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## Teetering on the Brink?

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Good morning, ladies and gentlemen. It is truly a pleasure to be here today with so many friends and colleagues, and humbling to be asked to speak among so many distinguished people whose work I so respect and admire. I have been asked to present some simple thoughts on the important issue at hand – the fuel to power the future nuclear power industry.

As a preface, I should say that in university I studied physics and nuclear engineering, but I wasn't very good at either, so rather than lose four years of hard work, I shifted my advanced degree to an M.B.A. and went to work in the business side of nuclear power. There are some in this room who would maintain that I wasn't any better at that, either. But I mention this because physicists like to build simple models, often using extreme cases, to help expose fundamental considerations. And it is in this context that I present this simple analysis today.

For me, the starting point is clear: Nuclear power is looking better today than ever, and clearly has a good prospective future – if we don't blow it through carelessness. Like all power sources, there must be fuel; and, in the case of nuclear, that means uranium. It is generally well accepted that the world has sufficient resources of uranium for most future growth scenarios. The question of practical availability does not apply so much to resources, but to the adequacy of commercial supplies. And here is where things may get dicey.

First, it is widely recognized that all forecasters of nuclear power in the western market, which I will concentrate upon today, agree within one to two percent on the number, size, even the identities of nuclear plants to be operational in the next ten years. After that, forecasts vary depending on each forecaster's personal approach to incorporating, or not, future planned or expected plants and their views on lifetime extensions. We see this illustrated in the WNA's Lower, Reference, and Upper Cases, in the 2003 Market Report just presented. What is strange, however, given the closeness of fit of the installed nuclear GWe, is the degree of difference when forecasters translate the GWe profile to uranium reactor requirements. In *Figure 1*, we see these differences illustrated graphically.

The uranium demand calculation is also sensitive to the tails assay that analysts use. For example, the amount of uranium needed to make 4.50 w/o enriched uranium product is 12.5% more when the enrichment is ordered at 0.35 w/o tails, than if ordered at a tails assay of 0.30 w/o. So, some of the variation in *Figure 1* can be explained just by the different tails assays used by the different forecasters.

Let us move quickly to supply. In *Figure 2* we present many of the key supply elements that exist today, and others which many people have been expecting will apply in the future. This figure has, for example, such big new mines as Cigar Lake in Canada coming on in 2007, Jabiluka in Australia coming on in 2011, the big contribution by Minatom in Russia from blending down weapons-grade nuclear material continuing after the first 500 MTu of high enriched uranium (“HEU-I”) is finished in 2013. It also has Russian/Central Asian uranium exports continuing strong, and Minatom still stripping Urenco and Cogema tails unabated to 2020. Finally, the big African mines in Namibia (Rössing) and Niger (Somair and Cominak) also continue at least to 2020. The one thing to notice in this figure is that it takes all these major contributors just to keep future supply flat. But demand is not flat; it is growing.

In *Figure 3* we combine the first two graphics to give the overall supply/demand balance. Now, admittedly, this chart is a little complicated, but it sends some very strong and straightforward messages. First, regardless of which demand forecast you prefer to use, a shortfall of uranium supplies is imminent. Pick the higher curves of NAC International or NRI, and the shortfall comes sooner; pick ERI or RWE Nukem, it’s a little later. In any event, we believe that a pending uranium supply shortfall is real, and to us this means one thing: uranium prices are going up; it is only a question of how soon and how high. We tend to believe sooner rather than later, but time will tell. The second key message from *Figure 3* is that even more supplies are needed than those shown.

But this leads to another question: Just how valid are the supplies shown? I have to be honest and say that *Figure 3*, with modest tweaking from time to time, has been our Base Case forecast at NRI for the last three years. But in Baltimore, Maryland this past April at the Nuclear Energy Institute’s conference “NEI Fuel Cycle 2003”, a variety of experts independently came to the podium and questioned the validity of a number of key assumptions included in *Figure 3*. “One should not take a Russian ‘HEU-II’ for granted for 2014-2020.” “In Australia, forget Honeymoon, it’s never going to happen.” “Same for Jabiluka.” Somebody even questioned whether Cigar Lake would ever be brought on!

This led to one of my favorite questions: What do these people know that I don’t know? What if they are right? What would the uranium supply/demand picture look like? So I went home, went into our model, and took out just these four future supplies. The result is shown in *Figure 4* – a market that could be teetering on the brink of chaos, just ten years out - in an industry in which ten years is our normal close-in planning horizon.

But you say: “Listen Mike, that goes beyond simple; it is simplistic! That scenario is never going to happen. Basic economics says that supplies will always expand to meet demand. Okay, you may have some different players, but supplies will get there – at a price.” And I say: “Maybe”. Let’s add back supplies and see what that tells us. But before doing that, let us simplify the picture by dropping the commercial uranium demand forecasts, and keep only the three WNA 2003 cases - Lower, Reference and Upper. This gives us *Figure 5*.

Next, in *Figure 6* we take our first steps back from the brink by adding back in mines likely to respond to higher prices, namely Honeymoon and Cigar Lake.

Next, we'll let the Russians continue to provide a scaled down HEU-II, if not to US utilities, then to other favoured long-time customers. Finally, we'll let Olympic Dam expand by about seven million pounds U<sub>3</sub>O<sub>8</sub> per year. Now such an expansion would really be more a function of what's going on with copper, but let's just put it in. What do we see? We see that we still have a long way to go to close the supply/demand gap.

So let's go on to *Figure 7* and add in Midwest Lake and Dawn Lake in Saskatchewan, and expand uranium production and exports from Central Asia by 80%. This helps, but a big gap still yawns from 2013-on.

At this point, with supply and demand still not in balance, with supplies tight and prices escalating, we might see the US utilities, bereft of HEU-II, petitioning the US Department of Energy to release some of their inventory and the feed that DOE purchased in 1996-1998 from Minatom under HEU-I. But the 2003 Energy Bill now wending its way through a conference of the US Senate and House of Representatives contains language limiting DOE supplies to a maximum of ten million pounds equivalent U<sub>3</sub>O<sub>8</sub> per year. Also, DOE does not see itself as a direct seller into the market, and no mechanisms have yet been established for how such DOE supplies might actually make it to the market. Nevertheless, for our study purposes, let's show this in *Figure 8* from 2013-on. The effect? We're still short.

