The Economics of Separating and Using Plutonium

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As you know, the United States believes that the separation and use of plutonium in civilian reactor fuels poses serious nonproliferation risks and international security problems. These include providing adequate safeguards and physical security to deter and prevent diversion or theft of plutonium. Even if adequate safeguards and physical security were provided—which is not the case today—the existence of plutonium stockpiles in non-nuclear-weapon states might be a constant source of concern and instability. The acquisition of fissile material is the most significant barrier to the acquisition of nuclear weapons, and access to civilian plutonium—which can be used to make reliable nuclear weapons—could shorten by many years the time required for a country or group to assemble a nuclear weapon.

In view of these security risks, we should avoid separating and using plutonium unless there are a compelling reasons to do so—reasons that outweigh the security risks.

The most basic argument of proponents of plutonium use is that uranium resources are limited, and that light-water reactors operating on a once-through cycle use uranium very inefficiently. In order for nuclear energy to supply a significant fraction of future world energy supply, it is argued, we must make more efficient use of uranium—by using plutonium that is bred from uranium in light-water or fast-breeder reactors. In other words, as the use of nuclear power grows, uranium will become increasingly scarce, driving up the price of uranium to the point where plutonium fuel is cheaper than uranium fuel.

In response to this argument, I would like to make the following points:

First, today the cost of uranium is a tiny fraction of the cost of nuclear-generated electricity. At the current spot price of $25 per kilogram, natural uranium adds about half a mill to the cost of electricity, or about 1 percent. The cost of nuclear electricity is therefore very insensitive to increases in the price of uranium. If the cost of uranium increased ten-fold, to $250 per kilogram, the cost electricity would increase by only 10 percent. (LEU cost-of-electricity slide)

Second, the use of plutonium fuels—in light-water or breeder reactors—is very expensive. Even under very optimistic assumptions about the cost of reprocessing and MOX fuel fabrication, the use of plutonium does not become economical under the price of uranium rises above $250 per kilogram. Under more reasonable assumptions, the breakeven price is $500 per kilogram. (LEU v. MOX slides)

Third, the price of uranium is unlikely to rise to levels that would make the use of plutonium fuel economical for a very long time, if ever.

- First, use nuclear power may not grow very rapidly. Current projections by the U.S. Department of Energy show only modest growth in the worldwide production of nuclear energy, even in the most optimistic case. Without substantial and sustained growth, uranium will remain cheap and plentiful for centuries. (EIA projection slide)

- Second, even if there is substantial growth, terrestrial uranium resources may be more plentiful than is now thought. There are been very little exploration for uranium in last fifteen years, mostly because uranium has been so cheap. (Price v. exploration slide)

- Third, it may already be possible to extract uranium from seawater at less than $250 per kilogram. John Holdren and I heard a presentation in Tokyo on this a few days from a researcher at the Japan Atomic Energy Research Institute. Using a technique that has been verified experimentally, he projected an extraction cost of $100 per kilogram of uranium. If, in addition, credit was taken for other metals extracted in the process—vanadium, titanium, and cobalt—the price could be even lower. The oceans contain nearly 5 billion tons of uranium—200 times than are thought to exist in high-grade uranium ores. (Seawater uranium slides)

- Finally, even if there is substantial and sustained growth in nuclear energy, and even if terrestrial uranium resources remain limited and seawater uranium cannot be extracted at reasonable prices, plutonium fuels will not be economically attractive for at least 50 years. (OECD scenario slides)

In conclusion, the separation and use of plutonium creates serious security risks is not economically justified, both today and for the foreseeable future. If nuclear power does not grow or if uranium can be extracted from seawater, plutonium may never be an economical reactor fuel. Countries should do research directed toward minimizing the risks of using plutonium, but it is premature to close the fuel cycle by building and operating reprocessing plants.