosing nuclear will end up relying on a handful of countries throughout the whole nuclear chain, from construction to financing, and from fuel supply to waste management.

Unlike the safety and proliferation concerns attached to nuclear power, renewable energy technologies and skills can be easily exported and global and domestic sectors build up. Decentralised renewable energy and energy efficiency can provide real energy independence without a political price tag.

The Pebble Bed Modular Reactor (South Africa)

In 1998 South Africa announced an 'unpolished gem' that was going to be the future of nuclear power. It was forecast that a demonstration plant would be built; at least 10 commercial orders would be placed from 2004 onwards.

Today, the programme is 20 years late, the estimated cost of the demonstration plant is more than 10 times over budget, and there are no customers.[16] The global economic crisis was the final blow for the project; implementation has stopped, and the plans have been put back on the shelf.

Nevertheless South Africa insists in pouring money to this black hole; the cost of the 80 MW reactor is now at 6 billion rands (€ 550 millions), making it cost € 7,000 per kW, more than any other current commercial design.[17] Electricity generation could only start after 2020, leaving many South Africans to struggle with an already existing energy gap.

[15] http://www.energy-daily.com/reports/Lula_Resumes_Nuclear_Program_To_Make_Brazil_World_Power_999.html

[16] Nuclear Engineering International, 'PWMR: Hot or Not' 01 April 2009 http://www.neimagazine.com/story.asp?storyCode=2052590

[17] Reuters, 'S. Africa says nuclear is key to easing power woes'. 30 July 2009 http://www.reuters.com/article/marketsNews/idUSLU60872820090730?pageNumber=2&virtualBrandChannel=0

Nuclear does not provide jobs for the local population

As an energy production technology, nuclear power is the least labour-intensive of commercial technologies and provides the least number of jobs per unit of energy generated. Furthermore, these jobs are highly specialised, requiring very specific qualifications, and are thus not usually available to local populations.

In January 2008, three French companies - Areva, Suez and Total - signed a partnership agreement proposing the construction of two EPR units in the UAE. Suez would be the operator, while Areva would supply the plant and manage the fuel.

The UAE is setting up a model of managing its nuclear power programme based on contractor services, rather than taking its time to establish indigenous expertise.[18] Therefore, few if any skilled positions will be left open to the local population.

Despite the global recession, the renewable industry has grown by about 5% in 2008[19]. So far, it has mainly been advanced economies that have shown leadership in developing viable renewable energy, but developing countries have a growing role. For example, China and Brazil account for a large share of the global renewable energy total, having strong roles in developing wind, solar thermal and biomass development.[20]

Greenpeace's Energy [R]evolution Scenario was developed to show how, technically and financially, the world could increase its production of renewable energy by nine times, replacing nuclear and a proportion of coal-fired power to avoid catastrophic climate change. If this revolution was implemented in developing nations then 1.3 million jobs could be created by 2030, compared to business as usual.[21]

Nuclear power is incompatible with most grids in developing countries.

As with most centralised energy production technologies, the energy produced by large-capacity nuclear power stations requires long distance, high-voltage grids for transmission. Such transmission networks are expensive, and are of little use in sparsely populated regions with lower rates of energy consumption.[22]

Any electricity supply system based on large, centralised units is also vulnerable to interruptions in the operation, suddenly resulting in loss of thousand megawatts of capacity. Outages of nuclear reactors can be long and take over year: out of 130 commercial units in the US fleet of reactors, one-third of them have seen outages lasting longer than one year.[23] Furthermore, incidents in nuclear power plants often require all reactors of the same type to also be shut down. For example, in 2003 when a 400 kV power line was cut off from the main grid, three Swedish nuclear reactors went offline, destabilising the grid and causing a loss of power to millions of people in Denmark and Sweden.[24] The Krummel nuclear power plant in Germany - which had been down for two years - caused a major power outage in Hamburg, Germany's biggest port, when it was re-started.[25]

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[18] World Nuclear Association, 'Nuclear Power in the United Arab Emirates', http://www.world-nuclear.org/info/UAE_nuclear_power_inf123.html

[19] According the UNEP, Global Trends in Sustainable Energy Investment 2008 the sustainable energy market has grown from $148 billion US dollars in 2007 to $155 billion. http://www.unglobalcompact.org/docs/issues_doc/Environment/climate/Global_Trends_2008.pdf

[20] http://www.greenpeace.org/international/press/reports/working-for-the-climate

[21] The numbers here were taken from 'Working for the Climate' which can be downloaded at www.greenpeace.org/greenjobs. The geographical regions represented include Developing Asia, Africa, Latin America, India and China.

[22] Nuclear power can be only supplied to densely populated countries, with a fast economic development, however in these cases lengthy construction times makes nuclear disadvantaged.

[23] David Lochbaum , Walking a Nuclear Tightrope: Unlearned Lessons of Year-plus Reactor Outages, Union of Concerned Scientists, September 2006; http://www.ucsusa.org/assets/documents

[24] Oskarshamn-3 (1160 MW) and Ringhals-3 (915 MW) and -4 (915 MW) all went off line; Ringhals-4 (915 MW) was still able to operate, but could not deliver electricity to the grid.

