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NUCLEAR POWER: BEQUEATHING MORE PROBLEMS FOR FUTURE GENERATIONS

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Thank you very much to CES for organising this important forum and inviting me to speak. Tragically, it is even more timely than we had anticipated, due to an event we desperately hoped to avoid. I will try to put the crisis in Japan in some context and provide some information that we generally aren't told by nuclear power proponents. I want to emphasise that nothing that has happened in Japan should have been unexpected – everything that has happened is consistent with warnings that have been given about the dangers of nuclear power, warnings that have been passed off as alarmist, once in a millennium risks etc.

I'm going to talk about a number of things, from the start to the finish of the nuclear fuel chain, from uranium mining to waste, bearing in mind that both these ends of the process directly affect Australia. I'll talk about accidents, the impact of terrorism, the links with weapons and a mention at the end about alternatives, because we need to kill off the myth that renewable energies cannot supply our energy needs.

Phases in the production of nuclear power

The process starts with the mining of uranium, which releases radioactive radon gas and leaves very large quantities of waste, called tailings; the tailings contain most of the original radioactivity and this will continue to contaminate the environment for literally tens of thousands of years. After mining is the milling process, where the ore is crushed and then the ore, in the case of Australian uranium, is exported as yellowcake and sent to a conversion facility where it is converted to uranium hexafluoride.

The next step is enrichment, where the percentage of fissile uranium (U-235 or uranium that is suitable to undergo nuclear fission, the process that releases such large amounts of energy) is increased. A by-product of this process is depleted uranium – that is, uranium that is depleted of the form that is suitable for reactors – and this depleted uranium is used for weaponry because of its very heavy armour-piercing qualities. It also is radioactive and has been spread around several war zones in recent decades. It is attractive for weaponry also because it is a waste product, in plentiful supply.

After enrichment, the uranium is made into fuel rods which are then used in a reactor to produce heat and steam that drives turbines. Very large quantities of water are needed for reactor cooling and we have seen in Japan the disastrous consequences if that water all evaporates and is not replaced. Several years ago, during a heat wave in Europe, some reactors in France had to shut down because the heat in their waste water was adversely affecting local aquatic life.

The construction of the power reactors is a vast technological undertaking in itself; it is lengthy and expensive and very prone to delays and cost blowouts. What we need to remember also is that nearly all the above phases, up to the actual operation of the reactor, produce carbon.

After the reactors have run their allotted number of years' service, which is generally around four decades (although some licences are being extended into time periods that were previously thought unsafe), there is the decommissioning. The reactors still house vast quantities of radioactivity. This step is by and large neglected, with future generations being expected to clean up the facilities from which current generations have extracted every bit of use we can.

Complexity of nuclear technology

I'm going to read here a description of the complexity of a nuclear facility, written by a MAPW member, Dr Peter Karamoskos, who is a nuclear medicine specialist:

> "Whichever way one looks at nuclear reactors, they are enormous. Their magnitude, scale and complexity put them in an industrial category of their own. ...
> The reactor core is enclosed by masses of steel and concrete for protection from the deadly levels of radioactivity. A vast amount of electrical wiring snakes its way throughout the complex. Few people occupy a nuclear plant because it mostly runs itself, with most of the human activity centred on the control room from which engineers monitor and occasionally inspect systems inside the plant.
> Visual inspection is impossible for the most critical and dangerous part of a plant – its core. Control room operators are more akin to pilots flying on instruments. Unable to visually inspect to any substantive extent the critical components of the reactor, they rely on interpretive analysis of the control room gauges to assess whether the reactor is functioning appropriately. … It is one thing to read gauges, however, it is another skill to correctly analyse their meaning. Different people may interpret the data very differently – with catastrophic results. Skilled engineers …can find themselves lacking the critical skills required when the linearity unravels in a crisis. Such was the fate at the Three Mile Island plant in Pennsylvania which suffered a partial core meltdown in 1976:
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> > *One malfunction led to another, and then to a series of others, until the core of the reactor itself began to melt, and even the world's most highly trained nuclear engineers did not know how to respond. The accident revealed serious deficiencies in a system that was meant to protect public health and safety.*
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> Unlike virtually any other major industrial accident, the impact of a nuclear reactor core accident and, specifically, an uncontained meltdown, can span multiple continents through the potential for contamination over vast distances."

