

The Promise and the Perils of Nuclear Power

Honorable Chairman, members of the panel, and concerned citizens of Hong Kong, thank you having me over to testify this afternoon.

Before I begin, I would like to establish a few things about my background so that you may understand where I am coming from. While I am a long time Senior Lecturer at The Hong Kong Polytechnic University, I am of course am not here on behalf of the PolyU, a publicly funded institution, but am speaking only as a concerned private citizen.

Background

My background may be particularly useful in enquiring into the situation of Nuclear Power. As an American Boy Scout I was one of the very first ever recipients of the Atomic Energy Merit Badge when it first came out in 1963. After my father, who was a multidisciplinary engineer left the U.S. Army following World War II as a full Colonel, he went to work for the then ultra secret Kellogg Corporation building plutonium production reactors at the Hanford Engineer Works in south central Washington State in support of the effort to build up America's stockpile of nuclear bombs. As he was to put it in later life, "in the days before I knew better". In a real sense, a recurring theme throughout my life has been the question of nuclear technology.

I am a graduate of New York City's Bronx High School of Science. I hold two undergraduate degrees in Chemistry and Physics from Rensselaer Polytechnic Institute in Troy New York, a Masters in Physics from the University of Hawai'i at Manoa and from that same institution a PhD in High Energy Physics. I am not a Nuclear Engineer and it is not details of technological implementation that I would feel comfortable or competent in testify to. However, I have made a career of teaching ecology in Hawai'i, Japan, and for over the past decade in Hong Kong. I can address the basic physics, chemistry, environmental, sociological, psychological, historical, and above all educational issues of nuclear technology. Even more importantly, I can take a systems or ecological view looking at the overall picture asking the question "how appropriate is it for Hong Kong to become even more dependent upon nuclear power than it already is?"

There is great ignorance in the public setting which, given the potential power of nuclear technology, is rather unsettling.

Inability of Hong Kong Government to Think in Systems Terms

For the past decade or so, there has been increasing concern in higher education circles within Hong Kong over what is called "critical thinking", the ability to conceive a situation, identify the bottlenecks and leverage points, and to then solve a problem. My observation in all of that time is that the Hong Kong Government is particularly persistent and consistent in its inability to view problems and challenges of society through an integrated systems framework. There is little in the way of critical thinking. The typical approach is one of viewing the problem through a narrow lens and then attempting to sell the solution to the public. No real effort is made to present alternatives and to encourage open public debate. It is mostly a paternalistic exercise, father knows best and a desire that the children not be too naughty. Education in true public discourse is rather rare around here. My fear is that this second round on nuclear power for Hong Kong will be no different although I am reminded

that Friends of the Earth's campaign last time around in 1983 did result in a very impressive collection of signatures, but I have to ask myself "what does the average 'educated' citizen of Hong Kong really know about the perils and promise of nuclear technology?"

It should be apparent with recent events in Fukushima that "business as usual" just will not cut it. Perhaps it is time for educators such as myself to step into the vacuum.

Perpetual Motion and Limitless Energy

The syllogism of limitless energy goes something like this. All social evils (poverty, famine, disease, ignorance, social instability, crime, etc.) are caused by resource shortages such as limited energy. Thus limitless, or at least inexpensive and available energy, will end all social evils. We yearn for perpetual motion machines.

As a physicist, I can assure you that perpetual motion machines are impossible. They violate the laws of thermodynamics. Historically the U.S. Patent Office was so overloaded with patent applications for perpetual motion machines in the late 19th and early 20th centuries that they finally had to make a rule that none will ever be entertained even with a "working" model.ⁱ

However, the dream does not die easily and after World War II and the nuclear bombing of Japan, the second best thing was invented, the nuclear powered electric generating plant with mottos such as "too cheap to meter".ⁱⁱ

Originally described in the likes of Popular Mechanics before World War II and in the New York Times right after the atomic bombing of Japan, nuclear energy devices would be potentially as small as a walnut or a typewriter.ⁱⁱⁱ In contrast, the reality is that practical nuclear power plants are huge complexes. The word complex is well chosen for they are very complicated devices in which one component, not operating according to intent, can result in a critical failure.

In manufacturing there are three common levels of equipment reliability, consumer, industrial, and military (mil-spec). However the requirements for reliability are so great with nuclear power since, among other things, once you start the plant you cannot get into the core or any primary cooling loop to repair anything for the entire operational life of the plant, that the standards of equipment fabrication and installation have to be way beyond mil-spec. This is a major hint at the problem of nuclear power. In almost every dimension, it is beyond the scale of practical human control.

