Nuclear Fuel Future

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Price volatility is not something that most people would associate with nuclear fuel, after more than twenty years of low, stable, and even decreasing nuclear fuel costs. Nuclear Energy Institute (NEI) data shows that nuclear fuel costs declined through the end of 2006 to $0.46 per kWh (see Fig. 1).

However, spot prices for uranium, the largest component of nuclear fuel costs, increased from less than $20 a pound in mid-2004 to an all-time high (even when adjusted for inflation) of $138 per pound in mid-2007 (see Fig. 2).

This inconsistency between reported nuclear fuel costs and uranium prices is the result of nuclear fuel purchasing and accounting practices that create a several-year lag between when nuclear fuel costs are incurred and when these costs are amortized.

This lag between component prices and reported costs is not a problem in itself but may lead to nuclear fuel cost forecasts that are too low in today's nuclear fuel market.

Nuclear fuel cost projections typically consist of current reported costs that are escalated at the rate of inflation. These projections usually consist of a single estimate in each year (i.e., they don't consider multiple scenarios). In the past, when nuclear fuel costs were low and declining, this approach was acceptable and may have even been conservative. But this approach is likely to understate projected nuclear fuel cost when nuclear fuel costs are increasing. The use of a single forecast rather than scenarios may not reflect the uncertainty and volatility in future nuclear fuel prices. This can lead to inappropriate financial decisions. In the natural gas industry, for example, reliance on forecasts that extended historical price levels led to significant over-investment in gas-fired combined cycle power plants before the natural gas markets changed in 2000.

Projections of nuclear fuel costs should, like natural gas and other fossil fuels, include price scenarios that reflect a full range of possible nuclear fuel prices.

Nuclear fuel amortization

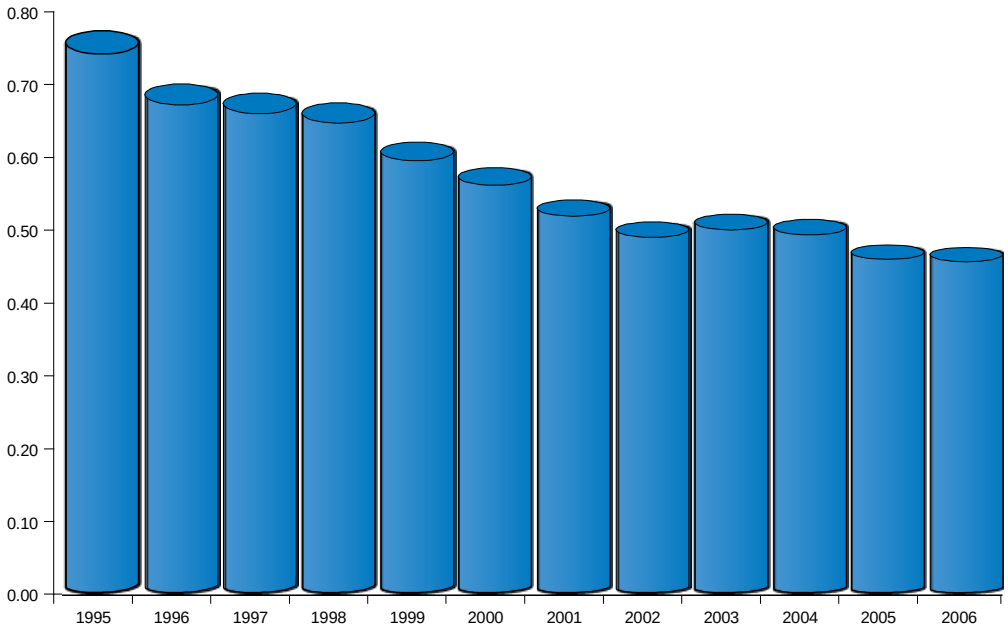
Nuclear fuel costs are incurred years before fuel is fabricated and loaded and usually are capitalized then amortized over projected plant output after the fuel is loaded in the core. This approach to accounting for nuclear fuel was developed as a mechanism for the recovery of nuclear fuel costs in regulated utility rates.

The price of uranium and other components of nuclear fuel may reflect prices that are three or more years in the past. This lag may be even longer if purchases are made under long-term contracts with pricing that is not tightly linked to current spot prices.