For a bit of comic relief, I read some quotes a week ago from officials of the US Nuclear Regulatory Commission, one of whom stated that nuclear power remained a clean harmless energy source that could only lead to disaster if events were to unfold in the exact same way they did in Japan. In other words, it's harmless (they say) as long as things go well. Note that this is not from the nuclear industry but from the body charged with regulating it. Concerns have arisen in the US as elsewhere, because the US has six reactors identical in design to, and seventeen similar to, the Fukushima reactors that have caused the current disaster.

As a further bit of background, I want to go back in time to the start of the age of nuclear power in the 1950s. Even as nuclear power was being promoted with that well-known catchcry of power "too cheap to meter" all technical evaluations made by government, industry and academics in the US in the late 1940s and the early 1950s concluded that nuclear energy would be difficult to master and would not be cheap.

However, as the US and the USSR embarked on their race to outdo one another's destructive capacity with the new technology, there was a need to render the technology acceptable to the public by presenting it as essential to mankind's progress. The "Atoms for Peace" promotional campaign extolled the virtues of the new source of energy, and the already-known health concerns were kept hidden.

WHAT ARE THE HEALTH CONCERNS ?

Nuclear power can expose populations to varying doses of radiation, from low-level emissions, which occur with the routine operation of nuclear facilities, to very high-level exposure from a nuclear accident. The health effects range from fairly predictable consequences of exposure to very high level radiation – radiation sickness, which can of course be fatal – to the more random effects of triggering cancers which will occur later, and genetic changes. It is this time delay that lets the industry off the hook, in that it is able to deny responsibility for health effects and genetic changes that don't become manifest for many years. A cancer caused by radiation exposure cannot be distinguished in any way from a cancer from any other cause and, because cancers are fairly common in our community, it is impossible to prove a link with any particular trigger.

Historically, it is the effects of low-level exposure that are more contentious. However, the scientific community is very widely of the view that there is no level of radiation exposure that can be regarded as safe. Most recently, in 2005, the Committee on the Biological Effects of Ionising Radiation (BEIR) of the US National Academy of Sciences, stated that "… the risk of cancer proceeds in a linear fashion … without a threshold and … the smallest dose has the potential to cause a small increase in risk to humans". During the crisis in Japan, it has been appalling to see the extent to which the known science has been overlooked, with endless commentaries claiming that low levels of radiation are harmless. The authorities have shamefully tried to save the reputation of the industry with the same misinformation that has been promoted for decades.

The industry even tries to claim that a little bit of radiation is good for you. Uranium mining companies do this in their public relations in rural Australia – it is deliberate and irresponsible.

As a further sign of the industry's need to keep people in the dark about radiation risks, we should look at the relationship between the World Health Organization (WHO) and the International Atomic Energy Agency (IAEA), the latter agency having the promotion of nuclear power as part of its mandate, of course. In 1959, an agreement was signed between the two bodies that sets out their respective roles in relation to research on atomic energy. The agreement states that "whenever either organization proposes to initiate a programme or activity in which the other organization has or may have a substantial interest, the first party shall consult the other with a view to adjusting the matter by mutual agreement."

In other words, the world's pre-eminent public health authority, the WHO, must consult with a non-medical body, the IAEA, whose mandate includes the promotion of nuclear energy, before undertaking any activity related to the health effects of nuclear energy.

Nuclear power – what are the other concerns?

