Roads Not Taken

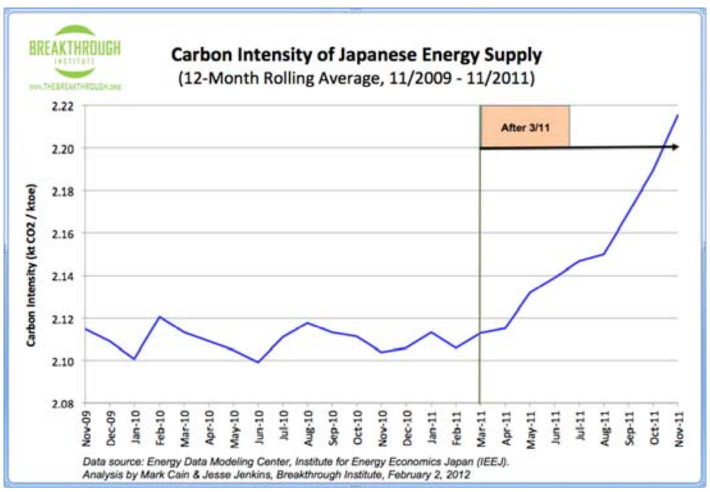
Those who grew up during the years of the Cold War will probably never forget the Cuban Missile Crisis of 1962, a time when two superpowers came perilously close to unleashing all-out nuclear war. Several of John Kennedy's generals were purportedly advising an attack at least on Cuba, if not on Russia itself. Kruschev was likely receiving similarly bellicose advice from some of his advisors. The fact that these two men took the decision to stand down brought the world back from the precipice.

But this harrowing incident was certainly not the only time that those two nations came close to initiating nuclear Armageddon. Yuri Andropov was also reportedly urged at one point by his military advisors to attack the United States, but refused to listen to them. And then there have been close calls caused by malfunctioning early warning systems, sometimes in the USA, sometimes on the other side. The average citizen was blissfully unaware of these near misses, and will likely never know about them except from hearsay or historical reporting many years after the fact.

But there is another nuclear road that was not taken. Ironically, the *failure* to take that road can lead to global catastrophe for both humankind and many of the species with whom we share this planet. This time the problem is not nuclear war but the threat of climate change, and nuclear power can be the solution.

This article is being written on the one-year anniversary of the Tōhoku earthquake and tsunami that devastated communities in northeast Japan in March of 2011. Though nearly 16,000 people were killed in the tsunami and over a million buildings were destroyed or damaged, if one were to ask nearly anyone outside Japan about the Tōhoku earthquake it would likely elicit no recognition. But mention Fukushima and immediately people know which earthquake you're talking about. For the press coverage of the nuclear accident at the Fukushima Daiichi power plant dwarfed the attention paid to the devastation wrought elsewhere by the tsunami.

As a result of this phenomenon, Japan has taken nearly every one of its 54 nuclear power plants offline amid pressure to abandon nuclear power entirely. Since those power plants were supplying about 30% of Japan's electricity, this has dramatically increased the country's carbon emissions as it turned to fossil fuel imports to keep the lights on and the factories running. It has also created Japan's first trade deficit in over thirty years, with an estimated cost of about $100 million per day for additional energy imports.[1]



But the impact of the Fukushima accident (can it truly be termed a "disaster" or "catastrophe" when there was not a single instance of radiation-induced injury to the public?[2]) reached far beyond Japan. Shortly before the accident, Germany had been arguing over whether to decommission their perfectly serviceable nuclear power plants in deference to political pressures from the Greens. Fukushima tipped the scales, consigning Germany to a future of more coal and gas burning and almost certainly more (ironically, often nuclear-generated) electricity from its neighbors. Some other European nations have likewise reacted to Fukushima by foreclosing the option of building any new nuclear power plants.

But the nuclear road not taken that was alluded to above was a far more consequential decision, and one that might without exaggeration be termed a disaster. Like many choices of great import, the decision to abandon a new type of nuclear power system was taken by a few people in key positions. History will not likely judge them kindly, though as in so many cases those who exercised the most influence remain for the most part nameless, unknown to those who were outside the process.

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[1] http://thebreakthrough.org/blog/2012/02/new_data_japanese_fuel_imports.shtml

[2] Even among emergency workers at the plant there were only a few who are expected to have any radiation-induced health risks. One worker died, but it was from a heart attack and had nothing to do with radiation exposure.
http://www.newscientist.com/article/mg21328566.500-dont-compare-fukushima-to-chernobyl.html

The road not taken was the one that would have led to the deployment of the Integral Fast Reactor (IFR). (I wrote about this nuclear power system in an article for this journal that came out shortly after the Fukushima accident.) The IFR had been invented by a group of brilliant scientists and engineers at Argonne National Laboratory who had recognized the need to solve all the problems with nuclear power if it was to become the world's first source of unlimited energy that could be economically and feasibly tapped. They successfully demonstrated a system that could consume nuclear waste, weapons-grade material, and even depleted uranium as fuel. It was designed to be inherently proliferation-resistant, passively safe, and over 150 times more efficient at utilizing the energy from uranium than the type of reactors currently in use around the world.

The author (at left) and colleagues visit the EBR-II shortly before its planned demolition. Dr. Charles Till, the director of the IFR project, is in the middle.

Then in 1994, as the project entered its final phase, the U.S. Congress peremptorily pulled the final funding request for the project that had taken years of dedicated work and billions of dollars. The Experimental Breeder Reactor II (EBR-II), which had operated flawlessly for over thirty years and demonstrated the many virtues of the IFR, was to be shut down and dismantled. Because Japan had offered tens of millions of dollars to help finish off the project, sending that money back across the Pacific meant that it actually cost the U.S. more to shut down the project just short of its goal than it would have cost to finish it. What on earth could have prompted such a short-sighted and self-destructive decision?