Tombstone Technology

While no one wants to talk about it, the reality is that much technological progress in modern society comes about through tombstone technology. This has been especially true in times of war where the imperative for rapid development is so great. Even in peacetime, technology and technique advance through accidents. Cars, trucks, and trains crash, ships sink, and planes fall out of the sky. A local steam boiler has a stuck safety valve and it blows up. The plant is destroyed. Workmen die. A cleanup and investigation ensue. Funerals are attended to. Insurance payments are made. Hopefully lessons are learned. Life goes on. This is the normal advancement of technology in our age although few wish to admit it.

The problem is that in practice that is exactly what is happening with nuclear power. It is hard enough to simulate a high-speed rail system, which still may crash. For something as complex as a nuclear power plant and the potential many modes of failure, only some of which may be identified, it is impossible.^{iv} Three-Mile Island, Chernobyl, and Fukushima were all different plant designs. In each case, I am sure, the plant designers were not amateurs having no idea how to go about their business.

The only conclusion that one can draw from such repeated experience is that *accidents will happen*. You just cannot say how, where, and when. And when they do, they have the potential to be a lot worse on every measurable scale than that of a coal fired steam boiler exploding. The air, sea, and, especially for our species, land that is affected is much greater and much longer lasting. The number of people affected both today and tomorrow is much greater. And some radioisotopes, once released into the general environment, will not go away until they decay thousands of years into the future. This is the reason why when it comes to nuclear technologies you keep hearing that all-important word “containment”. Unlike a chemical or biological poison, there is no way to neutralize the effect of a nuclear poison once it is released into the environment.

Overpopulation

One of the things that is obvious if you back away a little and look at the recent pattern of civilization over the past two centuries or even just the past decade is the sense that everything is in a race, that the pace of life is accelerating, that the world is out of control and becoming in time ever more complex (and vulnerable). This is particularly true of technological change. It is a runaway feedback situation snowballing to a less than desirable end.

It is so ubiquitous that most of us in society take it fore granted as “business as usual” that the future will continue to be more of the same. There is a very good question to be answered in “is this what you really want life to be like?” Our self image is that we are free yet most of us live lives of modern slavery caught in the nexus of the technological imperative (having to accept all technology, including nuclear technology, that is thrust upon us without any question) and free form thinking (such as belief in perpetual motion machines and the like not understanding that real science is grounded in a few important “impossibilities”). There is a need for society to be able to select among technological options, not just be forced to live with whatever comes along.

Because we do not select, we often end up not identifying and addressing root problems and our efforts remain superficial. Since they persist, our happiness index does not improve while our sense of alienation runs ever deeper.

The real driving force of the syllogism of social evils is not a deficiency in resources but an ever-growing population, which has now beyond any question crossed the threshold of planetary overpopulation. The World Wide Fund for Nature estimates that 1986 was the first year in which our species on a global level used up more of the Earth’s biocapacity in a year than the Earth is able to replace in that year. Every year, the deficit occurs earlier. By last year Earth Overshoot Day occurred on 21 August 2010.^v This is wholly and completely unsustainable.

Real problems are solved locally (“think globally, act locally” and “all politics is local”). An

ever-increasing population in a polity comes through either a greater than replacement birthrate from within or a net immigration from without. Since Hong Kong has one of the lowest birthrates in the world, 0.9 per adult,^{vi} far below the replacement rate of ~2.1, Hong Kong's ever-increasing population comes from immigration. Actually, this pattern is pretty typical throughout the developed world. You would think that the Hong Kong Government would enjoin the public in a deep dialog concerning this and in time take efforts to make sure that zero population growth (or even negative for a generation or two) would be the norm but it doesn't. It is locked into the mind trap that "bigger is better".

Instead, the Government automatically assumes in its planning that the population of Hong Kong will expand roughly one million souls a decade. With our industry having fled Hong Kong, the main reason to increase the supply of electricity is support for an ever-increasing population, which of course is also the justification for having to build more housing continuing to enslave the average citizen of Hong Kong to the property developers, and so the snowball keeps rolling – the syllogism of perpetual (economic) growth. Oh yes, it was just announced on Bloomberg TV the other day (18 April) that the average price of a flat in Hong Kong is the highest in the world with Hong Kong having pulled ahead of Moscow and London.^{vii} Is this what qualifies Hong Kong to be a world-class city?