I'm now going to go through just some of the problems associated with nuclear power, some in more detail than others. The first thing we should remember is that a resurgence of nuclear power, even if it were to occur, would be far too slow as a response to climate change. Because of the enormous complexity that I mentioned earlier, nuclear power plants take many years to build, even without the delays that are very common in the industry. We can't afford to wait decades for climate change action. Wind turbines and solar panels can be up and running in a far far shorter space of time.
The economics of nuclear power I will not say a lot about (I am not an economist) but it could well be the economics that are the death knell of the industry. The estimated capital cost of the new Westinghouse AP-1000 reactors that were proposed for the US are approximately $6.5 billion per reactor, which would provide extremely few jobs for that amount of outlay. ACF estimates that means around $A3.7 million per construction job and $A16 million outlay for every permanent job. Some say the average cost of new reactors is closer to $10 billion. That's even without considering the costs of decommissioning and waste management, because that will be for future generations, not us. President Obama is calling for tens of billions of dollars of loan guarantees for new reactors.

ACCIDENTS

To consider now the problem that is foremost in our minds – accidents. Remember that the Chernobyl accident occurred on April 26, 1986, just 25 years ago.

Chernobyl accident in April 1986

The Chernobyl disaster in the Ukraine in 1986, was the worst nuclear accident in history. On April 26, the reactor number four exploded, ironically following a safety test. The ensuing fire and core meltdown exposed the reactor core resulting in a massive release of radioactive material – hundreds of times more than that which occurred in the atomic bomb blasts at Hiroshima and Nagasaki – into the atmosphere which drifted over large parts of the western Soviet Union, and Europe. It is estimated that about 40% of the surface area of Europe was contaminated. Large areas in Ukraine, Belarus and Russia had to be evacuated, with over 336,000 people resettled. The first reports of the Chernobyl accident came not from the USSR but from Sweden, where the radioactivity was detected.

From the time of the disaster, official reports have minimised the potential for harm from Chernobyl and yet the death toll has been very high. Although no more than around 50 people were initially killed, the International Agency for Research in Cancer predicts that there will be up to 41,000 excess cancers as a consequence by 2065, with 16,000 fatal. Compare this to the oft-quoted mortality figure of several dozen deaths as a result of the

Chernobyl accident. The website of the Uranium Information Centre (UIC), until recently stated that 31+ people died as a result of the accident.

A startling report published by the New York Academy of Sciences in December 2009 , *Chernobyl: Consequences of the Catastrophe for People and the Environment*, examined much data from Russia that had previously not seen the light of day in the West, and concluded that approximately 985,000 people died, mostly from cancers, between 1986 and 2004 as a result of the accident, and that more would occur. The report said that the fallout spread globally as the winds kept changing direction.

It is not only human health that is affected by radiation exposure. Sheep in parts of Wales still cannot be sold because of the unacceptably high levels of cesium in their soil. Cesium-137 has a half life of approximately 30 years, meaning that after 30 years half of its original radioactivity will remain.

Three Mile Island partial melt-down

On 28 March 1979, the nuclear chain reaction in the Three Mile Island Unit 2 reactor went out of control. There were uncontrolled releases of radioactivity to the environment and radiation monitors at the site went off-scale. In addition, there was lack of knowledge as to how to shut down the reactor, lack of experience in dealing with such a situation, and conflicting reports about the severity of the situation. By April 1, industry and government authorities assured the public that levels of radiation were far below those that could cause harm. To this day, that is the claim of the industry.

Others disagree strongly, however. Hundreds of local residents reported very early health symptoms which may or may not have been related to radiation exposure – that remains contentious. Two separate studies found evidence of impacts of the accident on cancer incidence.

Approximately 2,000 local residents brought a class action against the industry for alleged health effects, arguing that the prevailing meteorological conditions at the time of the accident caused narrow plumes of intense radioactivity in the surrounding countryside. The researcher, Rosalie Bertell, claims that the nuclear industry "managed to frustrate the litigation by having all the expert witnesses, which the victims had engaged, dismissed. Information regarding doses received by the public was deemed "classified" and, therefore, not made available to the public.