Now it's time to really pull out the stops. If Jabiluka still can't see its way to the market, then the door is open for innovation. Utilities may start to order enrichment at lower tails assays to conserve inventories and extend contracted natural uranium supplies. Expanded MOX usage, more HEU/REPU/Fab blends, an "HEU-IIA", more tails to Russia (in this case, from the DOE stockpile) are some new, innovative, supplies that can and should emerge.

In *Figure 9* we show the effect of DOE tails to Russia. This would be an excellent way to further international nuclear security and non-proliferation, add to needed supplies at reasonable market prices, and preserve and use for the benefit of the Russian enrichment enterprise and the US and international utility consumer and ratepayers the US\$2-3 billion of economic value currently locked up in the DOE tails ... an economic resource that is currently destined to be thrown away once the two congressionally-mandated DUF<sub>6</sub> plants are built and operational at Paducah and Portsmouth.

But, while a good idea, DOE tails to Russia is not easy to turn on. Substantial barriers need to be cleared: the 2002 legislation mandating the construction of two DUF<sub>6</sub> conversion plants reduces DOE incentives to economise this way; the 2003 Energy Bill limits the amount of supplies DOE can make available in the future; the lack of a Section 123 Bilateral Agreement between Russia and the US inhibits the easy flow of materials; the current disagreement between the Russian and US governments concerning Iran inhibits the implementation of new initiatives that might benefit Russia; and, finally, any continuation of the current Department of Commerce's Suspension Agreement with Russia would limit the usefulness of this new supply source for US utilities. Still, we believe that this is an idea whose time has come, and that strong, innovative steps will be attempted to make it happen.

To conclude, with new supplies from Australia, Canada, Kazakhstan, Kyrgyzstan, Uzbekistan, Russia, the United States, and maybe India, Namibia and South Africa, with new, innovative forms of supply centred around unique Russian capabilities, with the help of government policy makers and negotiators, and strong, decisive industry executives on both the supply and consuming sides ... yes, we can get there. But it is going to take a lot of effort from a lot of dedicated people ... people who are willing to make long-term decisions near-term. But, we can do it, and we will.

# Teetering on the Brink?

## Two Radically Different Future Uranium Supply/Demand Scenarios for the Western Market

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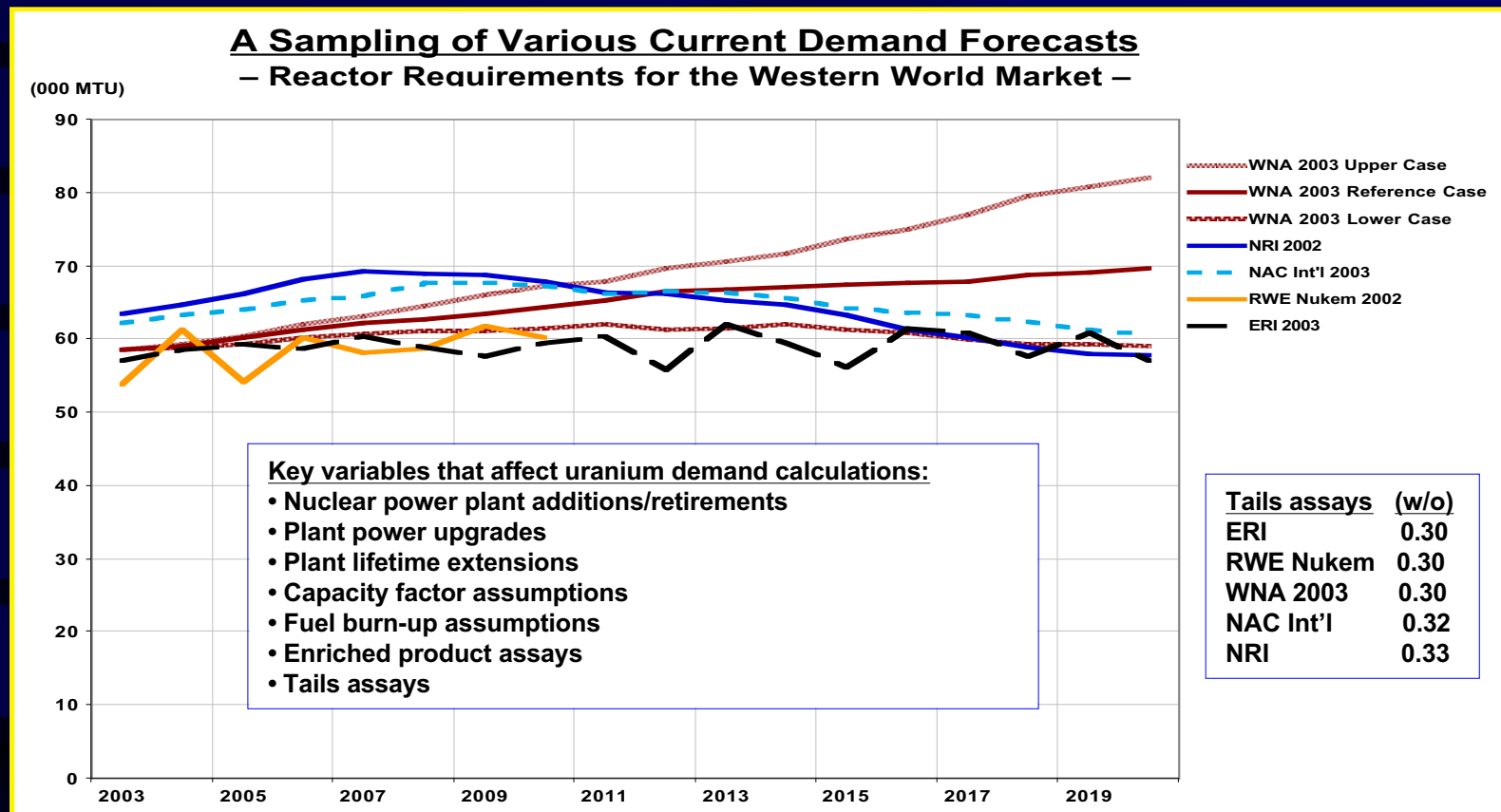
### Their Implications for Industry Executives and Government Policy Makers

