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Seven Myths of the Nuclear Renaissance

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Thirty years ago, my now-deceased colleague David Comey was asked to make a presentation before the annual meeting of the Atomic Industrial Forum, then the major trade association backing expansion of nuclear power worldwide. He was asked to deliver that speech because he had built credibility with the press and with key decision makers by being scrupulously careful with his facts and analyses. The industry understood that its reputation – particularly with the media – was poor, and they wanted to understand how David had received such good results. In Comey's view, there was an easy explanation - the nuclear industry regularly exaggerated and misled.

In the intervening years, not much has changed; the industry still seems to prefer the veneer of a splashy argument to a defensible case. Popular articles in the press, some opinion leaders and politicians, and even some environmentalists have bought the myth of a nuclear renaissance. I have not; you should not, and your job is to put this myth in its place. The Power Point slides will fly by quickly, and I do not intend to read them. All of you can do that at your leisure, and ask questions afterwards or tomorrow.

(Slide two) Of the seven myths I plan to talk about, the one that is most irritating to my ear is that nuclear power is cheap. Existing plants may be, but new ones are not, despite a number of often-cited studies claiming the opposite. (Slide three.) If you look closely at these studies, you find that, with the exception of the MIT study, they are vendor projections, reference each other, and are wildly optimistic with respect to construction time, capital cost, regulatory support, and many other factors. As you'll see later on, these aren't so much assumptions as a wish list. Reactors are approved based on what government think they will cost when finished – in the interim, the industry wants valuable commitments of scarce public funds. Nuclear power is therefore like a fat kid at the front of the line, insisting to be fed before anyone else, and promising in exchange to grow into another Schwarzenegger. His appetite and promises haven't changed in twenty years, and governments would be wise to stop feeding him.

(Slide four.) The last time the United States tried to build a number of reactors, costs rose spectacularly, particularly for those plants built during the inflation plagued 1980s. (Slide five.) Whether built in the early or later years, US nuclear reactors – on average - exceeded their original construction budgets by factors of between 2-4.

So where are we today with respect to construction costs – after a period of relative stability? (Slide six.) We have seen a steep rise in costs, mainly driven by steel, concrete, and other raw materials – averaging 4 percent above inflation since 2002. (Slide seven.) If you compare the recent slope to that of the 1980s, it is steeper. To get a grasp on the cost of new reactors, we have to toss out the paper studies and begin with real data (slide eight) – average the cost of eight recent Asian plants completed before the recent run-up in materials costs, escalate those costs at recent rates, and we end up at 11 cents/kWh in the US or about 4-5 times more expensive than a December 2005 study by the World Nuclear Association, and substantially higher than for wind energy or energy efficiency investments. One might expect the World Nuclear Association to amend their recent study or drop it from the website, much like a department store running an 80% off sale stops advertising when it runs out of inventory. Instead it ranks prominently.

(Slide nine.) The industry says, "give us a chance. Trust us. There's a lot we've learned, and we'll learn more if we build lots of new plants." That's not the way it worked before, and two decades ago, in the US, we had 400 nuclear suppliers and 900 holders of N-stamp certificates from the American Society of Mechanical Engineers. Today we have 80 suppliers and 200 N-stamp holders. Only two companies in the world can do heavy forgings – Japan Steel and Creusot Forge in France for pressure vessels, steam generators, and pressurizers. We also have 6 year lead-times for reactor cooling pumps, diesel generators, and control and instrumentation equipment, plus inexperienced contractors and skilled laborers. All translate into pinch points throughout the supply chain.

(Slide ten.) While the industry talks about a renaissance, it will have a very difficult time simply keeping pace with planned retirements – eight new plants per year in this decade and twenty new ones per year in the following decade. (Slide eleven.) Of course, governments can try to subsidize new reactors, as the US did with multi-billion dollar promises in the Energy Policy Act of 2005. The dollar contributions from the US taxpayer are far from trivial, but the effects are; the Energy Information Administration sees a US nuclear industry in 2030 barely larger than the one that exists today. And it will take truly heroic efforts to solve the fuel problem.

(Slide twelve.) Current uranium consumption in existing reactors is about 60% higher than uranium production, and one wonders how that can be. The answer is that current fuel supplies are supplemented by finite, but inexpensive inventories from cancelled and shutdown plants, and Russian and US government inventories – all driving prices down and mines and enrichment plants out of business since the late 1980s. These inventories will go away, and many are problematic.

(Slide thirteen.) Today, utilities have long term contracts for uranium and enrichment, typically with price ceilings. These contracts fall off substantially in the next two years and most are over in five years. With price ceilings in contracts and a relatively small spot market, mining companies aren't raking in huge profits or expanding rapidly. The same holds true for enrichment companies. Meanwhile, the spot market uranium prices have soared – nine times higher today than five years ago, doubling in the last four months. (Slide fourteen.) This presentation was from October 2006 – today's price ($85) is not just off the chart, but off the slide.

(Slide fifteen.) This is a complicated, but important slide and I won't spend much time with it. It and the following are from a recent presentation by Tom Neff, a professor at the Massachusetts Institute of Technology. The little box in the left corner shows existing uranium and enrichment capacity. The larger box to the right shows what's currently planned in both. We couldn't meet today's needs with the output of current and planned mines and enrichment facilities, and the green curves describe what's needed in both uranium and enrichment to support reactors in existence in 2015 and beyond. To some extent uranium and enrichment can substitute for each other; by operating the enrichment facilities with less uranium wasted in the tails, uranium requirements are decreased but enriched uranium production declines by about 25%.

