Note 1: ***Is Nuclear Power too Dangerous to Tell the Truth About - by Joaquin***
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I mentioned in the original posts that the more exotic fuel cycles create different kinds of waste or spent nuclear fuel (http://tinyurl.com/5udfpqa) that are even more dangerous and have other challenges. Here is a little summary of each of them:

MOX: (http://tinyurl.com/6g9xwvu)is a combination of 93% mined uranium and plutonium (http://tinyurl.com/2sw4zb). MOX cannot presently be safely made from old plutonium in spent fuel rods more than 5 years old because of the presence of Americurium; a gamma emitter. MOX can be run through a LWR like it was at unit 3 of Fukushima Dai-ichi but it can only be used once and not reprocessed because other isotopes of plutonium (http://tinyurl.com/5sfmejl) are created that quench the fission process by absorbing neutrons. The problem with this fuel is the waste contains about as much plutonium, though as different isotopes, as what was originally in the fuel making a long lived (long half life) toxic waste that will stick around for ten's of millennium and is a radioactive poison that accumulates in bone marrow.

> MOX fuel rods used in Japanese Nuclear Reactor present multiple dangers
> http://tinyurl.com/6hmhdwy
> "Goto said that the MOX also has a lower melting point than the other reactor fuels. The Fukushima facility began using MOX fuel in September 2010, becoming the third plant in Japan to do so, according to MOX supplier AREVA."
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> "The U.S. amassed 111.4 kg of plutonium from its nuclear arsenal; all the countries that are reprocessing have amassed 250 kg of plutonium with no place to go. The plutonium that has been used for MOX by the French is a very, very small fraction, and they have discovered that they can only use it once because this spent fuel is so hot and the cost of disposing of this spent fuel goes dramatically up compared to the other stuff. ..The French may be recycling 12 percent. The rest is sailing into burials as de facto radioactive waste. So there are dreams and there are realities. The reality is that this costs a lot of money. It is not working…," Alvarez says.

Reprocessed Uranium (http://tinyurl.com/4n6nrpg) The idea here is to reprocess uranium out of spent fuel because only a small percentage is actually used up before the reactor must be refueled; this has been done and it works. Most of the original uranium is left in all those spent fuel rods! What a bonanza! except for a minor problem. There is a contaminant, uranium 236, which cannot be removed from the reprocessed fuel. Running the reprocessed fuel through a reactor creates new contaminants including more U-236 which decays to neptunium 237 which is a contaminant that is feared could outlast any storage facility; even Yucca Mountain. Also, we get U-232 which emits gamma radiation making the spent fuel very unhealthy to handle.

Reprocessing: The Mythical Silver Bullet
http://tinyurl.com/6k86d52
The evidence is clear: reprocessing nuclear waste will not alleviate the need for a geologic (Yucca Mountain-type) repository for nuclear waste. Reprocessing creates a larger volume of nuclear waste because it dilutes radioactive materials; it does not make them disappear. In an analysis of nuclear power, an MIT study that supports the development of new nuclear power plants concluded that, "the incremental costs and short-term safety and environmental risks of reprocessing would have to be greatly reduced in order for reprocessing to become the preferred nuclear waste management solution."[1]

For more on reprocessing, click below:

- How it works (http://tinyurl.com/4vst2p5)
- Case Study: Sellafield in Great Britain (http://tinyurl.com/4w8n5h3)
- What is the Global Nuclear Energy Partnership (GNEP)? http://tinyurl.com/4ade2d4
- Security Risks (http://tinyurl.com/4py92wj
- Economics (http://tinyurl.com/4vkxcst)

Thorium (http://tinyurl.com/cwqkwd) Thorium could theoretically be used to fuel future reactors but probably nothing like what we have now; they would be cooled with liquid salt. The advantage is the Thorium is much more naturally abundant that Uranium. Another potential bonanza! Except of course for a few minor problems: it doesn't work yet, and it creates a contaminant that is a gamma ray emitter U 232 which decays into many more alpha and beta emitters making the spent fuel very difficult to handle and very toxic for hundreds of years.

Thorium Fuel: No Panacea for Nuclear Power
http://tinyurl.com/4wzopba
If the spent fuel is not reprocessed, thorium 232 is very long lived (half life:14 billion years) and its decay products will build up over time in the spent fuel. This will make the spent fuel quite radiotoxic, in addition to all the fission products in it. It should also be noted that inhalation of a unit of radioactivity of thorium 232 or thorium 228 (which is also present as a decay product of thorium 232) produces a far higher dose, especially to certain organs, than the inhalation of uranium containing the same amount of radioactivity. For instance, the bone surface dose from breathing an amount (mass) of insoluble thorium is about 200 times that of breathing the same mass of uranium.

Breeder/fast neutron reactors (http://tinyurl.com/45bgz7v) Oh the *Dream Machine* of the nuclear industry, these babies could take all the icky spent fuel stuff that we've been worried about here and transmute it into cotton candy, er I mean nuclear fuel - plutonium. We already noted the problems with using this stuff as fuel but oh well. Ignoring the Plutonium aspect of such a machine, it is actually hard to evaluate the dangers and benefits because no one has built such a reactor that actually works like it was designed

to and the industry has yet to produce a prototype but hey, it's a *dream*. The current designs have the minor problem that they are cooled with Sodium, which catches on fire if it is exposed to air or water but future designs might use molten Salt with Graphite. Graphite was the problem with Chernobyl. The Russians are experimenting with a lead/bismuth cooled design but there is only enough bismuth in the world to create a handful of these reactors and they are relatively small >100 MW and it is hard to know much about its disadvantages at this point.

> History and status of fast breeder reactor programs worldwide
> http://tinyurl.com/4qkaox8
> The report notes that "fast breeder" reactors already have been the focus of more than $50 billion in development spending, including more than $10 billion each by the U.S., Japan and Russia. Yet, the report further notes, none of these efforts has produced a reactor that is anywhere near economically competitive with light-water reactors ... After six decades and the expenditure of the equivalent of tens of billions of dollars, the promise of breeder reactors remains largely unfulfilled and efforts to commercialize them have been steadily cut back in most countries. The reactors have been plagued by high costs, often multi-year downtime for repairs, multiple safety problems, and unresolved proliferation risks.