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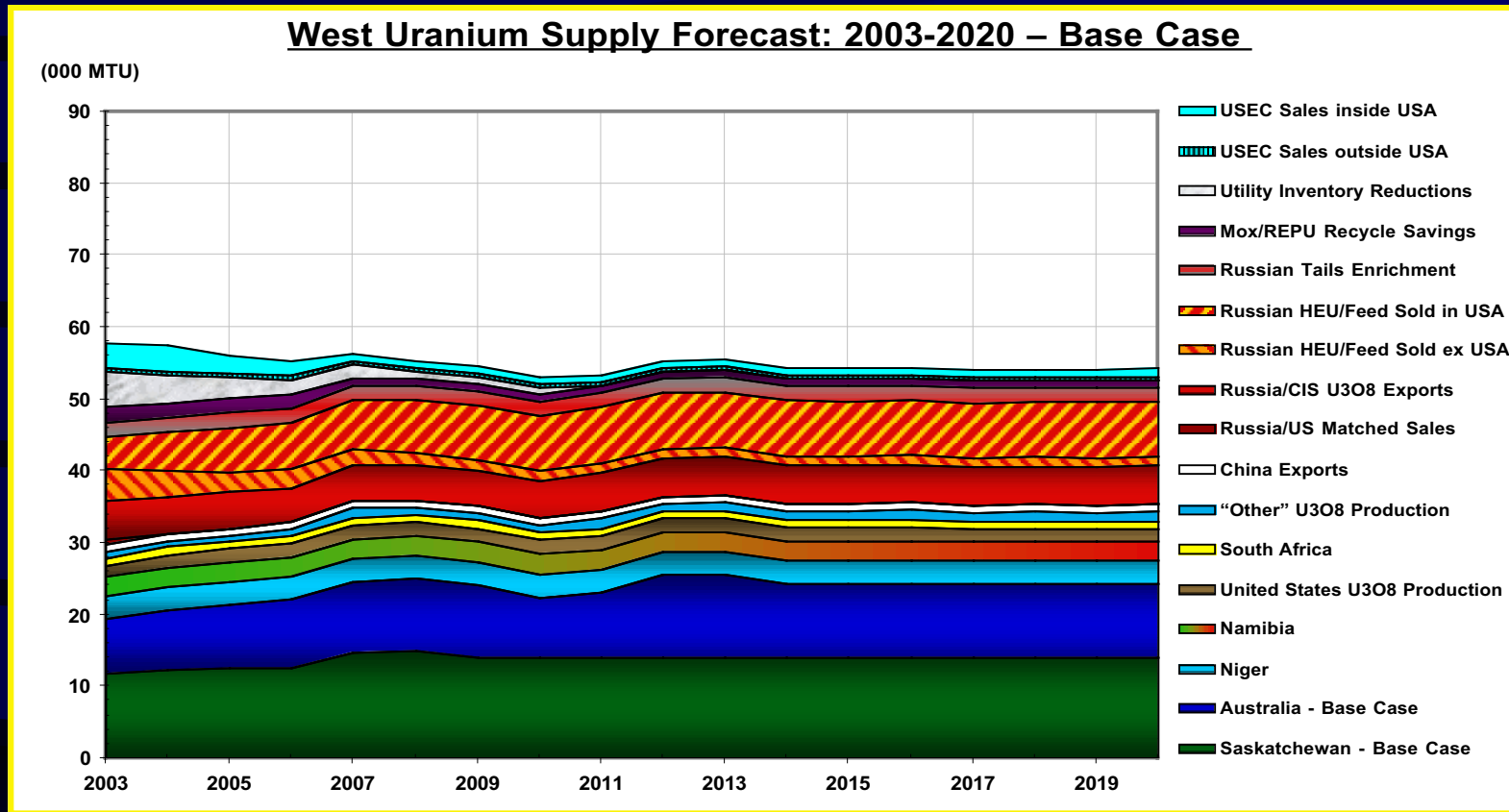
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# Future Uranium Demand – 7 Different Forecasts



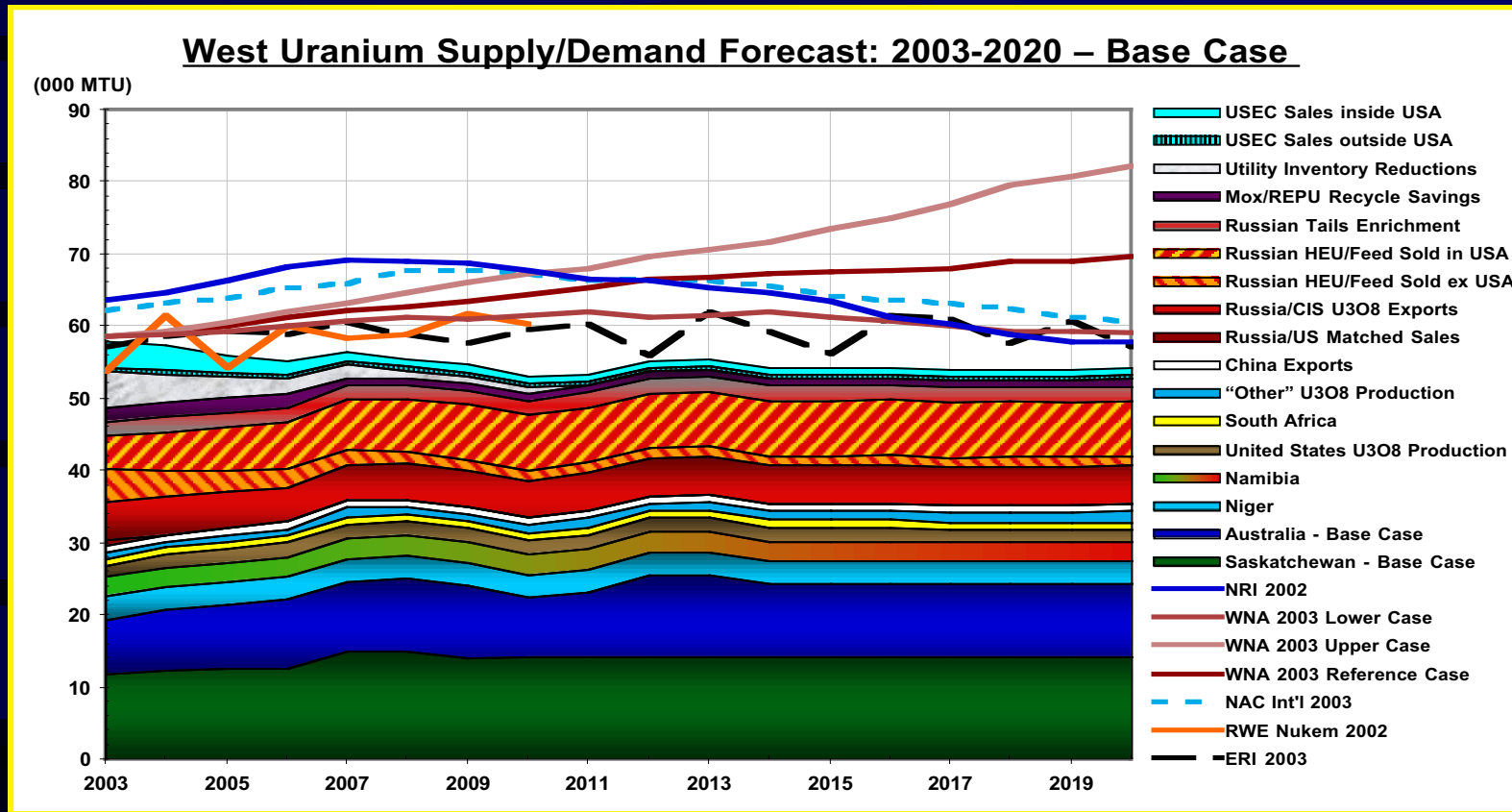
For the next 10 years, the different levels of Base/Reference Case uranium demands shown are for essentially the same number of installed nuclear power plants. Differences in uranium demand forecasts are due to different assumptions among forecasters – for plant capacity factors, fuel burnup, enriched product assays and tails assays.