Despite years of research into the subject, there has never been (to my knowledge) credible evidence of any sort of conspiracy. It seems—on the surface, at least—that like so many other good things gone bad, the IFR project was the victim of ignorance, misinformation, political self-interest, and abysmal shortsightedness. But if there were no powerful players at work behind the scenes to scuttle the IFR, it would only be because they were ignorant of what the IFR era portended.

The team at Argonne National Lab that developed the IFR expected that the final demonstration phase of the project would be finished by about 1996. Long before the fateful day that Congress pulled its funding, a consortium of major American corporations (including General Electric, Westinghouse, Bechtel and Raytheon, among others) had been working with the scientists and engineers at Argonne to design a commercial-scale version of the reactor, a mass-producible modular reactor dubbed PRISM (Power Reactor Innovative Small Module). The expected progression of events would have seen the first PRISM built by the turn of the millennium, and soon they could have been deployed not only in the United States but around the world.

France had already clearly demonstrated just how quickly a country could convert its electricity infrastructure to nuclear power. In the Seventies that nation's leaders realized the precariousness of relying on fossil fuel imports and decided that nuclear power was a far more stable option. The reactors that they decided to build were relatively primitive compared to today's new designs, requiring much on-site fabrication. Yet in little more than a decade France had replaced nearly all its non-hydro generation with nuclear, without even breaking a sweat. Today France has some of the cleanest air and lowest electricity rates in Europe, and electricity is their fourth largest export.

How much easier would it be if a country were to embark on a similar path with the opportunity to use modular systems that could be mass-produced in factories and shipped to the power plant sites? This is the promise of the PRISM system (and its somewhat larger offspring, the S-PRISM, which will hereinafter be simply referred to as PRISM). In my book *Prescription for the Planet*, I analyze the economic impact that France experienced during their nuclear transition and demonstrate that a developed nation could effect a similar conversion to nuclear power using PRISM systems within about a decade.

This is truly disruptive technology in the most wide-ranging sense. Half a century of nuclear power has left many countries not only with substantial amounts of spent fuel, mischaracterized as “nuclear waste”, but with vastly larger amounts of depleted uranium, the leftovers from the process of uranium enrichment that must be employed to fuel the light-water reactors (LWR) that comprise the vast majority of today’s nuclear power stations. All of this, plus material from decommissioned nuclear weapons, can be used to fuel PRISMs. Not only is the fuel already available, but its cost is less than free, for those in possession of these vast inventories would happily pay to get rid of them. (It should be noted here that there are some superb new LWR designs being built or planned that utilize both passive safety and modular design. The IFR solves the problem of what to do with their spent fuel. Both LWRs and IFRs can be used to speed the transition to nuclear and away from fossil fuels.)

Since PRISM reactors, like other nuclear power plants, operate very well at full power around the clock, imagine the impact on a nation that opts for an all-out conversion to IFRs. Today’s electricity generating systems are sufficient to meet peak demand, fueled mostly by coal and natural gas (except in France and a couple other countries that rely primarily on nuclear and hydro). Now think about what it would imply if those fossil fuel sources were replaced by IFRs. Since the fuel is free they could run at full power all the time. But peak electricity demand is 2-3 times average demand. This means that the system would have an excess of up to twice as much power as what’s needed to provide for the entire grid.

This state of affairs would completely overturn the energy status quo. Liquid fuels could be generated with the excess power in a number of different ways. Hydrogen derived from electrolysis of water could be combined with nitrogen from the air to produce ammonia, which is not only a widely-used fertilizer but can also be used as a liquid fuel for automobiles or trucks. And of course the deployment of electric vehicles would be far more desirable once their electricity wasn’t being generated by dirty coal.

After a decade-long conversion to IFRs, the fossil fuel industries would soon be on their way out. Coal would be first, the direct victim of the conversion. But natural gas and oil wouldn’t have much time left either. And let’s not forget that desalination projects (and the energy to move the freshwater to wherever it’s needed) would be possible on hitherto unimagined scales, enabling semi-arid and even arid regions to bloom.

Had the IFR road been taken in 1994, we would be well along on this path, and greenhouse gas emissions would be diminishing rapidly and on their way to a negligible level. Instead, emissions are rising precipitously, methane is bubbling out of the tundra, and the prospects for a future of severe weather, population dislocation from rising sea levels, and even runaway greenhouse effects threaten our very survival. Even if our politicians decided today to go all-out for an IFR transition, would it be too late to stop the effects of human-caused climate change?

But we’re not even close to such a transition. Politicians are still arguing about whether carbon emissions are even a problem, whether the spectre of climate change is even a real phenomenon. The Department of Energy has decided that the U.S. inventory of almost 800,000 tons of depleted uranium should be converted from its gaseous form into solid so that it can be buried—instead of used as IFR fuel. At the moment, it’s stored in vast storage areas of row upon row of canisters, tucked away where the public takes no notice. This so-called waste, if used to fuel IFRs, would be enough to provide all the energy America needs for hundreds of years. No more mining, no more drilling, no more imports.

May I make a suggestion? As those canisters are emptied, ship them to Washington DC and line them up on the National Mall, between the Capitol building and the Washington Monument. That way when legislators and employees of the Department of Energy are ruminating about where we can possibly obtain all the energy our country needs, they’ll be able to simply look out the window for the answer.

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