Frequently, amortized nuclear fuel costs are often compared to the fuel cost of coal – or gas-fired units even though nuclear fuel costs are not marginal generation costs. Instead, nuclear fuel costs are fixed costs.

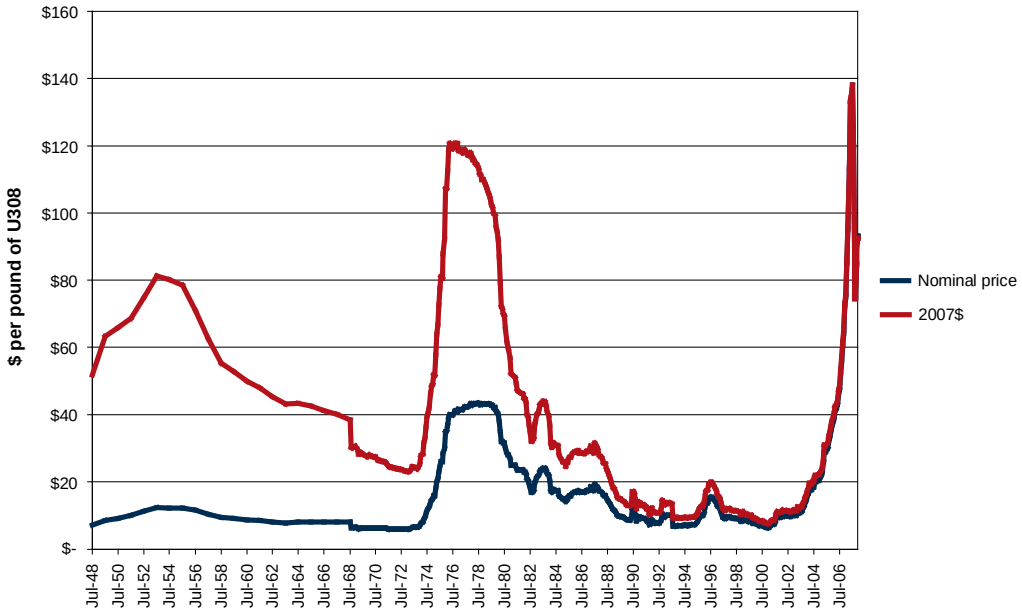
The historical decline in reported US nuclear fuel cost shown in Fig. 1 is the result of two factors: low historical costs for nuclear fuel (i.e., prior to recent price increases) and higher capacity factors. But in the future, market trends are expected to result in higher and more volatile nuclear fuel costs. [1]

Figure 1: US nuclear fuel cost



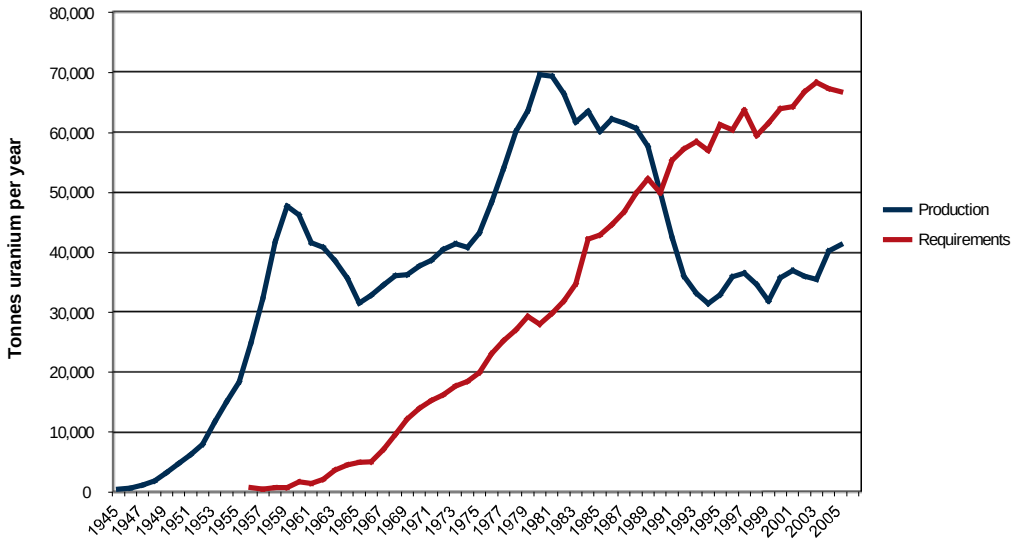
Global demand for nuclear fuel has grown as existing plants have undergone uprates to increase capacity and have had (or will have) plant-life extensions. This demand is expected to grow even more as a new wave of nuclear plants is built and placed into operation. While new nuclear plants will not be placed in operation until after 2016 in the United States, new nuclear plant development in Russia, China, Japan, and other countries will drive demand for nuclear fuel before then.