# Future Uranium Supplies – Base Forecast



Future Base Case supply is based on certain key assumptions, i.e., Cigar Lake, Honeymoon, and Jabiluka mines will all come in; the three big mines in Namibia and Niger will continue to 2020; the current level of CIS/Russian exports will continue undiminished, Russian HEU will continue after 2013 ("HEU II"); and Russian enrichment of tails by Urenco and Cogema will continue.

# Uranium Supply/Demand Balance – Base Case



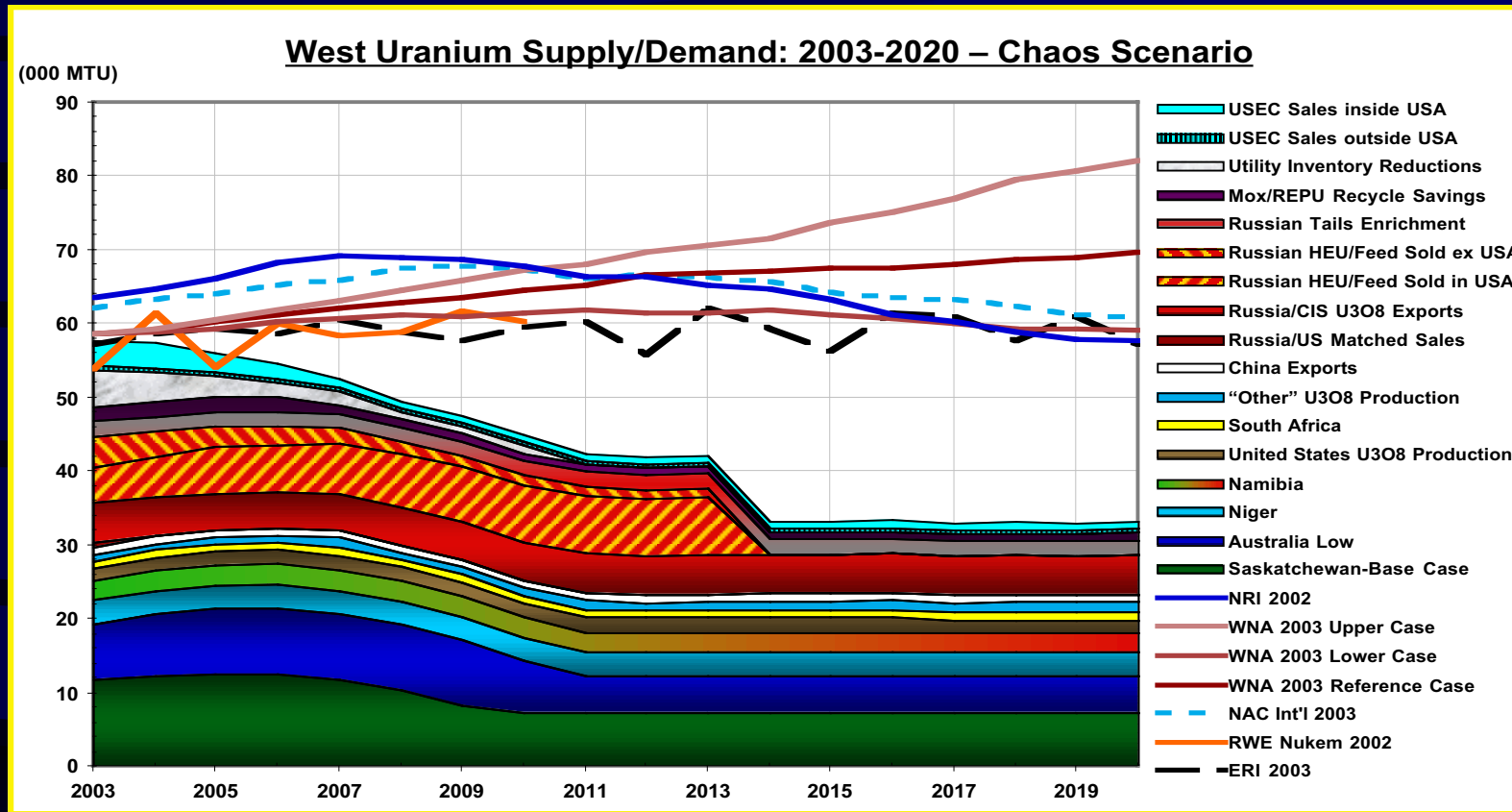
Combining supply and demand slides shows

- (1) a supply shortfall is imminent – regardless of which demand forecast one believes; and
- (2) even more new supplies are needed than presently expected.