There is a double burden involved. While the population of the less developed world continues to expand, the typical citizen of the developed world is very dependent upon resources from the underdeveloped world (and unaware of it). The continued imbalance distorts our view of both the human and non-human communities perpetuating human inequity and injustice and accelerating the degradation of Nature upon which we are all interdependent.

Shortage of Supply or "Longage" of Demand?

Supply and demand are not symmetrical concepts. Supply on a finite planet is inherently limited. Demand, driven by an ever-increasing population is potentially unlimited. You can only limit demand by limiting the number of demanders (or the amount each one demands).

The demanders around here, in large measure due to a very deficient education with respect to nuclear power, probably are interested in only two things. First, price and second, availability. The proponent will add in the legitimate concern of global warming and the claim that nuclear power does not directly contribute to it thus giving the public a warm fuzzy feeling in accepting a nuclear "Reddy Kilowatt".^{viii}

The real situation is more involved than that. The solution is not in asking how to provide more electricity but rather in how to reduce demand. Within crowded Hong Kong, there is a lot of room for doing just that if we only put our mind to it.

To begin with, is there a real need to have all of those electric lights wasting energy every night throughout the city? Many people have dark curtains over their windows just so that they can sleep. If there is an argument that we need to keep them on for the tourists, why not cut back to half or a quarter of what we use today? Or perhaps we can just turn them on Saturday night. The Chief Executive actually had a good idea a year and a half ago when he suggested that we replace incandescent light bulbs with compact fluorescents. We just need to establish a viable recycling plan as the devices wear out. Why do I constantly see students heading off to school on a hot day carrying a sweater because indoors the air conditioning is

turned up too high? What kind of daily lessons in energy use and conservation are we imparting to them?

Before the building craze of the last half-century, buildings in Hong Kong were passively cooled having the high ceilings and overhangs typical of tropical architecture. Somehow the building code should encourage a return to such low energy thinking. Two sources raise the air temperature of the city over the surrounding countryside. First, massive concrete structures absorb the solar load and reradiate it out overnight. Second, while air conditioners cool the interior, as a heat pump they heat the exterior. In principle, one could design a Hong Kong style housing tower in which the solar loaded side is actually a wall of solar water heaters. Thus the building would be cooled while at the same time one of the biggest demands on electric supply would be greatly reduced.

The government, through the UGC, ought to direct research to be done in all of the above areas, as they would have an immediate and long-term benefit to the taxpayer of Hong Kong. The other area of research, which ought to be actively supported, is to join the rest of the world in the pursuit of renewable energy sources (wind, wave, tidal, ocean current, and solar for example). One of the reasons they are more expensive today is because their research and support has not been massively subsidized by governments to a degree anything approaching that of nuclear power. Unlike nuclear or fossil fuel energy, they are sustainable because they are ultimately dependent upon the solar constant.

In this submission, I have already touched upon several important items which are missing and ought to be common in the public education system such as the fact that the world is finite, that demand and supply are not symmetrical concepts, that demand is driven by the human population explosion which is utterly unsustainable, and that there is a profound lack of awareness on the part of the public as to where our material support comes from. I would now like to look at some other fundamental issues in education, which we all need to examine critically in order to survive the 21st century.

Education and the Real Work

Above all, whether you adopt nuclear power or not, you need to educate the public. The recent events with Fukushima Daiichi have revealed great ignorance. Few understand the difference for example between “exposure” and “contamination”. The run on salt to the point that in order to obtain enough non-radioactive iodine that were you to ingest it you would be preserved like a salted fish, points to great anxiety with respect to a poison such as nuclear waste. Since it cannot be seen, tasted, or smelled, this anxiety lies in the depths of the psyche of the average person who either goes through life pretending that there is no problem (“not to worry”) or when an incident occurs reacts in completely irrelevant ways.

The problem with the education system in Hong Kong is that it is almost exclusively focused on the perceived needs of the workplace with little attention or value given to either the individual or society. Science for example is viewed as the handmaiden to technology which in turn is seen as a means to making money and not as the uniquely human adventure through which we can come to know ourselves and the world we all share.

The average school child needs to learn that we have only one world and that it is finite. Our proposed solutions must recognize this and be on a human scale. They also need to learn the basics of nuclear science so that as an adult they can actively participate in meaningful

discussion of the merits and demerits of adopting associated technologies. Adult education along these lines is obviously overdue and warranted.

