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HALEU AND THE PROMISE OF NUCLEAR ENERGY:

An interview with the DOE's Kathryn Huff

Deploying a fleet of advanced reactors in the 2030s means deploying high-assay low-enriched uranium (HALEU) infrastructure now.

The future fleet will need more than 40 metric tons of HALEU by 2030, according to Department of Energy projections. Getting to the 5–20 percent fissile uranium-235 content of HALEU involves either enriching natural or low-enriched uranium (LEU) or downblending high-enriched uranium (HEU).

Because downblending the limited stocks of HEU held at the DOE's Idaho National Laboratory and Savannah River Site is a short-term option at best, the Energy Act of 2020 authorized a HALEU Availability Program to build a sustainable enrichment infrastructure by the time advanced reactors are ready for commercial deployment.

Comments on a request for information reached the DOE in February 2022, just before Russia's invasion of Ukraine amplified global energy security concerns. While the war in Ukraine didn't change the DOE's plans, it "accelerated everything," said Kathryn Huff, who leads the DOE's Office of Nuclear Energy (DOE-NE) as assistant secretary. "Our attention is now laser-focused on this issue in a way that it wouldn't have been in the past."

As assistant secretary of nuclear energy, Huff is charged with overseeing the HALEU Availability Program. Before joining the DOE, Huff was as an assistant professor in the Department of Nuclear, Plasma, and Radiological Engineering at the University of Illinois–Urbana-Champaign, where she led the Advanced Reactors and Fuel Cycles Research Group with a focus on the modeling and simulation of advanced nuclear reactors and fuel cycles.

Nuclear News staff writer Susan Gallier spoke with Huff in September as the DOE prepared to release guidance and a request for proposals for the HALEU Availability Program.

Many people have said that HALEU availability is not a technical problem, but a "chicken and egg" problem. Do you agree?

I think both the chicken and the egg have now been solved by the twin DOE programs of ARDP [the Advanced Reactor Demonstration Program] and the $700 million in IRA [Inflation Reduction Act] funding for HALEU. Between these two things we now have a chicken and an egg—you can decide which one's which!

We now are supporting advanced reactor demos, which will signal the future of an advanced reactor commercial market. The IRA's $700 million for HALEU is the other signal that enrichers need to stand up and make fuel available for these reactor demos. Of that $700 million, $200 million will be for reducing risks, but about $500 million likely will be dedicated to offtake agreements that will allow us to establish a HALEU bank. So advanced reactor companies can rest assured that the fuel will be available when commercialization needs to happen in the late 2020s and 2030s, and HALEU providers can rest assured that those reactors will exist.

How much more money does the DOE need to support this program? Is the $1.5 billion September 2nd supplemental request from the White House critical to the program?

It's absolutely critical. The $1.5 billion would focus on standard LEU, given the situation in Ukraine and Russian dependence that we have in our front end of the fuel cycle. But it's still not quite enough. This is a down payment on what needs to be a longer-term set of offtake agreements to support our broader uranium strategy.

The $700 million in the IRA will get us fairly far, but it's likely to cover only the first couple of years—maybe only the first year, depending on the amount that we procure. We'll release a request for proposals, and the offtake agreements will depend on what prices the enrichers in the United States are able to offer. Those prices should inform how far those dollars will reach, but we expect it will probably need to be met with additional funds over the coming years.

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What advanced reactor demand assumptions are being built into the program?

A variety of different industry groups have projected different amounts of advanced reactors deploying, and we've been fairly conservative in the DOE. Our assessment is that certainly in the very near term—in the 2030s—we expect to see many small modular and advanced reactors that might need HALEU, and it's our assessment for our clean energy goals that we need to potentially as much as double total nuclear capacity in the United States by 2050.

We can meet our climate goals with an incredible ramp-up of renewables and just keep nuclear at its existing capacity, but if we want to slightly lower the slope of that renewable increase, doubling nuclear capacity is well within what might be required for our net-zero transition. If you imagine that slope, it's a lot of reactors in the 2030s that we're going to have to build, particularly if we want to help with our 2035 goal of 100 percent clean electricity.

That's on the high end of the projections of the federal government, but it's exactly aligned with, for example, the International Energy Agency projections for what the globe needs to do. We need to move from a little over 400 gigawatts of nuclear across the globe to somewhat over 800 gigawatts by 2050 if we're all going to meet our final targets.

What is the biggest challenge in meeting expected HALEU needs?

Our biggest problem is not that enriching uranium is hard or that it will take a really long time to get there, but rather that there's both a short-term need and a *very* short-term need. The short-term need in the end of this decade will be covered by folks who respond to our HALEU Availability Program by standing up new enrichment. Our biggest gap is really in the very short term, to make sure that we can provide material for the two [ARDP] demo awardees.

How can the HALEU Availability Program balance policy goals with the goals of private companies and investors to ensure that full system costs aren't higher than they need to be?

There are a number of different tools that can support industry by reducing the risks of their investments in the near term. But we can't forever subsidize all the fuels in our energy systems, so we need to be careful to make sure that industry can do what it's good at and begin competitions that can reduce costs overall.

The DOE's Loan Programs Office [LPO] can support cheap capital in some of these areas. [For more on the LPO, see Leaders on page 12.] Industry is facing a really exciting time with production tax credits from the IRA reducing the economic dangers of operating existing plants and production tax credits that will support the build-out of new advanced reactors, and those should provide a signal from the consumer side. By having industry and the consumer take on some of those first-mover costs that the government has historically been relied on to do, I think we'll see a magnification of our signal.