More inventory sales/usage than shown could push the shortfall out 1-2 years.

*But, what if some of these supplies, blissfully taken for granted, simply don't develop?*

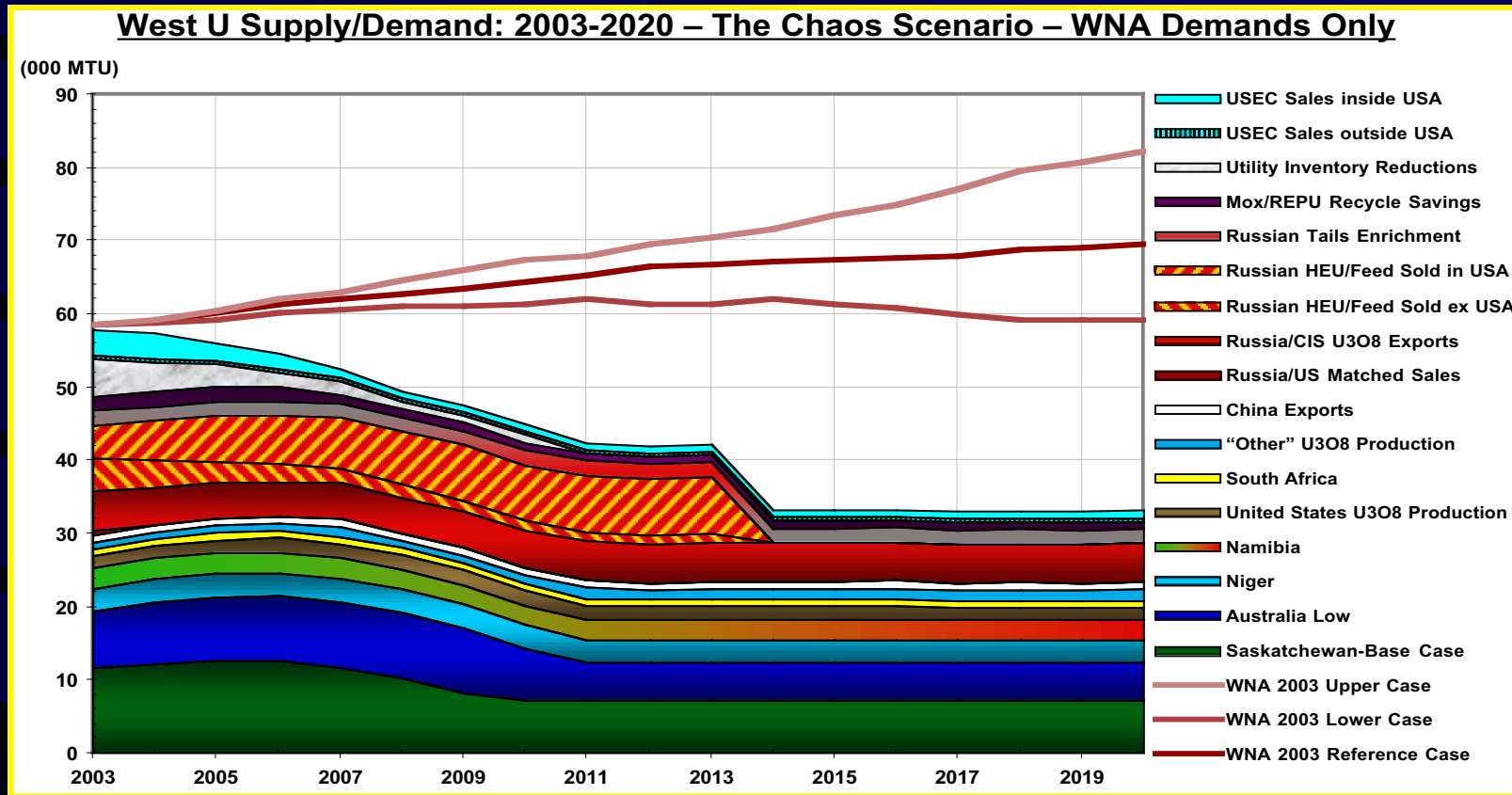
# Uranium Supply/Demand Balance – The Chaos Scenario



In April 2003, at NEI's "Fuel Cycle 2003" in Baltimore, a number of experts questioned whether a new Russian "HEU II" will ever happen... if Honeymoon, Jabiluka...even Cigar Lake...will ever be developed. Remove just these 4 supplies, and...with utility inventories in most cases essentially exhausted...

*Utility fuel managers could, very soon, face a market bordering on chaos.*

# U Supply/Demand Balance – The Chaos Scenario Restated



This is the same graphic but with only the WNA 2003 Demand Cases shown (Upper, Reference, Lower).

