The Evil Twins: Proliferation and High Energy Prices

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Proliferation and high energy prices go hand in hand. Why? We are running out of oil… Greenhouse gas emissions are increasing… Hurricanes, global warming, relentless oil price increases soon to pass $100/Bbl, air pollution…are pushing many countries to build new nuclear power plants. Nuclear power plants do not emit greenhouse gases, or acid rain producing sulfur emissions, and provide the only practical way to get cheap Hydrogen for future clean cars.

Whether we like it or not, currently, there are 23 plants under construction, 39 planned, and 73 proposed, for a total of 135 plants, all outside US and US control, and potentially producing about 70000kg of Plutonium a year, good for 10000 to 18000 nuclear explosive bombs! It is this Plutonium we should worry about, before we have a Hiroshima in Manhattan (or London, Moscow, Tokyo, Rome, take your pick).

The potential nuclear power plant suppliers are British, French, Russian or South African companies, not exactly under the thumb of US. Now is the time to develop and enforce proliferation-resistant technology, procedures, and international agreement, before things get out of hand.

The Relentless Rise in Oil Prices and Nuclear Power Resurgence

The world is consuming about 225 million oil equivalent barrels (MOEB) every day. In US alone, we are using 20 million barrels of crude oil daily. In less than two years, the price of crude oil trebled, to about $70/Bbl. In 2005, the US will spend $61 billion more on imported oil than last year.

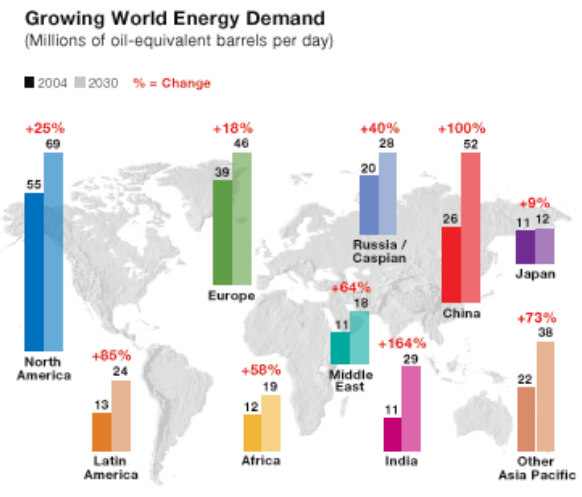

Fig. 1: Projected MOEB Consumption 2004-2030 [1]

Why? Because of oil consumption, particularly in China and India soared while replacement rate of oil produced lagged by about 5%.

Oil supply models predict a peak around 2016, give or take 10-20 years, followed by a steep production decline, guaranteeing oil prices exceeding $100/Bbl. Short of "Oil Wars", many countries won't have a choice but to find reliable, reasonably controlled-cost alternatives.

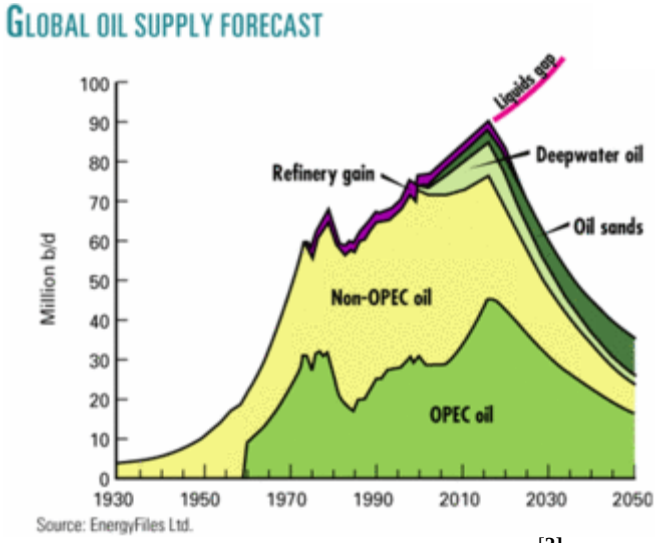

Fig.2: Peak Oil Production Model [2]

This is where nuclear fission power comes in: it is clean (no carbon dioxide "greenhouse gas" emissions, or sulfur dioxide, nitrous oxides, or volatile organic compounds)., and the high temperatures are ideal for economical production of Hydrogen for en eventual clean "Hydrogen economy"…

Nuclear Power for Clean Energy and Predictable Costs

In US and Western Europe, the public associates nuclear power with huge costs, Three Miles Island, Chernobyl, and Hiroshima, and fanned by the news media, an ignorant, "not in my back yard" attitude.