That also needs to be paired with communicating with sources of "patient capital." Building out infrastructure takes a different kind of capital investment than, say, technology revolutions. It takes long-term investment structures, like pension funds, for example, that are comfortable waiting a decade or two for their return on investment. Infrastructure includes things like HALEU fuel supply, so I hope that industry providers of this material are thinking about the kinds of investors they need that we might not have historically leveraged.

Will the DOE own the HALEU offered through the program, perhaps leasing it and then taking back spent fuel for storage, reprocessing, and/or disposal?

We may purchase that material initially as an offtake agreement and then make it available through a short fuel supply program, as we can—but have not yet done—with the American Assured Fuel Supply Program for standard 5 percent enriched fuel. But these are commercial plants—they should own their fuel and they should pay for it.

It has generally been the DOE's responsibility to take that fuel back eventually and put it in a repository, but we haven't done that yet for the existing fleet. There are some other questions as to what it would look like to imagine a standard contract for some of these future reactors, as well. But it's a little too early to talk about that.

In the decades before the recent surge in HALEU demand, the DOE's National Nuclear Security Administration (NNSA) downblended about 164 metric tons of HEU to LEU. In hindsight, if more of that HEU was still available, it could be used to help meet urgent HALEU needs. How is the DOE ensuring that actions taken today will not preclude future needs?

How do we "not preclude future needs"—I think that is a good way to phrase it. Because who knows what's

coming down the pipeline, and for the NNSA or others, some of this very special material is irreplaceable. We have to stand up a domestic enrichment capacity to avoid continued unnecessary downblending from HEU down into the LEU space.

It's as if you take a lot of time to intricately build some architecture, and then you break down that building just to burn the wood! We're in a place where the raw material, uranium, is not scarce in a way that perhaps would drive a real concern. The thing that's scarce is HEU.

So what are we doing? We're working really closely together. We're trying not to usurp any long-term NNSA missions, which take precedence over my mission in the civil nuclear sector. But we're also recognizing that leadership in nuclear energy goes hand in hand with our voice on international nuclear nonproliferation. Without a functioning, commercialized advanced reactor capability in the United States, the NNSA will have trouble with their other missions. The DOE-NE needs good nonproliferation and good nonproliferation needs the DOE-NE, so we are working together.

Moving to enrichment, what's next for Centrus's American Centrifuge technology?

You'll have to ask Centrus! What I will say is this: The Piketon [Ohio] demo is a DOE-owned facility, and Centrus got the first contract for that demonstration capability for production of HALEU. What they contracted for was the construction of the centrifuges, and the DOE paused this initial contract to hold a competition for the subsequent phases. The second phase of that contract was recently competed, and we're reviewing applications now to see who will operate that facility and begin producing HALEU.

Could the contract be won by anybody other than Centrus?

Sure, there are handful of companies that are quite familiar with the centrifuge technology at play, and I can't tell you who has applied or whether there are many, but I will say that certainly it's not a done deal.

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Top: The Centrus AC-100M centrifuge, sheathed in black protective covering, positioned in assembly stand, at the Piketon enrichment facility.
Bottom: A Centrus employee assesses the readiness of the centrifuge assembly stand. (Photos: Centrus)

Our intent is to make purchases of enriched uranium very soon, so this competition will benefit players in this game that are able to respond quickly with actual production material and standing up of new capacity.

All players are welcome, but the players capable of really quick responsiveness are going to be at an advantage.

How could other enrichers, like Urenco and Global Laser Enrichment, participate in the HALEU Availability Program?

In the request for proposals that we'll be releasing, Centrus can participate, and other companies capable of producing centrifuges and operating them could participate. Urenco is certainly ready to participate. They have a facility already out there in Eunice, N.M., and even are capable of potentially expanding fairly quickly.

Laser enrichment could also potentially play a role. Our intent is to make purchases of enriched uranium very soon, so this competition will benefit players in this game that are able to respond quickly with actual production material and standing up of new capacity. All players are welcome, but the players capable of really quick responsiveness are going to be at an advantage.

What new facilities need to be built? Could existing structures house front-end facilities or a physical HALEU bank?

My understanding is currently there is no obvious location beyond the Piketon demo location where we're doing this demonstration, which will produce, by the way, about 900 kilograms of HALEU a year when it is running. That facility certainly could be leveraged. But I fully expect that if any other location were considered, they would have to apply for a Category II Nuclear Regulatory Commission license to support that activity. Amendments would have to be made to the Urenco facility, for example.

Could Urenco produce HALEU up to 10 percent and then send it somewhere else for further enrichment?

You suggested it! It's not a bad idea. I hope we would see creative solutions like that in response to our request for proposals. Things that get us to the end sooner are going to benefit everybody.

The only uranium conversion facility in the United States began operating quite some time ago, in 1958. How soon will more conversion capacity be needed?

Conversion capacity is needed now. As we look out toward a possibility of a disruption in Russian fuel supplies, the first link in the chain that needs to be built for ensuring the stability of our LEU supply is conversion, not just for us but for the world. Down in Metropolis, Ill., at ConverDyn, they have plans to restart their facility and I hope they do so at a high capacity, because it will be needed.

What does the DOE need from the nuclear community to make this program a success?

I think we must reach out well beyond our community, especially to potential investors, and reassure them about the promise of nuclear energy. We know that advanced reactors are not only needed, but ready. We know that enrichment technology capable of providing HALEU is not only needed, but ready. We know that we cannot rely on untrustworthy sources of uranium like the Russian Federation, and so we must today increase the robustness of that fuel supply.

We can only do that by reaching out, especially to investors and the financial industry, to get our fuel services in the United States really stood back up and sufficient to support the largest nuclear fleet in the world. The DOE's dollars are not meant to go the whole way—they need to be magnified by private investment. We can communicate how serious this promise is—that it is real, and that it is truly coming.