Other accidents

Contrary to nuclear industry claims, there have been other serious nuclear accidents. Those living in the vicinity of nuclear accidents continue to be met with official refusal to provide accurate information regarding radiation releases.

The Sellafield nuclear facility in the UK was the site of a disastrous fire in October 1957 with large quantities of radioactive discharges into the environment. Again in 2004, a pipe at Sellafield commenced leaking spent reactor fuel and continued to do so for eight months until it was detected, by which time, about 83,000 litres of highly radioactive liquid, containing approximately 160 kgs plutonium, had been lost. This event remained largely hidden from public scrutiny, as had the 1957 fire.

In Sweden in 2006, workers described a near melt-down at a nuclear plant at Forsmark, and Swedish nuclear energy expert, Lars-Olov Hogland, accused the plant's operators of trying to play down the seriousness of the accident.

In July 2007, the seriousness of a fire at a nuclear power plant in Krummel, near Hamburg in Germany, was played down by officials who initially denied that the reactor itself had been affected. The reactor was, in fact, damaged by the fire and has been shut down.

In Japan, there have been a number of serious accidents at nuclear facilities in the past decade. In 1999, after a serious accident at the Tokai Mura uranium processing plant, details emerged about a company manual that legitimised breaches of government safety rules.

In July 2007, there was a fire and radiation leakage from the Kashiwakazi-Kariwa nuclear plant in Japan, after a 6.8 magnitude earthquake. The Tokyo Electric Power Company was very slow to provide reliable information on the scale and nature of the danger to nearby residents.

And so to the Fukushima disaster that is still being played out in Japan. There is little doubt that it is at least the world's second worst nuclear catastrophe, despite the paucity of reliable information on radiation levels that have been released. The IAEA stated that radiation levels at a location 20 kms from the plant were approximately 1,600 times normal background levels of radiation, with the level changing with changes of wind direction.

We should note that part of the fuel that was exposed in at least one of the damaged reactors was MOX – mixed oxides of both uranium and plutonium, as distinct from simply uranium fuel – a form of fuel that has been known to be particularly dangerous because accidents involving MOX fuel spread plutonium into the environment. This is precisely what has happened in Japan. The inhalation of approximately a millionth of an ounce (27 micrograms) of plutonium has a probability of causing lung cancer of around 100%. Its half-life – the time taken for its radioactivity to reduce by half – is 24,000 years. How many future generations is that, before the amount of plutonium is even reduced to half?

It is in the nature of accidents that unexpected things happen. The designers of the Fukushima reactors did not anticipate that a tsunami generated by an earthquake would disable the backup systems that were supposed to keep cooling the reactor in the event of an accident.

An energy source that has such potentially disastrous consequences when things go wrong demands a commitment to transparency and placing the public good above all else. Because the stakes are so high, and there are vested interests involved, however, what we consistently see is cover-ups from governments and other authorities. As the radiation spreads in time of accident, a veil of secrecy descends.

If we need any more convincing about the safety of nuclear power, think about this: If nuclear plants are as safe as their proponents claim, why do utilities need the U.S. Price-Anderson Act, which guarantees utilities protection against 98 percent of nuclear-accident liability and transfers these risks to the public? All U.S. utilities refused to generate atomic power until the government established this liability limit and they continue to do so. Why do utilities, but not taxpayers, need this nuclear-liability protection?

URANIUM TO WEAPONS

There are two things that pose an overwhelming threat to the planet as we know it – climate change and nuclear weapons. Nuclear war, in which large areas of the globe could be rendered uninhabitable in the space of a few hours or less, remains a distinct possibility unless we get rid of the 23,000 nuclear weapons that exist in nine countries.