Such power outages place very high demands on power grids and backup capacity, and entail high hidden costs. For example, Finland's power grid has had to be upgraded to cope with an instant capacity loss of 1600 MW because of the new French EPR under construction. The nuclear power plants now being marketed by most nuclear vendors are typically larger than any existing units in most countries, and these upgrades to existing grids will become more and more necessary.

The large size of the plants is also a disadvantage for a majority of countries, as most of the electricity is lost during transmission. For example, India - a rapidly industrialising country - is losing one third of its electricity during transmission and distribution due to technical difficulties and theft,[26] causing power cuts to many villages.

The many threats and causes of disruption already facing the supply are exacerbated in a world in which climate change is causing extreme weather conditions such as droughts and hurricanes.[27] Most nuclear power plants use water for cooling. Increased drought makes it very difficult for inland nuclear power plants to operate. During the heat wave in Europe in July 2006, Spain, Germany, France and the UK all had to close or limit operation of nuclear power plants because of droughts, and during the July 2009 heat wave in France, the extremely low levels of water in rivers forced the country to close down its nuclear plants and import its electricity from UK.[28]

A decentralised system where buildings (from homes to industrial units) have their own wind turbine, solar panels or co-generation units and smaller-scale power plants generate electricity closer to the communities they serve, is more energy efficient and less prone to disruption.

Nuclear power is not safe

Nuclear energy has been used for commercial power generation for over half a century now, with massive financial support from governments. Yet, it has not solved its intrinsic safety problems.

When the Chernobyl disaster occurred in 1986, releasing a hundred times more radioactivity than the atom bombs dropped in Hiroshima and Nagasaki, it went down in history as the worst civilian nuclear accident, Radioactive pollution has long-term impacts on health, and the precise death toll from Chernobyl will never be known, but may well exceed 90,000 people[29]. As former UN Secretary General Kofi Annan reportedly said on the 20th anniversary of the accident, "*seven million people are still suffering, everyday*". Three million children require treatment and many will die prematurely.

The nuclear industry wants us to believe that the Chernobyl disaster was the product of old Soviet technology, a one-off accident that could never be repeated. However, an accident can happen in any nuclear reactor, potentially releasing large amounts of deadly radiation into the environment; the nuclear industry is plagued by accidents and near misses. As recently as 2006, due to a chain of technical failures in the Forsmark nuclear power plant in Sweden, four of the country's six reactors had to be shut down, A former director of the plant said, "*It was pure luck that there was not a meltdown… it could have been a catastrophe*."[30]

Yet another advantage of switching to renewable energy, is not only their benefit for the environment with regards to zero carbon emissions, but also their safety. Countries investing in wind farms or solar power plants instead of nuclear reactors will encounter zero

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[25] Time, 'Nuclear Power Debate Reignites in Germany', 9 July 2009, http://www.time.com/time/world/article/0,8599,1909228,00.html

[26] http://www.thehindubusinessline.com/2005/12/03/stories/2005120303300900.htm

[27] In centralised systems, electricity is generated in large power stations and transmitted through wires in the electricity grid to homes and businesses.

[28] http://business.timesonline.co.uk/tol/business/industry_sectors/utilities/article6626811.ece

[29] The Chernobyl Catastrophe – Consequences on Human Health, Greenpeace, 2006. http://www.greenpeace.org/international/press/reports/chernobylhealthreport

[30] The Local, 'Nuclear plant could have gone into a meltdown'. 1 August 2006 http://www.thelocal.se/4487/20060801/

safety breaches, have problems of disposing of highly toxic waste, nor run the risk of contaminating the local population or environment.

An Energy [R]evolution is possible

Moving from coal and nuclear energy to renewables is a necessity if we are to avoid runaway climate change. *Energy [R]evolution: A Sustainable Global Energy Outlook*, published by Greenpeace International and the European Renewable Energy Council (EREC) in October 2008, sets out a vision of how to achieve this transition of the global energy supply. The report outlines two scenarios: the Reference scenario is the International Energy Association's 'World Energy Outlook 2007' projection, extrapolated from 2030 to 2050; the Energy [R]evolution scenario shows how - technically and financially, and by replacing nuclear and a large proportion of coal-fired power - the world can achieve a nine-fold increase in its production of renewable energy to avoid catastrophic climate change.

The Greenpeace Climate Vision, which builds further upon the Energy [R]evolution, shows that with the right choices we can develop a socially and ecologically sustainable zero carbon pathway without making use of unsustainable solutions such as nuclear energy and geo-engineering.[31]

Developing countries can be at the forefront of energy development. Greenpeace calls for financial support and technological cooperation for sustainable energy investments in developing countries to be a crucial element of the climate agreement to be made in Copenhagen Climate Change Summit in December 2009 Copenhagen Agreement. Industrialised countries should provide at least USD140 billion a year in support of clean energy and other mitigation activities such as deforestation and adaptation in developing countries. This funding should be used to pay for the incremental costs of developing countries Low Carbon Action Plans (LCAPs).

[31] Greenpeace Climate Vision, 27 May 2009, http://www.greenpeace.org/raw/content/international/press/reports/greenpeace-climate-vision.pdf