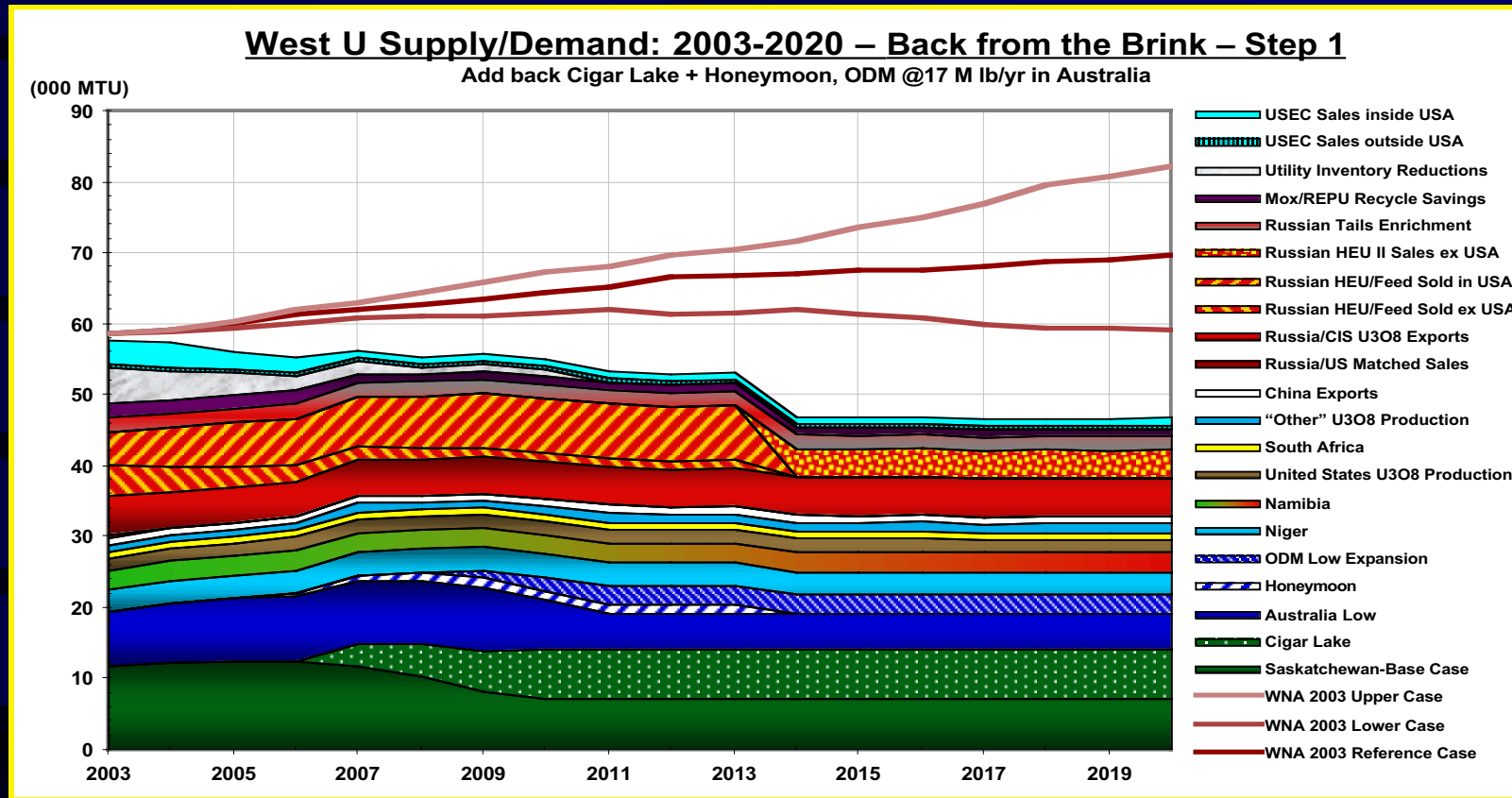
*Where will the new supplies come from, if not from Cigar Lake, Honeymoon, Jabiluka, and HEU II?*

## Initial Observations

- Removing just 4 currently expected key new supplies leads to a market basically in chaos. The market absolutely must have these 4 expected supplies, and more new ones in addition.
- In April 2003 in Baltimore, experts at the NEI's "Fuel Cycle 2003" forum sincerely questioned whether we should assume that any of these 4 new supplies can really be counted upon.
- In the "Base Case Supply/Demand", however, all 4 of these new supplies are counted upon – just to keep future long-term supply flat.  
Basic message #1: Prices are going to go up – it's just a question of how soon, and how high.  
Basic message #2: Even more new supplies are needed than those currently expected.
- In the "Chaos" scenario the issues go well beyond just price – with only 55% of supply identified 10 years out (in an industry where 10 years is tomorrow), the message is that the viability of nuclear industry generation is, itself, seriously endangered. It's not a question of reserves. It's a question of supplies.
- What are the alternate new supplies? Further expansion of Olympic Dam? Langer Heinrich in Namibia? Expansion of ISL in Kazakhstan and Uzbekistan? Kintyre in Australia? We may need all of these and more, especially if China starts to tap into the western market for their needs.
- Government policy-makers and negotiators in Russia and the USA, and industry supply-side mining executives, must immediately begin to take measures to ensure that all currently expected new supplies, and even more new ones, actually do occur.
- For their part, the utility consumers must accept that this is a real problem requiring their serious attention and strong contracting action to resolve...not in the future...now.