Currently available technology addresses most of these issues:

- Lower, predictable costs through the use of mass-produced, standardized, modular, 200-300 MW power plants using "off-the-shelf" components. For larger outputs, stack a number of the modules…
- Inherently safe reactor designs, such as the "Pebble Bed" high temperature gas cooled reactor
- "Pebble" type fuel that is more resistant to proliferation because it contains less fissionable material, and the layers of graphite and protective makes its extraction much more difficult by a would-be terrorist

However, the existing 440 nuclear plants and the 23 under construction[3] are the "conventional LWR" type technology, which while safer than Chernobyl-type designs, still suffers from the high, unpredictable costs, and still produce about 250kg/year of Plutonium for each 1000MWe.

Recommendations for Proliferation Resistance

Each nuclear fission reactor produces Plutonium, at about 200g/day/MW for a LWR. This Plutonium can be chemically extracted, and the metal can be used to make a fission explosive.

A low-tech cylindrical Plutonium pipe implosion fission explosive can be made with about 4 kg of power reactor grade Plutonium and "Radio Shack" components, fitting inside a 2 liter Coke bottle. The higher the Pu_{240} content and spontaneous neutron emission, the simpler the device, since these neutrons alleviate the need for an initiator[4]

Fig. 3: W-48 155-millimeter Nuclear Artillery Shell Mock-up [5]

Why the concern with Plutonium, and not enriched Uranium?

- The Plutonium critical mass is about one third of Uranium U235, or about 16 kg vs.50kg, which is lowered further through the use of a reflector…so it's relatively easier to get 4 kg than 15-20 kg…
- Plutonium has higher explosivity than Uranium U235 (higher $k\infty$); even a "fizzle" is more powerful
- Spontaneous fission from Pu_{240} alleviates the need for a neutron initiator

So, how do we address the issue of the spent fuel reprocessing; and potential for proliferation?

1. Set and enforce updated fuel reprocessing engineering standards and basic practices for design, construction, start up, operation, safeguarding, and decommissioning
2. Conclude international cooperation agreements subject to UN /international community sanctions with teeth (economic, political, military)

Some of the issues to consider are common-sense:

- Locate plants: away from population centers (400 to 500 km), with enough area to accommodate a cluster of plants sharing common facilities
- Locate plant reactor module underground (practical for a small pebble-type reactor) for additional containment of accidental radiation or particulate matter releases
- Keep spent fuel in "cooling pools"; the material is too "deadly-hot" to steal
- Consolidate reprocessing facilities in remote locations to make them more defensible, and avoid contamination in case of accidents
- All nuclear power plants providers should require return of the spent fuel to the seller

Conclusions

The short term solution to the relentless rise in oil prices and increased global warming is the revival of nuclear fission power. Many countries in Asia are already proceeding on this path, and others are considering embarking on a similar path. This opens up the "Achilles Heel" of cheap, plentiful Plutonium, and this is what we should worry about, not explosive design, which is rather trivial and all over the internet [6].

It is the US national interest to prevent proliferation to a terrorist group. Countries with a weak political and social infrastructure are unstable and vulnerable to terrorists obtaining access to nuclear power plant facilities. Obviously, unless these countries buy "old" US technology, the US will not have a say on the ultimate proliferation potential of such plants, and weapons diversion can be concealed readily as demonstrated by India, Pakistan, Iran, Libya and DPRK, .

The recommendations are straight forward common sense, not pushing any technology envelopes, but political ones. They should be implemented in a timely fashion.

References

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