What are the links between nuclear power and nuclear weapons? Well, there are many. The same technology that produces nuclear power can be used to produce weapons. To produce a nuclear weapon, the main stumbling block is access to the fuel, the fissile material, which is either enriched uranium or plutonium. Uranium is enriched for nuclear power reactors and plutonium is produced in those reactors. If you doubt the significance of this problem, just think of the concern about Iran's nuclear program. Iran says it's peaceful, the rest of the world is not so sure.

In a world with more and more reactors, the problems of distinguishing which countries can be trusted with nuclear power and which ones cannot will become more frequent. Who will decide? There will be more and more tensions, more and more threatening Security Council resolutions, more and more threats of warfare etc. Even if a government looks responsible right now, what about when the government changes and there is a far less friendly government in place? What do we do about the nuclear reactors and fissile material that are already there? Remember that Iran received its first nuclear reactor, in the 1960s, from the US, when they had a thriving relationship with the Shah of Iran. Politics change but nuclear technology and fissile material remain.

This is highly relevant to Australia, as an exporter of uranium. We are told that safeguards prevent the diversion of our uranium to weapons. Yet the facts are irrefutable and include the following:

- Safeguards rely primarily on book-keeping entries at nuclear facilities. They are simply not capable of detecting the diversion of the very small quantities of fissile material (e.g. 3-4 kgs plutonium) required to make a weapon.
- Safeguards are not even designed to *prevent* diversion of fissile material but simply to detect it after the event.
- Safeguards do not operate during the phase of the nuclear chain which is particularly vulnerable to sabotage or theft – the transport phase.

The export of uranium to China further exemplifies some of these issues. Safeguards do not even apply at the uranium's first port of call when it reaches China – a conversion facility – or at the enrichment plant most likely to process imported uranium, or at China's two fuel fabricating plants. Miraculously, the non-existent safeguards at these facilities will help keep our uranium out of weapons. The risks are magnified by the fact that the same organization, the China National Nuclear Corporation, controls all aspects of the nuclear fuel chain in China, both civilian and military.

Australia has now agreed also to sell uranium to Russia, where the assurance of safeguards is equally illusory. There have been virtually no safeguards inspections at Russian facilities for many years. The Australian Safeguards and Non-Proliferation Office is guilty of spreading misinformation on the subject of safeguards. All this is quite apart from the issue of nuclear waste management in Russia, which is atrocious.

For Australia, the prospect of losing a uranium sale appears to trump *all* other considerations, including that of at least trying to create a nuclear weapons-free world for future generations.

TERRORISM AND NUCLEAR FACILITIES

The issue of nuclear terrorism is a vast one in itself, because nuclear terrorism could take several forms – it could be:

- in the form of the theft of enriched uranium or plutonium to make a nuclear weapon;
- an attack on a nuclear power reactor or waste fuel cooling pond;
- an attack on nuclear fuel or waste containers in transit (when they are most vulnerable); or
- the construction of a "dirty bomb" to disperse radioactivity (and with it, panic).

Reports in both the US and the UK indicate that no reactors have been designed specifically to withstand the impact of a commercial aircraft. An attack on, for example, the Sellafield reprocessing plant, where there are large stores of plutonium, cesium and other isotopes, could release far more radioactivity than that released from Chernobyl. Similarly in the US, it is estimated that a terrorist attack at the Indian Point nuclear power plant on the Hudson River, 25 miles from New York, could cause up to 44,000 short-term deaths, up to 500,000 long-term deaths from cancer, and economic damage somewhere between $1.1 – 2.1 trillion. Documents belonging to Al Qaida, found after the September 11 attacks, showed that they were considering crashing into the spent fuel ponds and reactor at the Indian Point facility.

After September 11 in 2001, there were again renewed calls for greater security against terrorist threats at nuclear power plants, including proposals for the use of National Guard troops to deter attacks from land and water, deployment of advanced anti-aircraft weapons to defeat suicide attacks from the air, strengthened vehicle barriers to protect against truck bomb attack, and a thorough re-vetting of all plant employees and contractors to protect against sabotage from insiders. If a nuclear-powered world is to be as safe as possible, it would have to be an even more security-conscious world.