***People need to start to take long-term positions...now.***

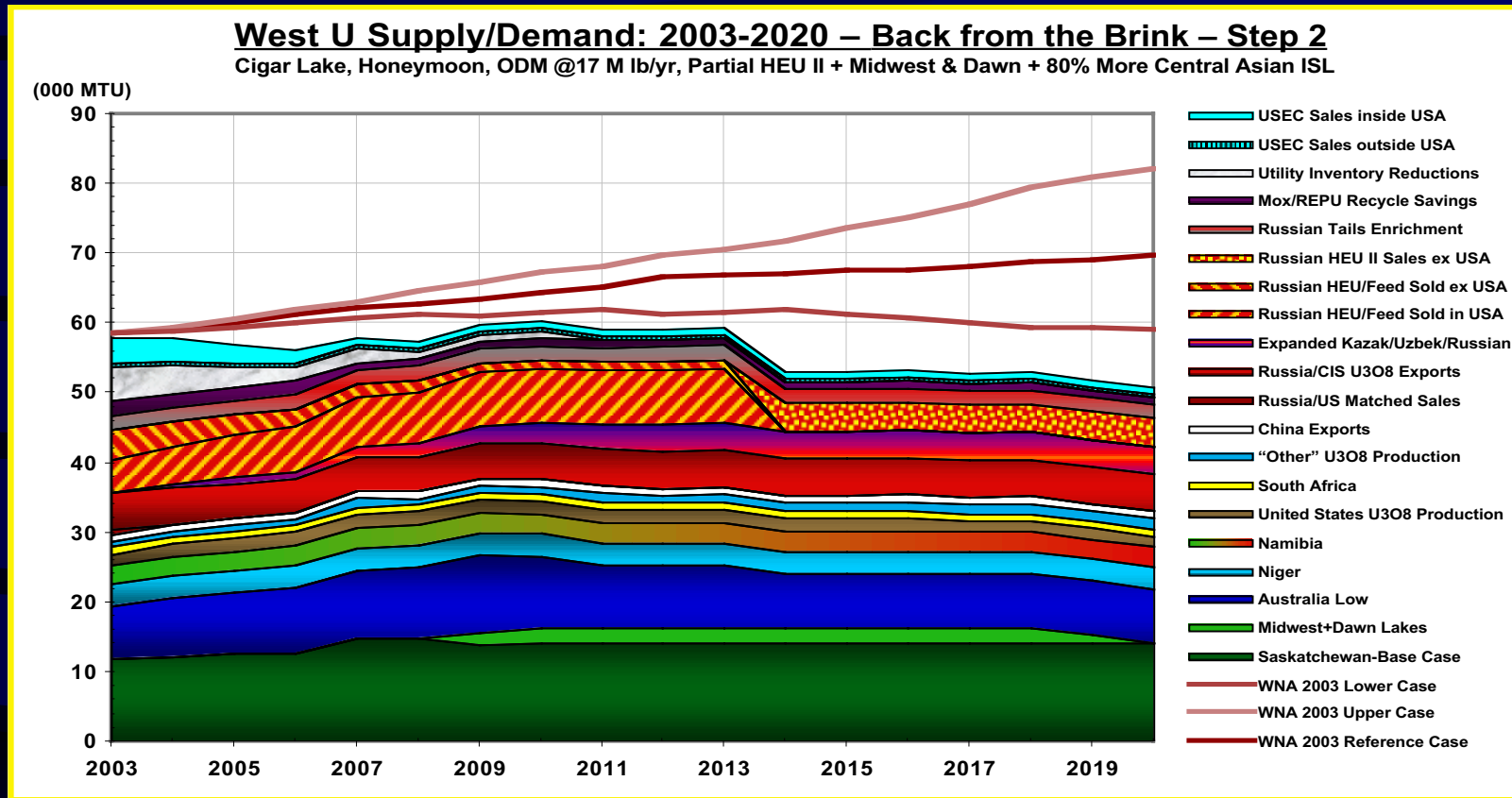
# Economics 101: Supply Always Expands to Meet Demand



*Maybe.*

Let us add back some supplies that can be reasonably expected to respond to higher prices. First are Cigar Lake and Honeymoon. Let’s postulate an expansion of Olympic Dam to 17 M lb/yr, even though that may be more a function of the copper market. Let the Russians provide a partial “HEU II” to their favored customers. Much of the gap is closed, but still more supplies are needed.

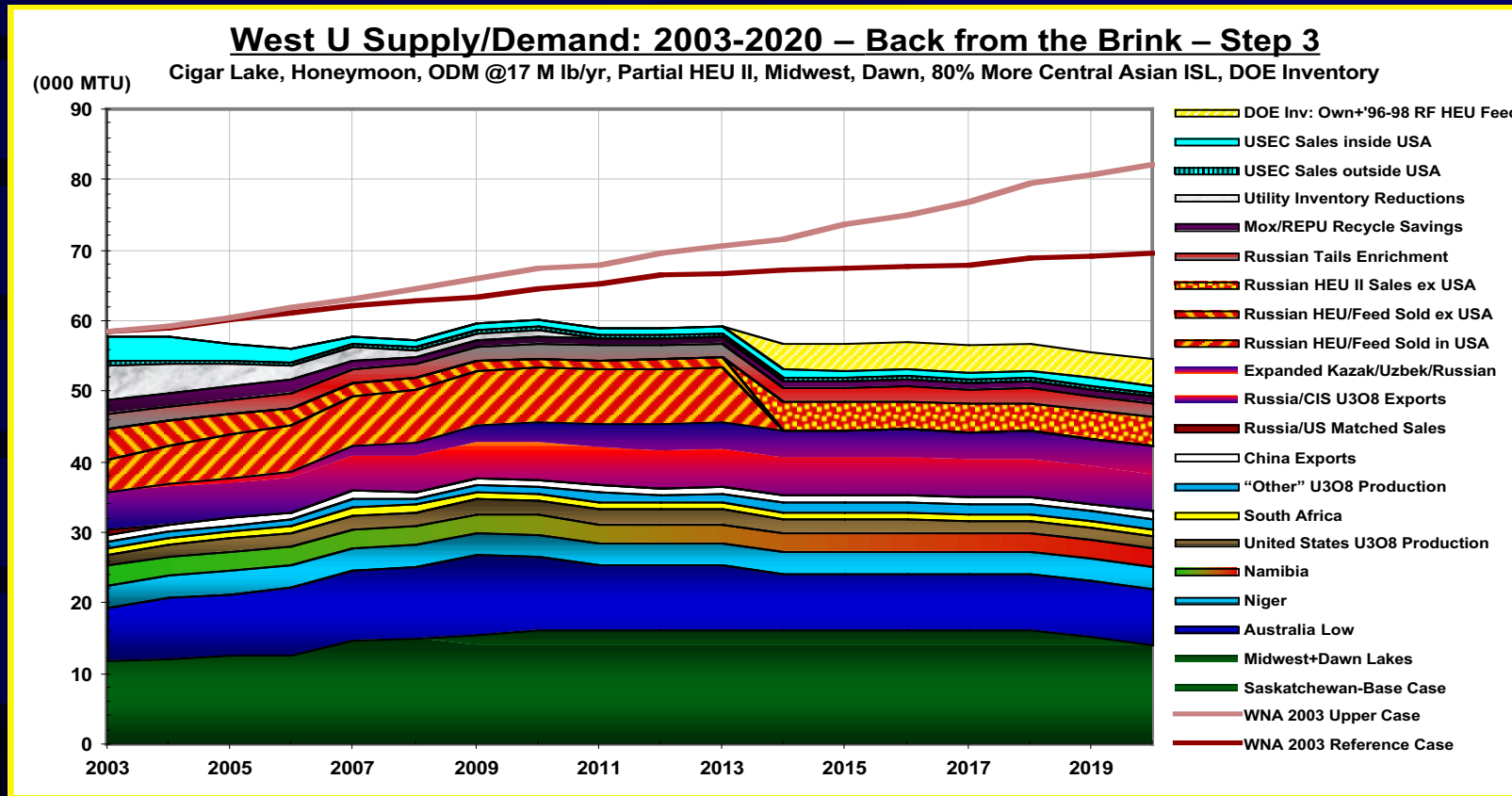
# Economics 102: More from Saskatchewan, Central Asia



Let's expand Central Asian ISL output by 80%, and bring Midwest Lake and Dawn Lake on in Canada. These additional supplies close more of the gap between supply and demand. But, this is still not enough. Even more supplies are needed long-term.

