

Submission to the Joint Standing Committee on Treaties on the Agreement between Government of Australia and the Government of India on the Peaceful Uses of Nuclear Energy (Australia-India Nuclear Cooperation Agreement) - January 2015.

I (Tom Bond) support the Australia – India Nuclear Cooperation Agreement because the over whelming priority of all global governments has to be the reduction of fossil carbon emissions to zero by 2070 to reduce the impact of dangerous climate change. Developing countries such as India require large increases in their energy production which if not met by nuclear, will be met by coal. If this occurs it is “game over” and humanity will face an extreme climate change event before the end of this century. Assisting and providing support to nations to develop a civilian nuclear power industry to replace coal energy generation is the most responsible, environmental act that could be conducted by any global Government.

The real tragedy is that Australia with one of the biggest per capita emission rates in the world, has not taken responsibility for our large contribution to global fossil carbon emissions and moved to replacing our 22 large coal burning power stations with nuclear energy generation.

The following data mainly from the IPCC and the United Nations can easily be checked and is provided in more detail to support my statements.

1. The major issue for global humanity is dangerous climate change caused by rising greenhouse gas (GHG) emissions. Today CO<sub>2</sub> atmospheric concentrations are 400ppm, up from 340ppm just 35 years ago and 280ppm 250 years ago. CO<sub>2</sub> is the Earth’s thermostat and it is now switched to “high”, but like a large building it takes time for the climate and the earth systems to adjust to the new “high” setting. Paleoclimate history gives an indication of what is to come, as the last time the CO<sub>2</sub> atmospheric concentration was 400ppm, was 3 million years ago when global temperatures were 2C to 3C higher than today, with sea levels 25 metres higher. It will be very difficult and costly for human civilisation to adjust to a climate change of this magnitude.
2. Emissions are increasing at 2.5% per year and thus the total accumulative emissions since 1765 will double again before 2050. On the “worst case” emissions pathway (RCP 8.5) the IPCC expect atmospheric CO<sub>2</sub> concentration to be above 900ppm by 2100. The last time CO<sub>2</sub> levels were 900 ppm was 50 million years ago when global mean temperatures were 12C higher and sea levels 80 metres higher than today. This is a catastrophic risk to humanity as it will be very difficult for the human species to survive a climate change of this magnitude.
3. The IPCC has clearly stated that to reduce the risk of such dangerous climate change requires a complete transition from fossil carbon energy generation to non fossil carbon energy sources by 2070. Considering that 80% of the world’s energy is currently produced by fossil fuel, a total of 14 billion tonnes, this is an almost impossible task unless every non fossil fuel technology is implemented.
4. Only three non-fossil carbon fuels can provide the dispatchable energy needed to power a developing nation, these are biofuels, hydro and nuclear. Biofuel and hydro resources are limited leaving the heavy lifting to nuclear which can be deployed anywhere. It is of interest that the three developed countries with the lowest GHG emissions are France (80% electricity by nuclear), Switzerland and Sweden (about 50/50 nuclear/hydro).
5. Intermittent renewable energy which is weather dependant can only provide power when the resource is available and requires backup when it is not, which must be then provided by other dispatchable sources such as gas or coal. Thus a country like Germany which has installed a staggering 70GW of wind and solar (capital cost of 200B euros) in just 15 years only obtains 15% of its energy from this vast energy infrastructure. With capacity factors less than 20% and backup using gas and coal generation, GHG emissions have not reduced.

6. Currently 400 nuclear reactors provide 5% of the world's energy needs saving more than 2 billion tonnes of CO<sub>2</sub> annually. The bottom line is only a WW2 type construction program to roll out 16,000 nuclear reactors over the next 40 years globally will enable us to meet the very aggressive emission cuts recommended by the IPCC.

Nuclear suffers a negative image which is not supported by engineering/scientific data and evidence.