Science also tells us that we are in the midst of a mass extinction event in which the bulk of life forms become extinct in a geologically short period of time. All five such known prior events happened long before our species evolved, the most recent being 65 million years ago when the dinosaurs were wiped out by an asteroid crashing into the Yucatan peninsula. Unlike the past, the current one is human caused.

Actually that is good news for otherwise we really would be in trouble not being able to do anything about it. If we are the cause it means we are also the solution. This is the “Real Work” towards which all of us, regardless of age, gender, or purported occupational orientation need to be educated towards. Global Warming is a significant and serious contribution towards this problem but nuclear power, with its additional challenges beyond human scale, is not a solution but a source of additional burden.

One of the problems of Nuclear Technology is that for the scientist it is as J. Robert Oppenheimer, the father of the Atomic Bomb put it, “technologically sweet”.^{ix} In other words one continuously finds oneself in the position that as soon as one technically challenging problem is solved another one appears luring you ever onward. Apparently the problem of nuclear waste is more difficult than that of designing a bomb for 66 years past the Trinity detonation it has yet to be solved.

We need to educate both ourselves and future generations in the Real Work.

Conclusion

Dependency upon nuclear power is a trap. My recommendation would be to start a conversation as to how to move away from even our current dependency upon nuclear power and to actively put human energy into helping the world find sustainable alternatives than to look to it for expansion. We have great human capital in Hong Kong. Why are we not making active use of it?

If there were ever to be a Fukushima scale nuclear event at Daya Bay, are we even minimally prepared? How many citizens in Hong Kong know the difference between a Geiger counter and a dosimeter or could interpret the readings? Hopefully many of us have some idea as to how to use a fire extinguisher and again all modern commercial buildings have built-in sprinkler systems and all have internal fire escapes so the average citizen has some idea as to how to cope with the outbreak of fire. But what would we do if there were a cloud of I^{131} and Cs^{137} heading towards Mei Foo? Would the disaster be greater than the fire? Can we devise a simple safety drill for school children to practice (a variation perhaps of “duck and cover”) to deal effectively with a radioactive threat?

At an absolute minimum, even if we do not add more nuclear power to our energy mix, the Hong Kong Government should seriously develop plans, in conjunction with Shenzhen, of how to evacuate its combined citizenry from the megalopolis. If this thought is sobering, then maybe you have some idea as to why nuclear power is not a solution to our problems.

The recent series of events in Fukushima have greatly upset the shipping industry for as was reported recently (25 March) in the New York Times should a container ship even be

suspected of having been contaminated, every port in the world will require it to first drop anchor outside the port for a complete radiological inspection.^x A series of delays like that will place the shipping company at a competitive disadvantage and the smartest thing they could do at that point would be to scrap their perfectly fine ship. Imagine what a Daya Bay incident could do to Hong Kong's shipping industry!

Nuclear power, wherever you find it, is utterly uninsurable. One incident easily bankrupts the insurance company. For that reason, unlike any other electricity source, nuclear power has to be directly supported by the government. It really is not that cheap. The taxpayer pays.

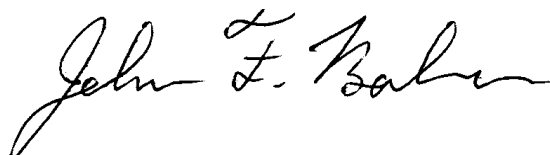
But let us be optimistic and assume that during the 40-year lifetime of such a reactor no such incidents occur. There is one little obstacle yet to be addressed, nuclear waste. Spent fuel, regardless whether it is reprocessed or not, needs to be safeguarded for 10,000 to one million years.^{xi} Should we encourage Hong Kong Scouting to support special units of Boy Scouts and Girl Scouts to inculcate from an early age the ethical responsibility to help safeguard that waste into effective perpetuity?

Since there is no way to neutralize nuclear waste poisons, they have to remain contained and actively safeguarded. So one visualizes a dedicated priesthood, like the Knights Templar of old. Alternatively, perhaps they would be more like the dragon guarding something of no personal value^{xii}, our nuclear waste. Admittedly the mythology is confused but what is clear is that the use of nuclear power in our generation condemns our unborn progeny for many generations into the future to an obligation that few of us would ever be willingly take up. How selfish! And how many human institutions have remained stable for even a few hundred years through human history, which itself is only a few thousand years long?