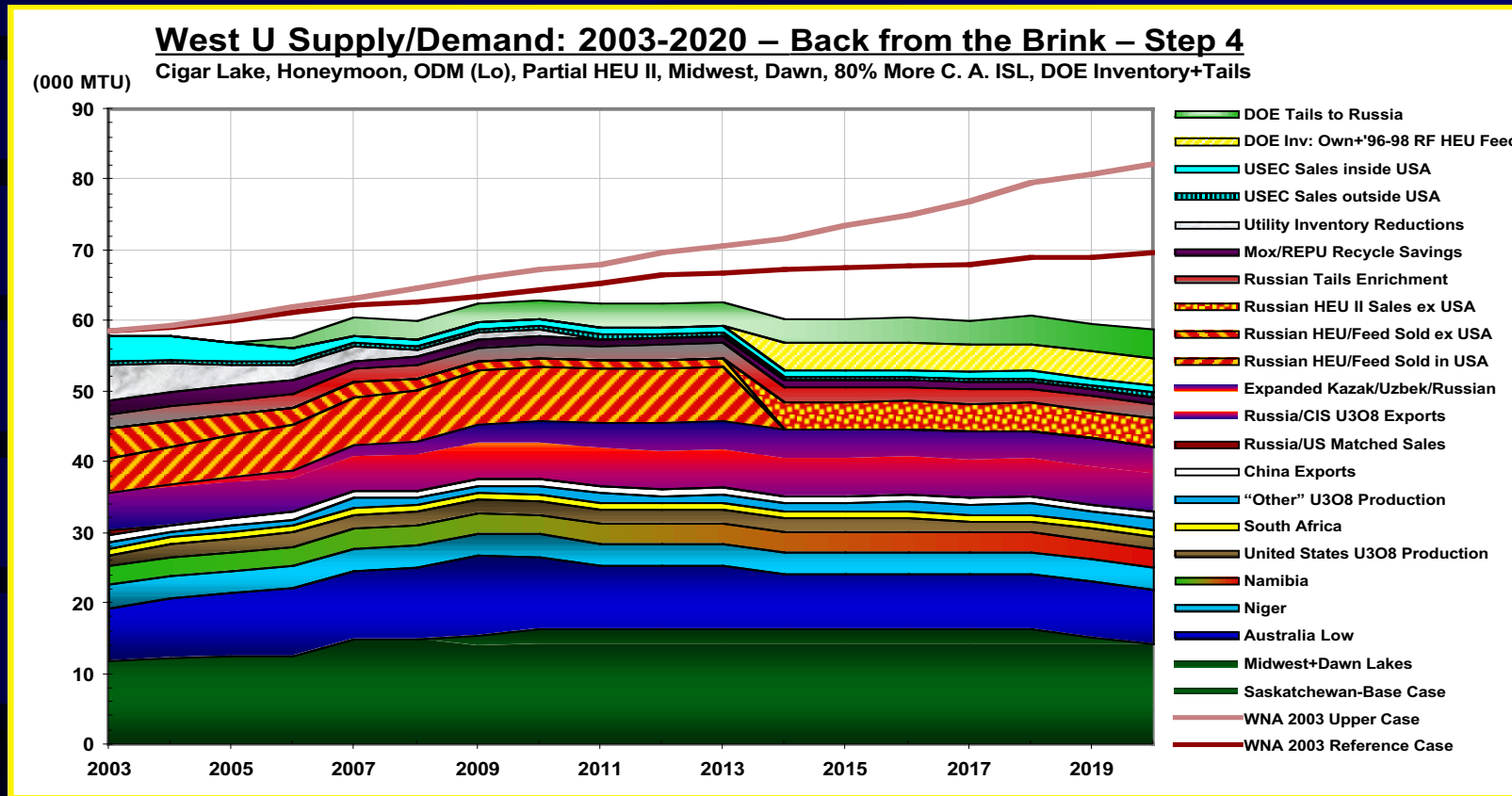
*And there is always the question of timing. How many years do prices need to be at new, higher, levels to stimulate the actual analyses, financing, and political decisions to support each new supply?*

# Farther Back from the Brink – Bring in the Cavalry?



With prices high, and supply and demand still not in balance, U.S. utilities may put pressure on DOE to sell their inventory, plus the HEU feed they bought from Minatom in 1996-1998. At the limits in the proposed 2003 Energy Bill, DOE supply closes some of the long-term demand gap. Remaining shortages could be covered by boosting output from existing mines, by downward utility adjustments to optimal tails, by additional HEU/LEU supply, or by innovative new forms of supply.

# Innovative New Forms of Supply? DOE Tails to Russia.



## Great idea, but several impediments exist:

- 2002 legislation mandated DOE to contract to build 2 DUF6 conversion plants.
- 2003 legislation in Energy Bill (currently in conference) imposes annual limits on DOE supplies.
- No Sec 123 Russian/U.S. Bilateral Agreement complicates shipping.
- Russia/USA/Iran standoff aggravates U.S./Russian relations.
- Russian/DOC Suspension Agreement limits usefulness for U.S. utilities.

## **Back from the Brink: With a Lot of Effort By a Lot of People**

- We can get there, but not without a lot of effort by a lot of people.
- 15+ new supply projects must be started in 10 different countries in the next 10 years.
- This will require new, higher, prices – sustained long enough to be believable.
- Remaining supply gaps can be covered by utilities ordering EUP at lower tails assays, by bringing in more new mines, by more HEU/LEU, and by DOE tails to Russia.
- But clearly, the strong, decisive, timely, energetic management actions required will need executives – and government policy makers and negotiators – operating with a sense of urgency, at peak levels of competency, taking long-term positions near-term.
- Some may ask: are we up to it? Or, might not the Peter Principle apply?
- On that note, let me close with Gen. McAuliffe's famous reply when offered surrender:

*“Nuts!”*

**We can do it, and we will.**