1. Nuclear proliferation – more than 30 countries in the world have nuclear reactors and thus (in theory) have the capacity to develop a nuclear weapons program. These countries are responsible for most of the world's GHG emissions and if they all developed a civilian nuclear energy system the risk of nuclear proliferation is unchanged from the current position.
2. Nuclear waste – is often seen as very dangerous by the general community. Yet after more than 40 years of nuclear power generation the world total of high level waste is just 270,000 tonnes from the world's 400 nuclear reactors which produce just 9000 tonnes of high level waste annually. In addition there is another 1.5 million tonnes of relatively safe depleted uranium. Despite the hysterical headlines, the high level waste is less dangerous than most of the toxic waste generated by our civilisation and can be stored safely in underground depositories. Paradoxically the global community/governments generally see dumping 37 billion tonnes of CO<sub>2</sub> into the atmosphere every year as socially acceptable but responsibly capturing and storing underground a very small volume of nuclear waste as unacceptable.
3. 4<sup>th</sup> Generation or fast breeder reactors – depleted uranium and high level nuclear waste still contains 99% of its nuclear energy. Used in fast breeder reactors the world stock pile of nuclear waste could generate the world's energy for a hundred years, reducing its volume and radiation levels 20 fold. The 270,000 tonnes of high level waste will be reduced to just 10,000 tonnes of low level waste only requiring storing underground for about 300 years. There are numerous fast breeder prototypes that have operated since 1951, clocking up 400 reactor years of generating electricity. The next urgent step is to urgently proceed to a commercial demonstration reactor then on to full production. India is a leading country in fast breeder reactor research.
4. Sustainable Nuclear Power – it is often claimed that the world will run out of uranium and thorium. In a fast reactor just a fist size piece of uranium could provide a person's energy needs for their lifetime. The world's oceans contain an unlimited supply of uranium and used in fast reactors it is economic to mine the oceans for this resource giving an unlimited supply of nuclear fuel.
5. Nuclear safety – all energy systems are unsafe but in terms of power produced, nuclear safety is better than most and the same as solar and wind (see Table 1 in Appendix 1 below). The United Nations UNSCEAR reports on Chernobyl and Fukushima show that there were only about 50 deaths from radiation after 25 years from Chernobyl and none are expected from Fukushima. The UNSCEAR report also said that radiation misinformation had generated an irrational fear of dying from low level radiation and this was the biggest adverse health effect to residents who lived near these damaged reactors. Neither Chernobyl or Fukushima are "waste lands" with radiation levels less than natural radiation at a number of sites around the world where communities have lived healthy lives for generations. For example Denver USA, Guarapari Brazil, Ramsar Iran, Yangjiang China and Karunagappally in Kerala, India.

## Appendix A – Table 1 from Key role for nuclear energy in global biodiversity conservation - Barry W. Brook and Corey J. A. Bradshaw

**Table 1.** Per terawatt hour (TWh) data for key sustainability and economic–environmental impact indicators associated with 7 electricity generation options and relative ranks<sup>a</sup> of the energy source.

Indicator (per TWh)	Coal		Natural gas		Nuclear		Biomass		Hydro		Wind (onshore)		Solar (PV)	
	value	rank	value	rank	value	rank	value	rank	value	rank	value	rank	value	rank
GHG emissions (t CO <sub>2</sub> ) <sup>b</sup>	1,001,000	7	469,000	6	16,000	3	18,000	4	4,000	1	12,000	2	46,000	5
Electricity cost (\$US) <sup>c</sup>	100.1	4	65.6	1	108.4	5	111	6	90.3	3	86.6	2	144.3	7
Dispatchability <sup>d</sup>	A	1	A	1	A	1	B	4	B	4	C	6	C	6
Land use (km <sup>2</sup> ) <sup>e</sup>	2.1	3	1.1	2	0.1	1	95	7	50	6	46	5	5.7	4
Safety (fatalities) <sup>f</sup>	161	7	4	5	0.04	1	12	6	1.4	4	0.15	2	0.44	3
Solid waste (t)	58,600	7	NA	1	NA	1	9,170	6	NA	1	NA	1	NA	1
Radiotoxic waste <sup>g</sup>	mid	6	low	3	high	7	low	3	trace	1	trace	1	trace	1
Weighted Rank <sup>h</sup>		6.0		2.0		1.3		6.7		3.3		2.3		5.3

<sup>a</sup>Energy source with the lowest environmental or economic impact for a given indicator (e.g., greenhouse-gas emissions, cost of electricity, etc.) is assigned a rank of 1, whereas the worst performing of the 7 energy sources is assigned a rank of 7. Ties are given the same rank. All calculations and supporting data behind this table are detailed in the Supporting Information.

<sup>b</sup>Includes production-related and life-cycle-embodied emissions.

<sup>c</sup>Levelized cost of electricity, includes cost amortization for long-term waste management and plant decommissioning for nuclear energy.

<sup>d</sup>Categorical rating of capacity and availability to deliver electricity on demand

<sup>e</sup>For fuel mining and generating footprint.

<sup>f</sup>Deaths from accidents, excluding chronic health problems.

<sup>g</sup>Categorical classification of the volume of the radiotoxic waste stream.

<sup>h</sup>Average of 3 multicriteria decision-making analysis scenarios with multiplicative weightings applied to the indicator ranks: (1) no weighting = 1 × multiplier for all ranks; (2) economic rationalist = 1 × land use, solid waste, and radioactive waste, 2 × cost and dispatchability, and 0.5 × greenhouse gas emissions and safety; and (3) environmentalist = 1 × safety, solid waste and radioactive waste, 2 × greenhouse gas emissions and land use, and 0.5 × cost and dispatchability. Weightings are arbitrary but illustrative of typical viewpoints.