THE BACK END – NUCLEAR WASTE

The problem of nuclear waste is often presented by the industry as resolved. Nothing could be further from the truth. Not a single country has in place a proven, viable, permanent nuclear-waste management plan.

In the US, soon after coming to office, President Obama ceased the ongoing research into the possible Yucca Mountain high-level waste facility. It will not go ahead. There is now no identified site for high-level waste in the US and, meanwhile, it piles up at facilities around the country. Even if Yucca Mountain had gone ahead, the tens of thousands of tonnes of high-level waste ready to be stored there would have already exceeded its capacity. That's quite apart from the enormous quantities of low and medium-levels of waste.

In the past, eyes have turned to Australia as a possible dumping ground for high-level waste. Currently, eyes in the US and France are turning to Russia as their dump site. In Australia, the parliament has just passed legislation that will impose a low and medium-level nuclear-waste dump on the aboriginal people of Muckaty Station in the NT. Once again, it is aboriginal people who will suffer the effects of radioactive contamination of their land.

Contrary to the statements from Resources Minister Ferguson, the waste dump is not needed to enable medical diagnosis and treatment of cancers and other conditions. That is the only respectable sounding spin that the minister can find to put on this imposition of waste on aboriginal lands. There has been no genuine consultation with the Northern Territory government or people, or those living along the proposed transport routes. There will simply be coercion of those whose concerns are not allayed, with the standard reassurances that the waste is safe.

The issue of community consultation and genuine debate is important. In 2006, Prime Minister Howard, while paying lip service to the need to consider all energy options for Australia, commissioned the Uranium Mining, Processing and Nuclear Energy Review (UMPNER), with a mandate clearly limited to examining only one form of energy production.

The UMPNER review panel was headed by nuclear physicist and, until then, board member of the Australian Nuclear Science and Technology Organization (ANSTO), Ziggy Switkowski. UMPNER's taskforce membership was heavily weighted to produce an outcome favourable to the industry. The panel, while purporting to address health, safety, waste and weapons proliferation concerns, included no health professionals, no environmental experts and no leaders in the field of weapons proliferation. The UMPNER report, predictably, expressed no serious concerns in relation to any of these matters.

Similarly, on the issue of nuclear waste, the report was a whitewash. It makes the false claim that, "Safe disposal of long-lived intermediate and high-level waste can be accomplished with existing technology." This begs the question, if it can be done, why isn't it being done?

ALTERNATIVES

Perhaps the most important thing for us to consider is an area that I am not at all an expert in – renewable energies and energy efficiencies. Therefore, I'm not going to pretend to be an expert but I would urge you all to read a little from those who are expert on the large untapped potential of both using our energy more frugally and wisely, and using the vast energies that the sun, the wind, the earth itself provide for us. One study in particular is worth noting. Dr Mark Diesendorf, of UNSW, states that Australia could reduce carbon emissions by more than 30% below 1990 levels, by 2020, with a mix of renewables, energy efficiencies and greater reliance on natural gas.

When renewables are talked about, however, one often gets the standard response 'yes, but they can't provide baseload", that is, 24-hour, non-stop power. Diesendorf is worth reading on this issue also. He writes:

> "The Base-Load Fallacy is the incorrect notion that renewable energy cannot supply base-load (24-hour) electric power. Alternatives to base-load coal power can be provided by efficient energy use, solar hot water, bioenergy, large-scale wind power,

solar thermal electricity with thermal storage, and geothermal, with gas power playing a transitional role. In particular, large-scale wind power from geographically distributed sites is partially reliable and can be made more so by installing a little additional low-cost, peak-load back-up from gas turbines."

I'm going to close by saying that it's to Australia's great shame that our governments have failed to support ground-breaking research here into harnessing solar, wind and other renewable forms of power and implementing them far more vigorously than they have.