Utilities will soon have to enter that market, and it will not be a friendly one, as the mines, mills, and enrichment plants needed to deliver these products and services do not exist today. We hear, meanwhile, that nuclear fuel is cheap, but that is only one side of the coin. The other side of the coin tells us that there are no substitutes and no price elasticity - a nuclear operator would pay almost any price to avoid shutting down. (Slide sixteen.) I agree with Neff that heroic measures will be needed merely to meet near term demand, prices for both products will rise – perhaps spectacularly. Miners and enrichers have monopoly pricing power in this situation, and it would be a mistake to think they won't use it.

(Slide seventeen.) The historical answer to high uranium prices has been chemical reprocessing of nuclear fuel, to extract unburned uranium 235 and plutonium 239 that can be used in existing reactors as a substitute for natural uranium. But reprocessing capacity is limited and the cost is enormous. So too is the cost of fabricating this type of fuel. Moreover, most current reactors cannot use a full core of reprocessed fuel without physical modification. (Slide eighteen.) In the best possible case, without reprocessing, there are no physical shortages, but fuel prices treble. With reprocessing, it takes no magic to calculate a septupling. One might expect parts of the nuclear industry – especially the utility operators – to recoil at such numbers. A three-fold fuel price increase for plants trying to survive in a more competitive wholesale market may be unavoidable and painful, but a seven-fold increase could be fatal. Instead we hear silence.

(Slide nineteen.) Capital cost and fuel supply are major challenging facing the industry, but so too is the waste problem. We easily forget the awful legacy on the front end of the fuel cycle – uranium mill tailings contain 85 percent of the radioactivity of the original ore body (thorium, radium, and radon gas) plus selenium, arsenic, vanadium, and lead – all quite dangerous, and sad for members of the Navajo tribe, documented recently in a six-part Los Angeles Times series.

The US approach to waste storage – the Yucca Mountain repository in Nevada – is also in jeopardy. It can take no more waste from the civilian nuclear industry without exceeding its statutory volume limit, and recent statements from the former US DOE project manager and a current NRC commissioner suggest the entire project may collapse.

(Slide twenty.) Meanwhile, the Bush administration has invented a preposterously silly answer to the Yucca problem – GNEP, or the Global Nuclear Energy Partnership. On the domestic side, the proposal is reprocess the waste, and store two of the hottest and most dangerous products (Cesium 137 and Strontium 90) on the surface for hundreds of years, so that more waste can be crammed into Yucca Mountain. As mentioned earlier, this approach vastly increases nuclear fuel cost, relies on unproven technologies, and increases the risks of waste storage. Abroad, nuclear power would be free to expand, but countries without either enrichment or reprocessing capacity would be forced to rely on the superpowers for fuel supply. Too many countries will reject this proposal in the near term, and turn to highly proliferative enrichment and reprocessing technologies as forms of self protection.

(Slide twenty one.) The good news in all of this, and you will not hear it from the nuclear industry, is that alternative renewable and cogeneration resources are growing very rapidly in the near term, while nuclear power – at least in the near term either declines or stays flat. You need to add all these curves together to get the full measure of the growth rate. (Slide twenty two.) Perhaps an even more important resource is the potential for energy efficiency improvements. This slide shows the difference between average per capita electricity use for the US as a whole, and for California, which has pursued that alternative aggressively - the equivalent of 22 reactors since 1970, neither possible to site nor finance.

(Slide twenty three.) Some people argue that efficiency is a limited resource, and that we've already grabbed the low hanging fruit. This slide shows the absurdity of that argument – the fruit can grow as quickly as we can pick it. Since 1970, US refrigerators, large then, have gotten 10 percent bigger. Efficiency improvements have cut electricity use by 75 percent, and the cost of the larger, more efficient fridge has fallen 60 percent. In short, the cost of this efficiency improvement is negative, and the slope continues to impress. The same basic chart could be shown for industrial electric motors or lighting.

(Slide twenty four.) I cannot end without talking about costs and prospects for new renewable resources. All of you know the experience with wind in Spain, Denmark, Germany, and elsewhere. Turbines are becoming more efficient, cheaper, and more reliable, and that is unambiguous good news.

We are also beginning to see truly exciting news in solar electric cell technology, and the one example I would cite here is a California firm, Nanosolar, started by Google's two founders, and backed, among others by Swiss Re, now building two 430 megawatt per year production facilities in California and Germany, using a non-silicon material and production process they equate to newspaper printing. Those two plants increase global solar cell production capacity by nearly 50%, and should be completed this year. Their target price - $0.50/peak watt – which would bring them into competition with delivered electricity prices in a large part of the world, and certainly below the nuclear costs I've shown earlier. Will it work? I don't know, but we will know quite soon, and if Nanosolar doesn't reach its ambitious goals this year or next, it might the following year.

Twenty years from today, light water reactor technology will be about the same as it is today.

So what does this mean for the nuclear renaissance? To me, it means that the renaissance may end before it even begins. Nuclear power is challenged on many fronts, and it is cannot expand rapidly without a compelling story to tell in terms of public acceptability, investor confidence, cost relative to alternatives, security and availability of fuel supply, safety, and resolution of waste issues. The industry nevertheless asks for our trust and support, in the absence of a credible case on any of these issues.

Myths survive for thousands of years throughout all our cultures, when they bring practical significance and inspiration to our lives. They are, in fact, important, and it is denigrating to call the nuclear renaissance a myth. The nuclear renaissance is a story based on a tall stack of fallacies, unsupported by past experience or future promises. This one seems to getting a second reading, but it does not deserve a third.