As I mentioned before, the fundamental problem of nuclear power is that the scale of almost every dimension (space, time, energy, materials standards, construction reliability, ability to anticipate problems, shutdown time, operator reliability, reaction time to cascading problems, etc.) is beyond effective human control. The ultimate failure of the dream is not technological but the reality and limits of the behavior of our own species.

Since I am a teacher, here is your homework assignment. Tonight, when you go home, with the help of your child or grandchild or just by yourself, take up your crayons and draw a picture. Your art assignment is to come up with a sign that unambiguously indicates to the denizens of the year 12,011 AD that they are living next to a nuclear waste dump. What shall we call this masterpiece? How about "Nukes Here, Stay Away" or "Al-Qaeda dig here!"

Thank you for your time.

A handwritten signature in black ink that reads "John F. Babson". The signature is written in a cursive, flowing style.

Dr. John Freeman Babson

29 April 2011

ⁱ Alder, Ken (1986) "The Search for Perpetual Motion." *American Heritage of Invention and Technology*: pp. 58-63

ⁱⁱ Ford, Daniel. (1982) *The Cult of the Atom*. New York: Simon & Schuster, p. 50.

ⁱⁱⁱ Corn, Joseph J. (ed.) (1987) *Imagining Tomorrow*. Cambridge, MA: MIT Press, pp. 60-61. Also see the series of articles by Walter S. Sullivan in the New York Times starting right after the bombing of Hiroshima on 6 August 1945.

^{iv} This was attempted by the U.S. Nuclear Regulatory Commission in the early 1970s only after some 60 nuclear reactors were first built in spite of it being understood from the beginning that nuclear technology is more dangerous than any alternative. Over budget and overdue, the "Rasmussen Report" or "WASH-1400" was 2,400 pages long and ultimately found by the American Physical Society to be wanting. The typical nuclear power plant is way too complex to lend itself to reliable analysis. Sabotage was not even considered. By 1979 the NRC withdrew its support of the report. The answer to the question "how safe is nuclear power?" is probably most honestly answered with "we don't know, we probably won't ever know." See Hardin, Garrett (1992) *Living Within Limits: Ecology, Economic, and Population Taboos*. Oxford: Oxford University Press, Chapter 15, *Nuclear Power*.

^v "Ecological Debt Day" *Wikipedia*. http://en.wikipedia.org/wiki/Earth_Overshoot_Day (retrieved 25 April 2011).

^{vi} "Population and Immigration" *Hong Kong Government Yearbook*. http://www.yearbook.gov.hk/2006/en/20_01.htm (retrieved 25 April 2011).

^{vii} "First Up" *Bloomberg News*. 18 April 2011.

^{viii} Reddy Kilowatt has been the long time cartoon "corporate spokesman" for the electric power industry in the U.S. See "Reddy Kilowatt" *Wikipedia*. http://en.wikipedia.org/wiki/Reddy_Kilowatt (retrieved 25 April 2011).

^{ix} "When you see something that is technically sweet, you go ahead and do it and you argue about what to do about it only after you have had your technical success. That is the way it was with the atomic bomb." J. Robert Oppenheimer.

^x Bradsher, Keith (March 25, 2011) "Global Supply Lines at Risk as Shipping Lines Shun Japan" *New York Times*.

^{xi} The current debate in U.S. courts is whether legal liability for safeguarding nuclear waste extends to *only* 10,000 or one million years into the future. Nuclear technology in all of its dimensions is beyond human scale and thus not controllable given human behavior. The problem is not technological, it is human behavioral. Mining and processing ore, fabricating fuel rods, constructing, running, and decommissioning power plants, storing and reprocessing spent fuel, transporting everything everywhere, and ultimately safeguarding nuclear waste for a thousand generations all require the assistance of fallible human beings. See the Testimony of Robert Meyers, Principal Deputy Assistant Administrator for the Office of Air and Radiation U.S. Environmental Protection Agency before the Subcommittee on Energy and Air Quality Committee on Energy and Commerce U.S. House of Representatives (July 15, 2008).

^{xii} In western mythology, the fire-breathing dragon guarded something useless to itself, such as gold or virgins, but of potential use to humans. Psychologically this is the ego of the hero knight, which needs to be slain by him in order to acquire the prize. That mythological metaphors get so badly confused in the business of safeguarding nuclear waste ought to be a major psychological indicator as to just how crazy this whole idea is!