Figure 2: Uranium spot prices



Excess uranium production for much of the last 20 years led to low nuclear fuel costs but also led to chronic underinvestment in uranium mines. The nuclear industry has been using stockpiles of uranium built up prior to 1990 with production of uranium only at about 60 percent of demand in 2006 (see Fig. 3). The prices for other nuclear fuel components, including enrichment, conversion and fabrication, have also increased.

Figure 3: World uranium supply and demand



At some point, new uranium mines and new enrichment facilities will be needed to meet growing demand for uranium and enrichment services. The development of these new mines and enrichment facilities will take some time and will require significant capital investment. This

investment will only occur if prices for uranium and enrichment are at or above long-run marginal cost, well above the costs over the last 20 years. Additionally, such investments may depend on long-term contracts that assure a buyer for the mined uranium.

Prices for uranium and other nuclear-fuel-cycle components likely will increase as excess supplies are depleted and the markets reach supply and demand equilibrium. The uranium spot market spike in 2007 is an early indicator of this new market dynamic.

It is also possible that nuclear fuel markets will reach equilibrium and return to relatively low and stable prices soon (as predicted in some projections for nuclear fuel cost).

It is this uncertainty about future nuclear fuel prices that makes it important to develop robust nuclear fuel cost scenarios.

Projecting nuclear fuel costs

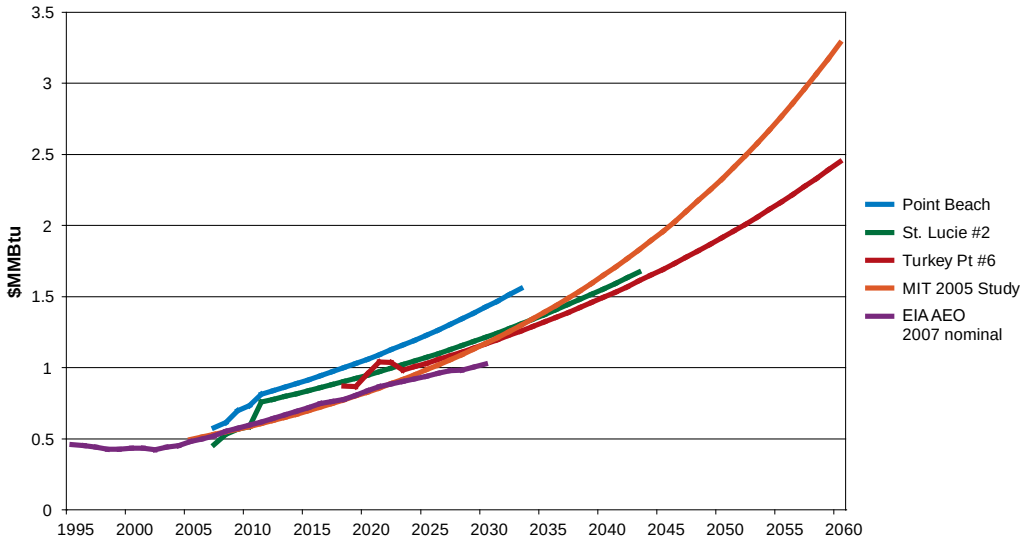
The typical approach to forecasting nuclear fuel costs involves using prices related to historical nuclear fuel costs, with near-term projections based on existing contracts, followed by escalation at inflation. Examples from publicly available documents and filings illustrate this approach (see Fig. 4). Specifically:

- A 2003 MIT study on the future of nuclear power[2] assumed nuclear fuel costs were at $0.47 (in 2005 dollars) per MMBtu in 2005 and then escalated at 3.5 percent per year thereafter.
- In the Wisconsin Public Service Commission hearing on the sale of the Point Beach nuclear plant, testimony was filed that used 5 years of detailed forecasts (based on contracts) then escalated the last year of this detailed forecast by 3 percent.[3]
- In the Florida Power & Light Determination of Need filing for new nuclear units at Turkey Point, Appendix E provided nuclear fuel cost projections for existing FP&L nuclear units and the new units.[4] Forecasts for existing units used a detailed forecast until 2011, with the 2011 nuclear fuel cost escalated at 2.5 percent each year thereafter (projections for St. Lucie #2 are shown in Fig. 4). Forecasts for the new Turkey Point units escalated the nuclear fuel costs at 2.5 percent a year.
- The EIA Annual Energy Outlook for 2007 also includes nuclear fuel cost projections in $2005. These real projections have been converted into nominal dollars using the EIA AEO reference case inflation rate of 2.03 percent.[5]
- These projections generally assume that nuclear fuel markets will return to equilibrium (and low and stable prices) by about 2011, after which nuclear fuel costs will generally go up at inflation.
- While the FP&L Determination of Need filing includes scenarios for uranium, conversion and enrichment costs, only the reference case for nuclear fuel seems to be used in the overall analysis.

The electricity industry consistently has moved toward using fuel price scenarios for natural gas, fuel oil, and even coal, reflecting the history of volatile prices for fossil fuels. Incorporating nuclear fuel cost uncertainty through the use of nuclear fuel scenarios may be a low priority

because new nuclear plants face other large uncertainties (e.g., initial cost, licensing, schedule, financing, and regulatory treatment).

Figure 4: Examples of nuclear fuel cost projections



However, the impact of higher nuclear fuel cost on overall project economics over a 60-year operating life can be significant.

For example, if nuclear fuel were priced at current spot prices, nuclear fuel cost might be as high as $1 per MMBtu, a level that is almost twice the 2007 cost in all the projections discussed above. An increase of 50 cents per MMBtu (about $5 per MWh) would mean about an increase of more than $50 million per year in fixed nuclear fuel costs for a new large nuclear plant.

Most new US nuclear plants have yet to enter into nuclear fuel contracts as procurement of initial core loads for these new plants will not happen for several years. Typically, a new nuclear plant sponsor may wait to procure the initial core load until a firm decision on investment has been made and construction has started, with this happening at about the same time that the NRC combined construction and operating license (COL) is approved. This means that the economic analyses of these new power plants will mostly use nuclear fuel cost projections that are not based on contracts.

However, resource planning and investment decision-making is taking place now. We should reflect the uncertainty in nuclear fuel costs in the same way that uncertainties in fossil-fuel-projections reflect uncertainties—using multiple scenarios.

By the time that 2007 increases in uranium spot prices appear in reported nuclear fuel costs and are incorporated into the traditional approach to nuclear fuel-cost projections, some decisions about new nuclear plant investments may have been made already.

Scenarios for nuclear fuel cost should include realistic high and low cases for nuclear fuel. The high case should be much higher than traditional projections with low cases at about the same level as traditional projections.

A full range of fuel price scenarios will be useful in resource planning for regulated utilities or for investment decision making for merchant plants.

The use of scenarios may show that nuclear plant economics are acceptable across all nuclear fuel price scenarios. However, high fuel price scenarios may mean that new nuclear plants will need to undertake some additional efforts to manage future fuel costs. In some cases, it may even mean that the nuclear plant investment should be reconsidered.

In either case, knowledge about the potential impact of nuclear fuel costs will inform the significant investment decisions that are now being considered.

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ENDNOTES

[1] "Nuclear Fuel: A New Market Dynamic." Edward Kee. *The Electricity Journal*, Vol 20, No. 10, December 2007, pp 54–64 (http://dx.doi.org/10.1016/j.tej.2007.10.009).

[2] "The Future of Nuclear Power, An Interdisciplinary MIT Study." Massachusetts Institute of Technology, 2003 (http://web.mit.edu/nuclearpower/).

[3] Public Service Commission of Wisconsin Docket No. 6630-EI-113, Exhibit JAS/DAW-1, p. 13.

[4] Florida Public Service Commission, Docket No. 07 0650-EI, Florida Power & Light Co., Appendix E.

[5] "Annual Energy Outlook 2007 with Projections to 2030." Figure 65, Energy Information Administration, (http://www.eia.doe.gov/oiaf/aeo/graphic_data.html).